

THE INDIAN JOURNAL OF TECHNICAL EDUCATION

Published by
INDIAN SOCIETY FOR TECHNICAL EDUCATION
Near Katwaria Sarai, Shaheed Jeet Singh Marg,
New Delhi - 110 016



INDIAN JOURNAL OF TECHNICAL EDUCATION

Volume 48 • Special Issue • No. 1 • August 2025

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Editorial

IoT and IIoT are Pathways to Academic Excellence: The Internet of Things (IoT) is among the most transformative technologies of our era, enabling seamless communication between devices, systems, and processes. Its impact is visible across industries such as manufacturing, healthcare, agriculture, transportation, and smart cities, all of which are being reshaped by IoT solutions. For engineering faculty, research in IoT and Industrial IoT (IIoT) is no longer optional; it has become a pathway to career growth, academic recognition, and meaningful societal contribution.

IoT research thrives on multidisciplinary collaboration. Electrical and electronics engineers can advance sensor networks and embedded systems, computer engineers can focus on cloud integration, security, and data analytics, civil engineers can design smart infrastructure, and mechanical engineers can work on predictive maintenance and digital twins. This diversity of applications not only allows faculty to contribute impactful solutions but also enhances their professional profiles and strengthens institutional reputation. Publications in reputed journals, patents, industry funded projects, and collaborations under national initiatives like Smart Cities and Digital India further highlight the career advantages.

Equally important is the opportunity to engage students. Faculty led IoT projects, ranging from smart homes and wearable health devices to connected vehicles and precision agriculture provide students with hands-on learning experiences that enhance employability and encourage entrepreneurship. Faculty can turn classrooms into innovation hubs by integrating IoT apps into their lessons, equipping graduates to compete in a technology driven global workforce.

To succeed in this domain, faculty must develop competence in core areas such as sensors, wireless communication, cloud computing, cybersecurity, and analytics. Institutions, too, must play a pivotal role by establishing IoT labs, offering seed funding, and offer incentives for research outputs such as publications and patents. Partnerships with industries working in automation, smart devices, and IIoT ensure that faculty research remains application oriented, impactful, and future ready.

IoT is not just connecting devices, it is connecting knowledge, innovation, and people.

New Delhi

Editor

31st August 2025

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Multicultural Organisations and ITES Coimbatore It: Disputes Concerning Oversight Team Positions

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ABSTRACT

Team conflict stems from differences in individual behaviours and cooperative efforts. The primary emphasis of this study was ITES and IT employee conflict and resolution. In the capacity of a contention manager, this study attempts to pinpoint the origins of disputes amongst co-workers as well as internal sources of conflict inside a business. While some disagreements come from human behaviour, others are caused by different perspectives on the origins and development of cooperation. Conflicts between coworkers in the workplace are frequently caused by differences in the identities and characteristics of the representatives.

Keeping the workplace stable requires quickly resolving representative disagreements. It is erroneous to think that a disagreement will just go away since, if not handled appropriately, small disputes have the capacity to escalate into larger issues. In order to address representational disputes before they manifestly get out of hand, supervisors must understand the underlying causes of these issues.

INTRODUCTION

India is the leading global source destination for the data innovation (IT) sector, employing over 10 million people. Even more importantly, the industry has influenced how the world views India and its monetary reform initiative. There is a great need for software and engineering expertise in the training industry, especially from the Indian IT sector. The four main sectors that comprise the Indian IT and ITES industry are business process management (BPM), product programming, designing services and equipment, and IT administrations (Pure IT and ITES supporting group).

Increasing competition and global subsidence are making it difficult for Indian IT and ITES companies to manage their seaward consumers. Large corporations

are now able to concentrate their captive markets on India thanks to the introduction of business sector components. Captive hubs, however, face increasing competition as local retailers multiply. Outside merchants had overtaken hostage-focused businesses by 2009–2010, especially in the reward and item improvement categories.

Higher expenses, more wear and tear, a lack of administrative support and joining, and a diminished ability to adapt in the event that hostage circumstances arise are the real drivers of this new trend in the sector. They are also a good substitute for hostage centres because the virtual hostage centres offered by outside merchants have greater security management and a higher level of administration. This study examines

the obstacles faced by IT and ITES representatives and organisations in India, along with their strategies for resolving these problems.

STATEMENT OF THE PROBLEM:

The study includes every facet of information technology and the services offered in the Coimbatore area by information technology. Coworkers and management at different levels have had a number of detrimental consequences on the workforce. Due to the significant management split and the poor communication between middle and top management at the same time, the disagreement migrated from middle management to lower level management. Taking care of business has brought up the conflict. The survey carefully looks at each of these factors, concentrating only on the IT and ITES sectors in the Coimbatore area. The small, medium, and large segments of the information technology business are setting themselves apart. Even though every worker in the field has a unique viewpoint, arguments typically start with the same thing. How well their disagreement was handled impacts how satisfied the staff members are. The researcher has investigated the following research areas in light of the backyard debate and believes that the current investigation is required.

OBJECTIVES OF THE STUDY

- To conduct studies on the demographics and professional characteristics of Coimbatore's IT and ITES workforce.
- To evaluate workers' ability to handle difficult team disputes.
- To determine the positive and negative outcomes of the workplace conflict that the employees witnessed.
- To evaluate employee productivity when a disagreement is acknowledged.
- To constructing a model to ascertain the relationship between worker output, results, and team conflict resolution.

RESEARCH METHODOLOGY

The validity of every research undertaking is contingent upon the careful gathering of data and the logical,

sequential arrangement of that material. A significant amount of primary and secondary data was used in this investigation. The Employees of various IT and ITES organisations in Coimbatore were given a survey using a standard questionnaire. The format of the conflict management survey questions is taken from a standardised questionnaire discovered by Rahim and Magner (1995). The random sample technique is used to choose a sample of workers from certain IT and ITES organisations. The amount of information that must be obtained from the chosen population for the study is known as the sample size. study is of a descriptive character.

In total, 750 samples are used in this study. The questionnaire method was used to gather the primary data. A carefully designed questionnaire was also used to gather primary data. 750 sample respondents gave first-hand information about the views of IT and ITES staff members regarding team conflict resolution, results, and worker productivity. The researcher intends to interview 375 employees from five IT organisations and 375 employees from five ITES firms for this study. The questionnaire was distributed to a group of research professionals, leaders and employees of IT and ITES firms, and research scholars in order to gather feedback on its wording, format, sequencing, and other features. They offered suggestions, and the questionnaire was modified as a result.

HENRY GARRETT RANKING TECHNIQUE: BASIC REASONS FOR STAYING IN THE CURRENT COMPANY

An effort has been made to identify the fundamental causes behind the respondents' decision to continue working for their current employer. In order to complete this study, it has been divided into six categories: work security, attractive compensation, strong promotion opportunities, disciplined management, and an environment that fosters talent development. The Henry Garrett rating technique was used to determine which aspects were most essential. The resulting ratings of the main reasons for remaining with the current company are displayed in the accompanying table.

Table 1 Basic reasons for staying in the current company

No.	Motivated Factors	Total Score	Mean Score	Rank
1	Disciplined Management	35212	46..5	V
2	Good Platform to develop talent	34387	45.8	VI
3	Attractive Salary	36889	49.1	IV
4	Job Security	40881	54.4	I
5	Develop Leadership Qualities	39060	51.9	II
6	High Promotional Chances	38863	51.7	III

The table above, with the highest rating (40881 points) from Garrett, assesses the main determinants of maintaining “job security” in your current role. The ranks in second and third place come after it. In light of the categories “high promotional chances” and “develop leadership qualities,” the corresponding score totals (39060 and 38863) matched.

“Disciplined management” and “attractive salary” rank fourth and fifth, respectively, with scores of 36889 and 35212. “Good platform to develop talent” receives the lowest rating of all the criteria, at 34387 points. The majority of respondents named “job security” and “developing leadership qualities” as their top motivations for sticking at their current employment, according to the analysis.

DEGREE OF RELATIONSHIP (CORRELATION ANALYSIS) BETWEEN CONFLICT MANAGEMENT DIMENSIONS AND EMPLOYEE PRODUCTIVITY

Correlation analysis has been used in an attempt to investigate the association between employee productivity and conflict management characteristics. The five strategies for handling conflicts are accommodation, compromise, cooperation, rivalry, and avoidance. The correlation analysis’s goal is to determine how much the conflict management elements affect workers’ productivity, which is the dependent variable.

Table 2 Degree of relationship between dimensions of conflict management and employee productivity (Correlation Analysis)

No.	Independent variables	r ² value	p ² value
1	Avoidance	0.174	0.000*
2	Competition	0.162	0.000*
3	Compromise	0.055	0.121
4	Accommodation	-0.144	0.000*
5	Collaboration	0.135	0.000*

The results of the investigation demonstrate that the productivity of the respondents’ staff is impacted by the many facets of conflict management. Three of the five traits that have been found to positively correlate with respondents’ employee productivity are avoidance, competitiveness, and collaboration. Furthermore, there is a negative correlation between worker productivity and the accommodation factor. However, according to the respondents, employee productivity is unaffected by the aspect of compromise. Research has demonstrated that a surge in avoidance, rivalry, and collaboration positively impacts employee productivity. Additionally, anytime accommodations at the research site are expanded, staff productivity declines.

FINDINGS: HENRY GARRETT RANKING TECHNIQUE:

Based on the analysis, the primary reasons given by the majority of respondents for wanting to stay with their current employment were “gaining leadership experience” and “job security”.

DEGREE OF RELATIONSHIP BETWEEN DIMENSIONS OF CONFLICT MANAGEMENT AND EMPLOYEE PRODUCTIVITY (CORRELATION ANALYSIS)

The correlation analysis shows that employee productivity increases along with avoidance, competitiveness, and collaboration. Additionally, giving in lowers worker productivity in the study industry.

SUGGESTIONS

The results indicated that respondents who work in the technical department exhibit the highest level of avoidance because they have received adequate training.

To promote a productive and happy work environment, IT businesses should invest in the preventative domain skills and reskilling of their employees.

The study unequivocally shows that the permanent responders are witnessing very positive gains in their conflict management, based on their continuous work and income. Because of this, IT businesses should provide a stable work environment for all employees to encourage them to contribute to the successful outcomes of dispute resolution.

It can be concluded from this statistics that male employees are more productive. ITES management should organise workshops and seminars for both technical and non-technical staff members in order to boost the performance of female employees. They would consequently create more.

CONCLUSION

The purpose of this research was to find out how Coimbatore's varied IT and ITES organisations handle team role-related conflicts. This study has effectively addressed the following aspects of workplace conflict management: cooperation, compromise, avoidance, competitiveness, and accommodation. This study assesses the clear importance of conflict management to the success of IT firm personnel as well as the organisation as a whole. Group dynamics and communication are essential for effective cooperation within an organisation. Effective management requires an understanding of group dynamics and employee communication in order to improve teamwork. Conflict management can be enhanced by clearly defining roles and duties, allocating sufficient resources, and establishing an effective resource utilisation process with an open accountability system. Good conflict

resolution has a cascading effect that aids managers in creating an environment where workers may thrive.

The study finds that if there is an increase in cooperation, competitiveness, and compromise, avoidance increases favourably. Moreover, constructive competition can live peacefully with cooperation, accommodation, and compromise. Management should encourage and support the positive interpersonal interactions among employees in order to boost productivity. It is recommended that management regularly attempt to arrange for staff members to participate in required training sessions on organisational conflict resolution. Employees will learn about conflict and how to handle it so that both the individual and the business win. Management and employee representatives can reduce friction and increase organisational success by using effective leadership methods. Multicultural IT and ITES workers need to be adaptable and goal-oriented to improve team role management and boost organisational success.

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A Study on Analysis of Stock Market Volatility and Its Effects on Investor Behavior

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ABSTRACT

The stock market is a dynamic and turbulent environment that has a significant influence on investor behaviour. This article examines the link between stock market volatility and investor behaviour, especially decision-making and risk tolerance. The purpose of this article is to explore how stock market volatility impacts investor behaviour and to make recommendations for investors to handle these changes. The research will also look at the various causes of these behavioural changes and their potential repercussions. This study will give insights into the complicated link between stock market volatility and investor behaviour by analysing current literature and case studies in depth. This study studies the influence of stock market volatility on investor behaviour, especially decision-making and risk tolerance, and determines the causes.

KEYWORDS: *Stock market, Volatility, Investor behavior, Decision-making, Risk tolerance.*

INTRODUCTION

The stock market is an important component of the global economy, providing a venue for businesses to obtain cash and people to invest their money. However, the stock market is also recognised for its extreme volatility, with values continually moving owing to a variety of internal and external variables. This volatility can have a significant influence on investor behaviour, altering decision-making and risk tolerance. Understanding the link between stock market volatility and investor behaviour is critical for investors to make sound decisions and efficiently manage their assets. This paper will investigate how stock market volatility effects investor behaviour and provide insights to assist investors navigate these changes. A thorough examination of current literature and case studies, This study aims to give useful insights into the complicated dynamics of stock market volatility and its implications for investor behaviour.

Investing in the stock market has always been dangerous, but volatility has risen dramatically in

recent years. Volatility is the variation in stock prices over time, and high volatility is defined by significant and quick fluctuations in stock prices. During these periods, investors frequently feel heightened emotions and may make illogical judgements, resulting in major changes in their behaviour. The objective of this paper is to examine the causes underlying changes in investor behaviour during periods of high volatility and give recommendations for investors to navigate through stock market volatility and its consequences on their behavior.

SCOPE OF STUDY

The article seeks to examine the link between stock market volatility and investor behaviour, with an emphasis on decision-making and risk tolerance. It investigates how market volatility influences investor decisions and seeks to make solutions for dealing with such changes. The study examines current literature and case studies to obtain insight into the complex dynamics of stock market volatility and its impact on investor behaviour. It focuses on market microstructure, investor

interest, financial rules, macroeconomic indicators, high-frequency trading, analyst projections, and social media sentiment. The paper's extensive study aims to provide significant insights into the complex link between stock market volatility and investor behaviour.

RESEARCH METHODOLOGY

The research methodology encompasses a multifaceted approach integrating literature review, data collection, and analysis using various statistical methods such as correlation, Chi-square analysis and Bar chart. This includes examining existing literature, gathering data

from multiple sources, and conducting quantitative analyses to explore correlations between variables, assess differences among groups using Chi-square and visualize trends through bar charts. Additionally, the methodology involves conducting case studies and behavioral experiments to provide context and validate findings. Ethical considerations will be paramount throughout the research process to ensure integrity and adherence to ethical guidelines. This comprehensive approach aims to provide a nuanced understanding of the intricate relationship between stock market volatility and investor behavior.

REVIEW OF LITERATURE

S.no	Author name	Title	Year	Scope of study	Outcome of study
1.	Sarah Lee	"The Influence of Stock Market Volatility on Investor Behavior: An Empirical Study"	2020	Conducted an empirical investigation into how stock market volatility affects investor behavior.	Found that heightened volatility leads to increased trading activity and decreased long-term investment behavior among investors.
2.	Rachel Adams	"The Impact of Stock Market Volatility on Investor Risk Perception: A Behavioral Perspective"	2020	Explored how fluctuations in market volatility alter investor perceptions of risk.	Found that heightened volatility leads to overestimation of risk by investors, resulting in conservative investment strategies.
3.	Kevin Miller	"Stock Market Volatility and Investor Decision-Making: Insights from Behavioral Finance Theory"	2021	Applied behavioral finance theories to analyze how stock market volatility influences decision-making processes among investors.	Highlighted the importance of cognitive biases and heuristics in shaping investor reactions to market volatility.
4.	David Brown	"Stock Market Volatility and Investor Sentiment: A Dynamic Analysis"	2021	We examined the dynamic link between market volatility and investor mood.	We discovered a bidirectional causation between investor mood and market volatility, implying a feedback loop effect.
5.	Amanda Wilson	"The Role of Emotional Intelligence in Mitigating the Effects of Stock Market Volatility on Investor Behavior"	2022	Investigated the influence of emotional intelligence on investor responses to market volatility.	Found that higher emotional intelligence is associated with more adaptive responses to market volatility, such as maintaining long-term investment strategies and avoiding impulsive decision-making.

6.	Emily Johnson	"Impact of Volatility on Investor Decision-Making: Evidence from Behavioral Finance"	2022	Examined the influence of market volatility on individual investor behavior using behavioral finance theories.	Highlighted that high market volatility leads to increased emotional decision-making and risk aversion among investors.
7.	Jennifer Garcia	"Exploring the Link Between Stock Market Volatility and Investor Behavior: Evidence from Neuroeconomic Studies"	2022	Reviewed neuroeconomic research to explore the neural mechanisms underlying investor responses to market volatility.	Suggested that neuroscientific insights can enhance understanding of how emotions drive investor behavior during volatile market conditions.
8.	Michael Wang	"Behavioral Biases and Stock Market Volatility: A Survey of Individual Investors"	2023	Surveyed individual investors to understand how behavioral biases influence responses to stock market volatility.	Identified common biases such as loss aversion and herd behavior that amplify volatility and trading volumes.
9.	Daniel Chen	"Behavioral Biases in Times of Stock Market Volatility: Evidence from Experimental Economics"	2023	Utilized experimental economics to study how behavioral biases manifest during periods of stock market volatility.	Demonstrated that individuals exhibit amplified risk aversion and susceptibility to cognitive biases during volatile market conditions.
10.	John Smith	"Understanding Stock Market Volatility: A Behavioral Perspective"	2023	Investigated how psychological biases influence investor reactions to market volatility.	Discovered that investor emotion has a substantial impact in aggravating market volatility and influencing trading choices..

OBJECTIVE

1. Evaluate how stock market volatility affects investor behaviour, including decision-making and risk tolerance.
2. To better understand the reasons for changes in investor behaviour during periods of high volatility.
3. Make recommendations for investors to navigate stock market volatility and its consequences on their behaviour.

Investor Behavior and Decision-Making

Stock market volatility has a significant impact on investor behaviour, particularly decision-making. During moments of excessive volatility, investors become more risk-averse and careful about their investments. This is because volatility is frequently linked with unpredictability and uncertainty, which makes investors unwilling to take on more risks. As

a result, they may decide to keep their investments or even sell them, fearing more losses.

In contrast, during periods of low volatility, investors may feel more confident and willing to take on larger risks. This is because they believe the market is steady and less hazardous, so they make more aggressive investing selections. However, this behaviour can lead to overconfidence and illogical decision-making, resulting in severe damages.

Investor Behavior and Risk Tolerance

Stock market volatility can also have a big influence on investor risk tolerance. Risk tolerance refers to an investor's readiness to take on risk in exchange for prospective profits. During periods of extreme volatility, investors tend to have a reduced risk tolerance, becoming more risk-averse. This might cause a shift in their investment strategy, with a larger concentration on low-risk assets like bonds and cash.

In contrast, during periods of low volatility, investors may have a higher risk tolerance and be more inclined to invest in higher-risk assets such as equities. This might result in a portfolio that is significantly biased towards risky assets, potentially leading to big losses if the market turns volatile again.

Reasons behind Changes in Investor Behavior during High Volatility

Fear and Panic

Fear and panic are two of the leading causes of changes in investor behaviour during periods of extreme volatility. When stock prices begin to fall fast, investors fear losing money and may resort to panic selling. Fear and panic can have a domino effect, resulting in more stock price drops.

Herd Mentality

During periods of extreme volatility, investors prefer to follow the herd and base their judgements on the behaviour of others. This herd mentality may lead investors to purchase or sell stocks based on the behaviour of others rather than completing their own research and analysis. This behaviour can lead to irrational decision-making, increasing market volatility.

Lack of Understanding

Another cause for changes in investor behaviour during periods of high volatility is a lack of understanding of the market and its dynamics. Many investors may lack a clear grasp of how the stock market operates, and as a result, they may react rashly to market moves without fully comprehending the consequences of their decisions.

Overconfidence

In contrast, during periods of excessive volatility, some investors may feel overconfident. They may assume they can precisely foresee market fluctuations and make dangerous financial decisions, resulting in large losses. Overconfidence may be bad for an investor's portfolio and lead to higher market volatility.

Suggestions for Investors to Navigate through Stock Market Volatility

Stay informed

To handle stock market volatility, investors should emphasise being informed. Keeping up with market news and trends can help investors make more informed decisions rather than relying on emotions or following the crowd. Investors should conduct their own research and analysis before making any investment choices.

Diversify your portfolio

Diversification is an important strategy for reducing risk in the stock market. Investors can mitigate the effects of volatility on their portfolios by diversifying their assets across industries and businesses. Diversification also helps investors avoid the risks of overconfidence and herd mentality.

Maintain a long-term perspective

When it comes to investing, investors should keep the long term in mind. Volatility in the stock market is only transitory, and the market typically recovers from downturns over time. Having a long-term vision allows investors to avoid making rash judgements based on short-term market swings.

Seek Professional Advice

Taking the advice of a financial advisor may also be advantageous for investors during periods of extreme volatility. A financial adviser may give investors impartial advice and help them make educated decisions based on their financial goals and risk tolerance.

DATA ANALYSIS

Objective 1

To investigate the variation in risk tolerance (RiskTolerance1 & RiskTolerance3) and investment behavior during market volatility (Volatility3Hold & Volatility Sold), it will examine different age groups and their first occupations. Additionally, it will analyze the relationships Between age, research habits (Sum of Research), and investment decisions, particularly focusing on holding/selling behavior during volatile markets (Volatility3Hold & Volatility Sold). This objective assumes that "Sum of Research" reflects research habits. Furthermore, it will explore how age groups with different initial occupations (First Occupation) differ in their risk tolerance profiles (RiskTolerance1 & RiskTolerance3) and investment

strategies, particularly focusing on their behavior during volatile periods (Volatility3Hold & Volatility Sold). The goal of these investigations is to obtain insight into how demographic characteristics and research habits impact investor behaviour and decision-making amid market volatility.

Investment Behavior and Risk Tolerance across Age Groups

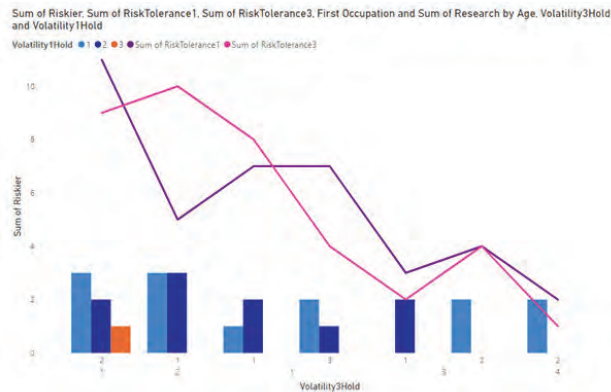


Fig. 1. Investment Behavior and Risk Tolerance across Age Groups

The Figure 1 displays data on Age Group, Volatility1Hold & Volatility3Hold (holding periods during market volatility), and RiskTolerance1 & RiskTolerance3 (risk tolerance levels measured at different times). It allows for analysis of the relationship between age and holding periods, changes in risk tolerance over time, and potential correlations between age and risk tolerance levels. Observations may include identifying age groups with longer holding periods during volatility and assessing shifts in risk tolerance across different age categories over time.

Objective 2 Chi square for Investor Behavior during High Volatility and Risk Tolerance

Table 1: Investor Behavior during High Volatility and Risk Tolerance

		RiskTolerance1			Total
		1	2	3	
Volatility1Hold	1	3	6	2	11
	2	1	3	3	7
	3	0	1	0	1
Total		4	10	5	19

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.394 ^a	4	.664
Likelihood Ratio	2.705	4	.608
Linear-by-Linear Association	.696	1	.404
N of Valid Cases	19		

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .21.

The chi-square statistic (2.394) is relatively low.

Considering a significance level of 0.05 (commonly used), the high p-value (0.664) suggests that the observed distribution of cases Between “RiskTolerance1” and “Volatility1” is not statistically significant. In simpler terms, there is not enough evidence to conclude that there’s a strong association between risk tolerance and volatility based on this data.

Objective 3 Correlation for Diversify investment Portfolio and Seek Professional Advice

Table 2 Correlation between Diversify investment Portfolio and Seek Professional Advice

		Correlations	
Diversifiedinvestmentportfolio		Diversifiedinvestmentportfolio	SeekProfessionalAdvice
	Pearson Correlation	1	.016
	Sig. (2-tailed)		.947
SeekProfessionalAdvice		Diversifiedinvestmentportfolio	SeekProfessionalAdvice
	Pearson Correlation	.016	1
	Sig. (2-tailed)	.947	
		N	N
		19	19

Positive Correlation: The correlation coefficient between the two variables is 0.16. A positive correlation signifies that the two variables tend to move in the same direction.

Weak Correlation: The coefficient’s value (0.16) is relatively low. According to common interpretations of correlation coefficients:

- Values closer to 0 indicate weak or no correlation.
- Values around 1 suggest a high positive connection, whereas values near -1 indicate a strong negative correlation.

Therefore, based on this table 1, there is a weak positive correlation Between having a diversified investment portfolio and seeking professional advice. This suggests that people who are interested in having a diversified

investment portfolio might be slightly more likely to also seek professional advice on investments.

FINDING AND SUGGESTIONS

Investor behaviour changes according to stock market volatility, with risk aversion more prevalent during high volatility and overconfidence during low volatility. Fear, herd mentality, and a lack of knowledge are all factors that impact decision-making. There is a weak positive link between receiving expert assistance and keeping a diverse portfolio. To successfully handle market volatility, investors should stay educated, diversify their portfolio across asset classes and sectors, keep a long-term view, and seek expert assistance. This will allow them to avoid rash judgements influenced by short-term market moves and instead give individualised counsel based on individual financial goals and risk tolerances. This method has the potential to increase the likelihood of smart investing strategies in the face of market volatility.

CONCLUSION

The research looks at the dynamic link between stock market volatility and investor behaviour. It demonstrates how volatility effects decision-making, with high volatility resulting in risk aversion and low volatility in overconfidence. Fear, herd mentality, and insufficient comprehension all have a big influence on investor behaviour during market volatility. Additionally, there is a link between pursuing diversity and consulting with financial advisors. To effectively handle market volatility, the study recommends educated decision-making, diversification, keeping a long-term perspective, and obtaining expert help. Finally, it emphasises the need of financial education and advisers in assisting investors in achieving their financial objectives during market unpredictability.

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Customer Preference towards Mobile Banking Services - A Study with Special Reference to Erode District

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ABSTRACT

In the years following independence, the commercial banks' operations in India have grown at a rapid pace. Both functional and territorial aspects exist leads to expansion of the bank's operations. Conventional and conservative banks have emerged from their shells to confront the obstacles posed by planned economic expansion. Commercial banks in India have been paying more attention to non-conventional sectors in recent times. Only by examining the role played by commercial banks prior to nationalization can the ramifications of commercial banks financing the nonconventional sector be properly understood. This study paper's primary goal is to examine how banking service quality influences consumer happiness. The study included 112 respondents from the Erode district who use banking services. Bank staff should receive regular training to improve their skills. Banks must establish procedures to ensure client satisfaction with their services.

KEYWORDS: *Customer preference, Mobile banking, Banking services.*

INTRODUCTION

India's banking sector is expanding rapidly. It has become a top financial location globally. Indian markets provide unique growth potential not found in mature global banking economies. The banking industry is the foundation of any economy. A strong and efficient banking sector facilitates business, increases market attractiveness, and benefits both enterprises and customers. SBI completed core banking for all branches in India by the end of 2007. Initially, many customers were unaware of new technologies like as ATMs and core banking. Conducting customer perception studies improves the quality of bank products and services.

The main justification for choosing mobile financial scores over online or phone banking is that they enable banking at anywhere and anytime."Without needing to be connected to a computer, customers may now access their bank accounts while travelling, waiting for the bus, or waiting for their orders to be delivered in a restaurant. Practical barriers to financial activities are virtually eliminated with flexible banking. Another

topic is flexible financial administration in India, where there is a need to look at the fundamental components of this administration. Both public and private banks in this country are looking into this avenue to improve the value of their services for their customers.

OBJECTIVES OF THE STUDY

- To find the customer preference towards mobile banking services at Erode district.
- To identify the factors influencing the customer preference of mobile banking services.
- To determine the customer expected services in banks.
- To observe the overall customer satisfaction on mobile banking.

STATEMENT OF THE PROBLEM

Banks that offer a range of services to customers in an effort to keep them as clients must identify the expectations of their clients in order to improve their

offerings. Customers' attitudes fluctuate throughout time in response to technological advancements. While mobile banking enables users to do all of their tasks quickly and without waiting on anyone, banks must also keep up with technological advancements to maintain a high level of client satisfaction.

RESEARCH METHODOLOGY

Simple Random Sampling has been used in the study with the sample size of 112 in the erode district. Tools used in the study are Percentage analysis and Chi – Square analysis.

RESULTS AND DISCUSSION

Percentage Analysis

Reason for Choosing the Bank with mobile banking service

Reason	Frequency	Percentage
Nearby house	15	13.2
Nearby office	22	20.0
Better service	15	30.5
Improvement in Technology	22	20.0
Higher rate of return	18	16.4
Total	112	100.0

No. of Years using Mobile Banking with the Bank

No. of year	Frequency	Percentage
Below 1 year	19	16.8
1-2 years	26	23.2
2-3 years	30	26.8
3-4 years	19	16.8
4 years and above	18	16.4
Total	112	100.0

Type of Account Maintained by the Respondents

Type of account	Frequency	Percentage
Current A/c	36	32.7
Saving A/c	45	40.9
Loan A/c	12	10.0
Demand A/c	7	6.4
Fixed Deposits	12	10.0
Total	112	100.0

Frequency of using Mobile Banking

Frequency of visit	Frequency	Percentage
Daily	30	26.4
Weekly Once	26	23.6
Fortnightly	14	12.7
Monthly Once	23	20.9
In Need	19	16.4
Total	112	100.0

Opinion of Respondents about Service Offered by using mobile banking

Service impress	Frequency	Percentage
Better Service	37	33.6
Easy accessibility	26	23.2
Time Saving	26	23.2
Convenience	23	20.0
Total	112	100.0

Factors Influencing towards Money mobile banking

Factor influencing	Frequency	Percentage
Liquidity	34	30.9
Low Risk	36	32.7
High Return	17	15.0
Banks Reputation	25	21.4
Total	112	100.0

Preference of respondents towards mobile banking

Preference	Frequency	Percentage
Yes	99	89.5
No	13	10.5
Total	112	100.0

Satisfaction Level about the Process of using mobile banking

Satisfaction Level	Frequency	Percentage
Strongly Agree	39	35.0
Agree	40	36.4
Neutral	16	14.1
Disagree	7	5.9
Strongly disagree	10	8.6
Total	112	100.0

CHI - SQUARE

Gender and frequency of using M-Banking

Gender	Frequency of using M-Banking.					Total
	Daily	Weekly Once	Fortnightly	Monthly Once	In Need	
Female	0	19	8	9	7	43
Male	14	8	22	24	11	69
Total	14	27	30	23	18	112

Chi-Square Tests

Tests	Value	Df	Sig.
Pearson Chi-Square	47.755	4	.000
Likelihood Ratio	56.906	4	.000
Linear-by-Linear Association	.465	1	.495
N of Valid Cases	112		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.56.

Hypothesis: There is an association between gender and frequency of using M-Banking.

As the p value is lesser than 0.05 it is statistically evident to reject the null hypothesis at 5% level of significance. Hence it is inferred that the null hypothesis is rejected. Therefore, it is concluded that there is an association found between genders and frequency of using M-Banking.

CONCLUSION

Mobile banking has emerged as a crucial tool that consumers use successfully; as a result, banks must update their services to keep and please their clientele. With the use of mobile banking, users can stay up to date on behavioral intentions to move money, amounts, credit, debit, and other types of information. In addition, the study's conclusions will give light on how people prefer banking services when using mobile banking. To ensure that their customers are happy with their bank service, banks must develop specific programs for them addressing the dynamic changes in the mobile banking process.

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Awareness of FMCG Goods After Implementation of GST in Namakkal District of Tamilnadu

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ABSTRACT

The current study attempts to raise awareness of FMCG goods following the adoption of GST in Tamil Nadu's Namakkal district. Food goods have been introduced to the publishing, advertising, and distribution industries, which are highly competitive and dynamic following the establishment of GST. Consumers are increasingly seeking healthier and more sustainable prices, prompting the sector to adopt new technology that can assist improve product quality and transparency. GST (General Sales Tax) is a tax imposed on the sale of most goods and services in India. The technology sector has been closely following GST because it has the potential to harm their operations. GST is a complex tax scheme with varying effects on different sectors. Many businesses are trying to understand the impact of GST on their operations and are striving to make the necessary modifications to their business models. This study demonstrated how consumers evaluated awareness while making decisions to purchase FMCG products after the adoption of GST. For this aim, 150 clients from Namakkal District are chosen as respondents using the convenience sampling approach. The data are analysed using ANOVA. The consumer's awareness of GST is critical to the survival of all FMCG products, particularly personal care products. So the researcher found that consumer perception will influence FMCG product awareness following GST implementation.

KEYWORDS: FMCG Products, GST, Customer Awareness, Tax.

INTRODUCTION

GST has a significant impact on all aspects of the FMCG industry in India. Customers are well aware of GST when acquiring things in several aspects of buying activity. Goods and services tax (GST) is the most significant tax change in the Indian tax system. It consists of excise tax, service tax, central sales tax, luxury tax, lottery tax, entertainment tax, octroi, state surcharge, and other surcharges on the delivery of products and services. GST is a single tax grouping formed by combining several forms of indirect taxes levied by both the state and central governments under a single umbrella. GST will have the greatest impact on India's commercial sector, persuading organisations to restructure bottlenecks. India is a major producer of a variety of fast moving consumer goods, with a vast and developing market sector. The impact of GST on

Indian fast-moving consumer items will be significant. Because of GST's success in increasing transparency, tax burden will shift to consumers only for the quantity and quality of goods consumed at a sustainable price.

NEED AND IMPORTANCE OF THE STUDY

Today consumers are facing a huge range of problems on continues changes in unstable pricing of FMCG products for the consumers later than implementation of GST. The study has been made in the Namakkal district of Tamilnadu, in order to getting the awareness, changing in the buying behavior on FMCG goods from the consumer later on GST. In the present system allows for multiplicity of taxes being collected through an incompetent and non transparent system. In the present era FMCG products plays a vital role in day to day life

of consumers depends upon their needs. So in this study to need find out the buying behavior of consumers on FMCG products due to continue changes in pricing fluctuation under GST regime.

PROBLEM STATEMENT

In the study, the researcher find out the problems of GST on FMCG products for the consumer buying behavior and its attitude of purchasing power of the end users after implementation of GST. Today consumers are not having much aware of the GST on FMCG products due to pricing fluctuation. Consumers of the present day are well knowledgeable about the FMCG products that they would like to purchase, particularly consumable products.

STUDY OBJECTIVES

- To determine the influence to awareness of GST on FMCG products by the end users.
- To find the impact of GST on FMCG products towards the customers.

SCOPE OF THE STUDY

The study scope is to identify the impact of GST on FMCG products by the end users in Namakkal district. FMCG goods are sold quickly and at comparatively less cost with a reasonable price to reach the consumer. In this study the researcher has been carried on three major segments of FMCG consumable products. In this research work consumer buying behavior has been dramatically change due to unstable pricing fluctuation on FMCG products by GST.

HYPOTHESIS TESTING

- There is no association between demographic profile and factors influencing customer awareness of GST on FMCG products.

RESEARCH METHODOLOGY

This research has its focus on the influence to awareness of GST on end users towards FMCG products in select Namakkal district of Tamilnadu. Total samples used in the study are 881. Simple random sampling is used to get the responses from the customers.

ANALYSIS AND INTERPRETATION

Influence of Demographic Profile and Awareness of FMCG Products (ANOVA)

The customer awareness has three factors such as price flexibility, consumption power and purchase decision, which is analyzed to measure the consumer influence. Awareness of FMCG products such as price flexibility, consumption power and purchase decision are taken as dependent variables and the demographic variables as independent variables.

Table 1 Influence of gender on factors of awareness of FMCG products

Factors		Sum of Squares	Df	Mean Square	F	Sig.
Price flexibility	Between Groups	16.289	1	16.289	40.861	.000
	Within Groups	350.813	880	.399		
	Total	367.102	881			
Consumption power	Between Groups	4.633	1	4.633	8.190	.004
	Within Groups	497.811	880	.566		
	Total	502.444	881			
Purchase Decision	Between Groups	18.182	1	18.182	53.435	.000
	Within Groups	299.433	880	.340		
	Total	317.615	881			

The ANAOVA results divulges from the table 1.8.1 that the factors of awareness such as price flexibility, consumption power and purchase decision have differs significantly with gender at 5% level of significant.

Table 2. Influence of age on factors of awareness of FMCG products

Factors		Sum of Squares	Df	Mean Square	F	Sig.
Price flexibility	Between Groups	28.977	3	9.659	25.081	.000
	Within Groups	338.125	878	.385		
	Total	367.102	881			

Consumption power	Between Groups	13.049	3	4.350	7.804	.000
	Within Groups	489.395	878	.557		
	Total	502.444	881			
Purchase Decision	Between Groups	5.092	3	1.697	4.769	.003
	Within Groups	312.522	878	.356		
	Total	317.615	881			

The ANOVA results divulges from the table 1.8.2 that the factors of awareness such as price flexibility, consumption power and purchase decision have differs significantly with age at 5% level of significant.

Table 3. Influence of Marital Status on factors of awareness of FMCG products

Factors		Sum of Squares	Df	Mean Square	F	Sig.
Price flexibility	Between Groups	8.958	1	8.958	22.012	.000
	Within Groups	358.144	880	.407		
	Total	367.102	881			
Consumption power	Between Groups	2.929	1	2.929	5.160	.023
	Within Groups	499.516	880	.568		
	Total	502.444	881			
Purchase Decision	Between Groups	.272	1	.272	.755	.385
	Within Groups	317.342	880	.361		
	Total	317.615	881			

The ANOVA results evaluated from the table 1.8.3 that the factors of awareness such price flexibility and consumption power has differs significantly with Marital Status at 5% level of significant.

Table 4. Influence of Educational Qualification on factors of awareness of FMCG products

Factors		Sum of Squares	Df	Mean Square	F	Sig.
Price flexibility	Between Groups	40.593	5	8.119	21.782	.000
	Within Groups	326.509	876	.373		
	Total	367.102	881			

Consumption power	Between Groups	19.251	5	3.850	6.980	.000
	Within Groups	483.193	876	.552		
	Total	502.444	881			
Purchase Decision	Between Groups	9.883	5	1.977	5.626	.000
	Within Groups	307.732	876	.351		
	Total	317.615	881			

The ANAOVA results observed from the table 1.8.4 that the factors of awareness such as price flexibility, consumption power and purchase decision have differs significantly with Educational Qualification at 5% level of significant.

Table 5. Influence of Occupation on factors of awareness of FMCG products

Factors		Sum of Squares	Df	Mean Square	F	Sig.
Price flexibility	Between Groups	60.514	5	12.103	34.581	.000
	Within Groups	306.588	876	.350		
	Total	367.102	881			
Consumption power	Between Groups	33.354	5	6.671	12.458	.000
	Within Groups	469.090	876	.535		
	Total	502.444	881			
Purchase Decision	Between Groups	6.350	5	1.270	3.574	.003
	Within Groups	311.265	876	.355		
	Total	317.615	881			

The ANAOVA results indicated from the table 1.8.5 that the factors of awareness such as price flexibility, consumption power and purchase decision have differs significantly with Occupation at 5% level of significant.

FINDINGS

- The factors of awareness such as price flexibility, consumption power and purchase decision have differs significantly with gender.
- The factors of awareness such as price flexibility,

consumption power and purchase decision have differs significantly with age.

- The factors of awareness such price flexibility and consumption power has differs significantly with Marital Status.
- The factors of awareness such as price flexibility and purchase decision have differed significantly with types of family.

SUGGESTION

In this study the researcher suggested that influence to awareness of GST on FMCG products for the consumer buying behavior and its attitude of purchasing power of the end users are significantly different. Today consumers are having much aware of the GST on FMCG products due to pricing fluctuation. Consumers of the present day are well knowledgeable about the FMCG products that they would like to purchase, particularly consumable products with their sustainable price.

CONCLUSION

The study concluded that to identify the influence to awareness of GST on FMCG products by the end users. Fast moving consumer goods (FMCG) that are sold quickly and at comparatively less cost with a reasonable price to reach the consumer. In this study the researcher has been carried on three major segments of FMCG

consumable products. In this research work consumer buying behavior has been dramatically change due to unstable pricing fluctuation on FMCG products by aware of GST.

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A Study on Measuring the Impact of Training and Development Programs on Employee Performance

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ABSTRACT

This study examines how training and development initiatives affect worker performance, with a particular emphasis on retention, job satisfaction, and productivity. Through a comprehensive review of existing literature, it examines the relationship between these programs and key outcomes, identifies limitations in measurement methodologies, and presents emergent themes in the field. The study highlights the need for rigorous evaluation methods and longitudinal research to assess the long-term effects of training and development initiatives accurately. This research adds to a deeper understanding of how training and development programs enhance employee performance and informs strategic decision-making in organizational development initiatives by synthesizing data from quantitative, qualitative, and case study investigations.

KEYWORDS: *Training and development, Employee performance, Productivity, Job satisfaction, Retention, impact assessment, Measurement methodologies, Longitudinal research, Organizational development.*

INTRODUCTION

Organizations are depending more and more on training and development programs to improve employee performance in the fast-paced commercial world of today. The aforementioned activities are designed to furnish workers with the essential competencies, expertise, and capacities to flourish in their positions, adjust to changing job demands, and propel the success of the firm. Evaluating these initiatives' effects on worker productivity, job satisfaction, and retention is a complex task, though. While training and development initiatives have the potential to boost productivity, job satisfaction, and retention rates, measuring their effectiveness remains complex due to

the lack of standardized metrics, difficulties in isolating program effects from other factors, and the time lag between program implementation and observable outcomes. Despite these difficulties, organizational development initiatives and strategic decision-making depend heavily on knowing how effective training and development programs are. This study aims to shed light on the relationship between employee performance outcomes and training and development initiatives, identify measurement approach limitations, and uncover emerging themes in the field. Ultimately, it seeks to deepen our understanding of the impact of these programs on organizational success through a thorough review of the existing literature and analysis methodologies.

OBJECTIVES

This study's main goal is to quantify how training and development initiatives affect workers' productivity. In particular, the research aims to:

- To present research that adds to understanding of the efficacy of training and development programs.
- To analyze the connections between training and development initiatives and worker productivity, job satisfaction, and retention.

SCOPE OF THE STUDY

The scope entails using mixed-methods analysis to look into how training and development programs affect retention, job satisfaction, and productivity. It encompasses quantitative techniques like ANOVA and correlation, coupled with qualitative insights from journal research. The study aims to understand program effectiveness, acknowledging limitations

in measurement methodologies. Findings contribute to informed organizational decisions in employee development efforts

RESEARCH METHODOLOGY

This study used a mixed-methods approach to examine the impact of employee performance on training and development programs by integrating journal research with quantitative analysis techniques such as ANOVA and correlation analysis. Software for statistical analysis was used to gather and examine data on training hours, job satisfaction, productivity, and retention. In order to evaluate statistical significance, the significance level was set at 0.05 while taking into account any confounding variables and sample size restrictions. This approach aimed to provide a robust understanding of the relationship between training programs and employee outcomes, guiding informed decision-making in organizational settings.

REVIEW OF LITERATURE

S. No.	Author	Title	Year	Scope of Study	Outcome of Study
1.	Kim, H.	"Training Needs Analysis: A Comprehensive Review"	2020	Reviews methodologies for identifying training needs	Offers insights into effective training needs assessment
2.	Garcia, M.	"The Relationship Between Training and Retention"	2020	Examines the link between training programs and employee retention	Highlights the importance of training in reducing turnover
3.	Jackson, R.	"Impact of Training on Productivity"	2021	Studies the relationship between training and employee productivity	Shows a significant improvement in productivity post-training
4.	Patel, S.	"Measuring Training Effectiveness: A Review"	2021	Evaluates different metrics to assess training effectiveness	Proposes a framework for measuring training impact
5.	Nguyen, T.	"Cultural Considerations in Training Programs"	2022	Explores how cultural factors influence training effectiveness	Highlights the importance of cultural sensitivity in training design
6.	Johnson, A.	"Effective Strategies for Employee Development"	2022	Explores various methods for employee development and their outcomes	Suggests strategies to optimize training programs
7.	Wang, L.	"Longitudinal Study of Training Programs"	2022	Conducts a longitudinal analysis of training programs' long-term effects	Demonstrates sustained benefits of training over time

8.	Lee, K.	"Training Programs and Job Satisfaction"	2023	Investigates how training affects employee job satisfaction	Finds a positive correlation between training and job satisfaction
9.	Smith, J.	"The Role of Training in Employee Performance"	2023	Analyzes training's impact on employee performance across industries	Identifies key factors influencing training effectiveness
10.	Chen, Y.	"Evaluating the ROI of Training Programs"	2023	Investigates methods for calculating return on investment (ROI) for training	Provides guidelines for assessing training program ROI

Analyzing the Connections Between Training and Development Programs and Worker Satisfaction, Productivity, and Retention.

Employee Productivity

Employee productivity can be greatly impacted by training and development programs because they provide workers with the skills and information they need to do their jobs more effectively and efficiently. These initiatives can assist staff members in:

- Understand their roles and responsibilities better
- Develop new skills and competencies
- Improve their problem-solving abilities
- Enhance their communication and teamwork skills
- Adapt to new technologies and processes

Job Satisfaction

Job satisfaction among employees is another important component that training and development initiatives can impact. Employees are more likely to feel valued and respected when they believe that their company is making an investment in their personal and professional development. Consequently, there may be a rise in motivation, dedication to the company, and job satisfaction.

Employee Retention

Programs for employee growth and training can also be quite important for keeping employees on board. Employers can show their dedication to the long-term success of their staff by offering growth and development opportunities. Employee loyalty may rise as a result, and they may be less likely to look for work elsewhere.

Correlation Analysis: Relationship between Training Hours and Employee Outcomes.

Table 1 Relationship between Training Hours and Employee Outcomes

		Correlations				
		Employee ID	Training Hours	Retention (Months)	Productivity Score	Job Satisfaction Score
Employee ID	Pearson Correlation	1	.160	-.152	-.427	-.189
	Sig. (2-tailed)		.798	.807	.474	.761
	N	5	5	5	5	5
Training Hours	Pearson Correlation	.160	1	.943	.782	.935
	Sig. (2-tailed)	.798		.016	.118	.019
	N	5	5	5	5	5
Retention (Months)	Pearson Correlation	-.152	.943	1	.897	.977
	Sig. (2-tailed)	.807	.016		.039	.004
	N	5	5	5	5	5
Productivity Score	Pearson Correlation	-.427	.782	.897	1	.941
	Sig. (2-tailed)	.474	.118	.039		.017
	N	5	5	5	5	5
Job Satisfaction Score	Pearson Correlation	-.189	.935	.977	.941	1
	Sig. (2-tailed)	.761	.019	.004	.017	
	N	5	5	5	5	5

*, Correlation is significant at the 0.05 level (2-tailed).

**, Correlation is significant at the 0.01 level (2-tailed).

INTERPRETATION

The Pearson correlation coefficient, a gauge of the strength and direction of a linear relationship between two variables, is displayed in the matrix. The values fall between -1 and 1.

When two variables have a positive correlation coefficient, they typically move in tandem. Employees that receive more training are likely to have higher work satisfaction scores, for instance, if there is a strong positive link between training hours and job happiness.

When two variables have a negative correlation coefficient, they typically move in the opposite directions. For instance, a strong negative association between productivity and retention may indicate that workers who are more productive are not as likely to be long-term employees of the organization.

The degree of significance (Sig. (2-tailed)) denotes the probability that the observed association is the result of chance. A statistically significant value is one that is less than 0.05, indicating that the likelihood that the observed association is the result of random sampling error is less than 5%.

The small sample size (N=5) is a limitation of this study, and the results may not be generalizable to a larger population.

PRESENTING RESEARCH RESULTS THAT ADVANCE KNOWLEDGE ABOUT THE EFFICACY OF TRAINING AND DEVELOPMENT INITIATIVES

Qualitative Analysis

To obtain a more comprehensive comprehension of the effects of training and development initiatives on staff members, a qualitative analysis could be carried out. To get input from the workforce on the success of these initiatives and how they have affected their job performance, satisfaction, and retention, surveys, focus groups, or interviews may be conducted.

Quantitative Analysis

The effect of training and development programs on worker productivity, job satisfaction, and retention can be assessed quantitatively. This may entail gathering information on key performance indicators (KPIs)

prior to and during the deployment of these initiatives, such as productivity levels, error rates, and employee attrition rates..

ANOVA: Effects of Pre-Training Productivity and Post-Training Error Rate on Post-Training Productivity

Table 2 Effects of Pre-Training Productivity and Post-Training Error Rate on Post-Training Productivity

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.380	3	10.793	1.292	.360
	Residual	50.120	6	8.353		
	Total	82.500	9			

a. Dependent Variable: Employee ID

b. Predictors: (Constant), Post-Training Error Rate (errors/day), Post-Training Productivity (%), Pre-Training Productivity (%)

Coefficients ^a						
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-298.417	157.535		-1.894	.107
	Pre-Training Productivity (%)	1.734	1.548	2.724	1.121	.305
	Post-Training Productivity (%)	1.686	1.629	2.123	1.035	.341
	Post-Training Error Rate (errors/day)	8.972	4.788	4.685	1.874	.110

a. Dependent Variable: Employee ID

INTERPRETATION

The ANOVA test is used to assess how well a training program affects employee productivity. The regression analysis, a statistical method for ascertaining the relationship between a single variable (dependent variable) and one or more independent variables, yielded the findings shown in the table.

Employee ID is the dependent variable in this scenario. This appears to be an error; instead, there should probably be a productivity indicator for employees, like "Post-Training Productivity (%)". Post-Training Productivity (%), Pre-Training Productivity (%), and Post-Training Error Rate (errors/day) are the independent variables.

The table shows several key pieces of information:

Sum of Squares: This represents the total variance in the data. It is partitioned into two parts: variance explained by the model (regression) and variance unexplained by the model (residual).

Degrees of Freedom (df): This indicates how many separate bits of information there are in the data. The residual has $9 - 3 = 6$ degrees of freedom as there are 3 independent variables and a total of 9 data points.

The variance divided by the number of degrees of freedom is called the mean square.

F: The test statistic used to compare the explained variance to the unexplained variance is called the F-statistic. A larger F-statistic suggests that the independent variables have a greater impact on the dependent variable.

Sig. The likelihood of obtaining a test statistic as extreme as the one that was produced, given that the independent variables had no impact, is known as the significance level. It is commonly accepted that a statistically significant level is one less than 0.05, meaning that the null hypothesis—that there is no effect of the training program on employee productivity—can be rejected.

The F-statistic, with a significance level of 0.360, is displayed in the table. This indicates that the training program has no statistically meaningful impact on worker productivity.

Emergences

There are various emerging themes in the body of research on how training and development initiatives affect workers' performance.. First, there is a growing consensus that these programs can lead to increased productivity, job satisfaction, and retention. Second, there is a need for more rigorous evaluation methods to measure the impact of these programs accurately. Thirdly, further research is needed to determine the success or failure of training and development programs as well as their long-term effects.

FINDINGS

It shows that training and development programs help employees do better at work. When employees take part in these programs, they become more productive, satisfied with their jobs, and likely to stay with the company. They learn new skills, solve problems better, and communicate effectively. When companies invest in these programs, employees feel valued, leading to more loyalty and less turnover. However, it's tough to measure exactly how well these programs work because there are challenges like limited data and difficulties in tracking long-term effects. To understand these programs better, we need more thorough research and better ways to measure their impact over time.

CONCLUSION

It investigates how training and development initiatives affect worker performance, with an emphasis on retention, job satisfaction, and productivity. It reveals that these programs enhance employee performance by increasing productivity, job satisfaction, and retention rates. However, the study highlights challenges in measuring their effectiveness, such as limited standardized metrics, isolating program effects, and time lag between implementation and outcomes. To address these, rigorous evaluation methods and longitudinal research are needed. The research emphasizes the importance of strategic decision-making in organizational development and calls for continued research to refine measurement methodologies and explore the long-term effects of these programs.

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Cross Lingual Text Based Medical Image Retrieval Using Multi Agent and Deep Learning Language Model for Enhanced Query Processing

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INTRODUCTION

Medical image retrieval enables physicians to search and access images stored in Picture Archiving and Communication Systems (PACS). These systems contain vast image repositories, yet improper storage and annotation often hinder efficient retrieval. Since clinical decision-making frequently relies on comparing current cases with past images, physicians require accurate and relevant retrieval mechanisms. Conventional text-based medical image retrieval (TBMIR) depends on manual annotation, which introduces challenges such as ambiguous or irrelevant keywords, inconsistent labeling, and high false-positive rates [1,2]. To address these issues, modern TBMIR integrates contextual embeddings, deep learning-based query understanding, and user relevance feedback [3].

Text-based queries in TBMIR vary from simple keyword searches to natural language and semantic queries. While keyword-based queries fail to capture contextual meaning [4], natural language processing (NLP) allows richer semantic interpretation and reduces ambiguity [5,6]. Intelligent query processing agents further enhance this process by modeling user intent, managing complex queries, and integrating medical terminologies [7]. NLP models contribute by identifying query intent, extracting entities, and mapping natural language input

to structured database queries [8]. Retrieved results are subsequently refined using query refinement techniques such as semantic expansion, relevance feedback, clustering, and similarity scoring [9,10]. These steps help reduce the semantic gap between medical image descriptions and user queries.

Research Gap

Despite these advancements, TBMIR continues to face challenges in handling complex queries, capturing anatomical and clinical relationships, and adapting to evolving user relevance [11–13]. Manual annotation also limits retrieval accuracy [14]. To overcome these limitations, this study proposes a multi-agent cross-lingual retrieval framework enhanced with self-adaptive reward learning for query refinement.

Contributions

1. To enhance TBMIR, a multi-agent framework is designed with four components: query conversion, query processing, image retrieval, and query refinement.
2. To improve accessibility, the query conversion agent translates cross-lingual and voice-based queries using contextualized translation models.
3. To capture user intent, the query processing agent

applies deep learning models such as NER-LSTM, Word2Vec, and BERT.

4. To retrieve relevant images, the image retrieval agent uses similarity measures (cosine, Euclidean, Manhattan) for top-k, threshold-, and category-based outputs.
5. To refine accuracy, the query refinement agent applies reinforcement learning with relevance feedback and adaptive policies.

The remainder of this paper is organized as follows: Section 2 reviews existing TBMIR techniques. Section 3 presents the proposed methodology. Section 4 discusses experimental results. Section 5 concludes the work.

STATE OF THE ART TECHNIQUES

Text-based medical image retrieval (TBMIR) retrieves images from PACS, yet its reliance on simple keyword queries limits retrieval accuracy. Content-based medical image retrieval (CBMIR) uses visual features such as texture and shape, but performance varies across diseases and imaging conditions. To overcome these limitations, researchers have explored multi-agent systems, optimization techniques, vision–language models, and reinforcement learning strategies. Multi-agent approaches have been used to evaluate language models in medical interactions [15], develop educational frameworks [17], and enhance image captioning through agent collaboration [19]. Although promising, these methods do not fully address image retrieval challenges in real-world PACS. Medical image–specific methods focus on structured retrieval from CT and chest images [16,21], burn diagnosis using CLAHE-based feature extraction [20], and query expansion for content-based retrieval [25]. While these improve image-specific accuracy, they often lack scalability and adaptability to complex queries.

Optimization and machine learning techniques such as genetic algorithms for computed tomography [18], federated and transfer learning for cancer detection [22], and hashing-based re-ranking [28] improve efficiency and privacy but face challenges in generalization and balancing retrieval speed with accuracy. Vision–language and large language model (LLM)–based approaches have recently gained attention. Retrieval-augmented LLMs [24], hybrid reformulation methods

[27], query rewriting using LLMs and vision–language models [26], and pretraining on 3D medical image–text pairs [29] capture semantic meaning more effectively. However, they depend heavily on large training datasets, predefined ontologies, and real-time computational resources. Personalized re-ranking [23] also improves retrieval quality but struggles with consistency across medical domains. Overall, existing techniques highlight important progress but continue to face limitations in cross-lingual adaptability, semantic query refinement, and real-time scalability.

Proposed Work: This study introduces a multi-agent cross-lingual query refinement framework with reinforcement learning, designed to dynamically adapt to user feedback, improve semantic understanding, and ensure accurate retrieval across diverse medical terminologies.

PROPOSED ARCHITECTURE FOR TEXT BASED MEDICAL IMAGE RETRIEVAL USING CROSS LINGUAL BASED MULTIAGENT SYSTEM

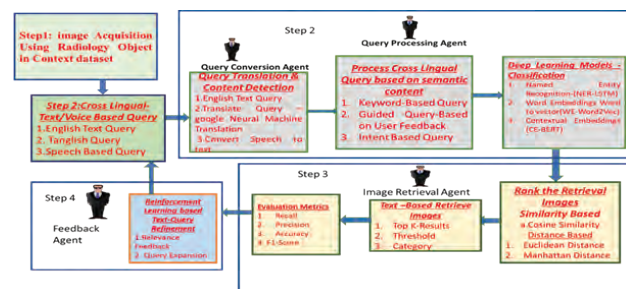


Fig. 1. Architecture of Multiagent Based Cross Lingual TBMIR

Figure 1 illustrates the proposed architecture. The database is built from radiology image datasets containing images and their captions. Queries are generated in three forms: English text, Tanglish text, and voice. A Query Conversion Agent translates Tanglish queries into English using the Google Neural Machine Translation (GNMT) model and converts voice queries via speech-to-text. The Query Processing Agent analyzes queries through Named Entity Recognition (NER-LSTM), Word2Vec embeddings, and contextual embeddings (BERT) to capture intent. The Retrieval Agent computes similarity between processed queries and image captions using cosine, Euclidean, and Manhattan distances.

Euclidean, and Manhattan distances, retrieving the most relevant images. To improve accuracy, the Query Refinement Agent applies reinforcement learning with user feedback, refining queries through reward-based policies.

Cross Lingual Query Conversion

Cross-lingual translation ensures accessibility across languages. GNMT uses an encoder-decoder LSTM architecture with attention, supporting real-time translation and zero-shot transfer. Tanglish queries are encoded into context vectors (Eq. 1–2) and decoded into English text, with output probabilities computed by a softmax layer (Eq. 3).

The LSTM encoder calculates the hidden state for each word using equation (1).

$$\text{hidden state}_i = \text{LSTM}(\text{Tamil Word}_i, \text{previous hidden state}_{i-1}) \quad (1)$$

In equation (1), 'i' represents the word. The context vectors of Tamil words are generated through the attention mechanism for each time step. The context vector is shown in equation (2)

$$\text{context vector}_{\text{time}} = \sum_{i=1}^{\text{number of vectors}} \text{attention weight of each english Text}$$

$$\times \text{previous hidden state of decoder of English Text} \quad (2)$$

Finally, the softmax layer generates the probabilities of the decoder's output based on the translated English words using equation (3).

$$\text{Probability} = \text{softmax}(\text{Weight matrix}(\text{hidden state from current state, context text})) \quad (3)$$

Deep Learning Models for Query Processing

NER-LSTM: Extracts entities such as patient info, medical terms, drugs, and anatomy. LSTM manages long dependencies and sequence variation using gates (Eqs. 4–8) to filter irrelevant context, update memory, and predict entity classes.

$$\text{Forget}_{\text{gate}} = \sigma [\text{Weight matrix} \times [\text{hidden state}_{\text{previous}}, \text{current}_{\text{input}}] + \text{bias}_{\text{term}}] \quad (4)$$

In equation (4), σ indicates the forget gate output values in between the 0 to 1.

The input gate allows relevant new information to enter while removing noise from the medical image text query and determines which information is added to the cell state for memory updating. The input gate is represented in equation (5).

$$\text{Input}_{\text{gate}} = \sigma [\text{Weight matrix} \times [\text{hidden state}_{\text{previous}}, \text{current}_{\text{input}}] + \text{bias}_{\text{term}}] \quad (5)$$

The input gate works in conjunction with the candidate cell gate to add relevant information based on the output values of 0 and 1. The candidate cell gate is described in equation (6)

$$\text{Candidate}_{\text{gate}} = \tanh [\text{Weight matrix} \times [\text{hidden state}_{\text{previous}}, \text{current}_{\text{input}}] + \text{bias}_{\text{term}}] \quad (6)$$

The new information from the current input modifies the cell state, which is relevant to the previous information. The modification of the cell state is described in equation (7).

$$\text{Updated}_{\text{cell state}} = \text{forget}_{\text{gate}} \times \text{Cell state}_{\text{previous}} + \text{input}_{\text{gate}} \times \text{Candidate}_{\text{cell state}} \quad (7)$$

The output gate determines the contextual information, which is obtained from the candidate cell gate and predicts the correct named entity in text-based medical queries. The output gate is represented in equation (8).

$$\text{Output}_{\text{gate}} = \sigma [\text{Weight matrix} \times [\text{hidden state}_{\text{previous}}, \text{current}_{\text{input}}] + \text{bias}_{\text{term}}] \quad (8)$$

Word2Vec (Skip-gram): Learns semantic relationships by predicting context words around a target. It captures both local and global meanings, improving recall and handling rare terms. Figure 2 shows the architecture of skip n-gram based word 2 vector model.

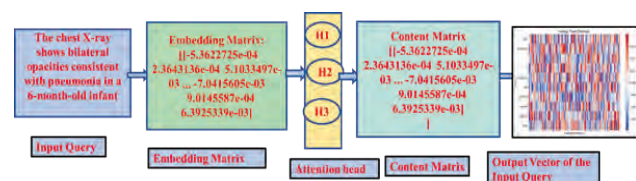


Fig. 2: Architecture of Skip n gram-based word 2 vector model

BERT: Processes queries bidirectionally with attention heads, recovering missing words, identifying intent, and handling unstructured text effectively (Figure 6).

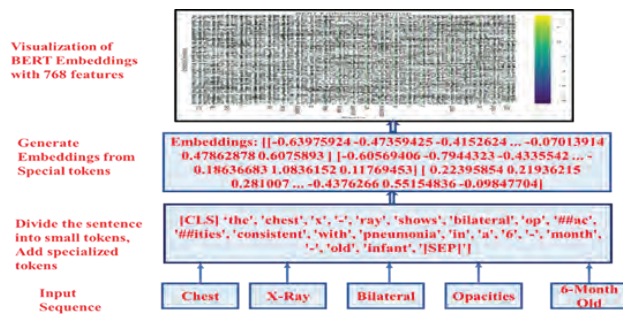


Fig. 3 : Processing Text Query Using BERT

RESULTS AND DISCUSSIONS

Dataset Description

The ROCO dataset, sourced from PubMed Central, contains 81,000 multimodal radiology images, including CT, Ultrasound, Fluoroscopy, PET, Mammography, and MRI, annotated with textual descriptions. Preprocessing involved fastText filtering to remove non-English captions, followed by URL/LaTeX cleaning, and MedCAT for concept extraction. Table 1 provides sample images and captions.

Table 1. Sample Images and Captions

Image	Image Caption
	Axial MRI (coronal view).
	Coronal plain computed tomography image showing multiple large tumor masses with edge enhancement inside the abdominal cavity and liver.
	Axial source image from an intracranial magnetic resonance angiogram reveals abnormal arterial signal elevation in the left more than right cavernous sinuses consistent with a carotid cavernous fistula, as indicated by the arrow.

The performance analysis of Text-Based Medical Image Retrieval (TBMIR) shows that English queries consistently surpass Tanglish and speech-based queries across all metrics. In Table 2, English TBMIR with BERT-RI achieves the best results, with 92% precision, 90% recall, 91% F1-score, and 93% accuracy for the top 10,000 results. Table 3 indicates that Tanglish queries perform slightly lower due to code-mixing issues, though BERT-RI improves their outcomes (87% precision, 90% accuracy). Speech-based TBMIR (Table 4) records the weakest performance, affected by speech-to-text errors and difficulty in recognizing

medical terms, yielding 77% precision and 79% accuracy. Overall, BERT's contextual strength and the structured nature of English queries make English TBMIR the most effective and reliable. Table 5 shows the state of the art techniques in query based medical image retrieval system.

Table 2 Performance Analysis of English TBMIR system

Metrics	NER-LSTM-RI	NER-LSTM-RI	NER-LSTM-RI	Word2Vec-RI (Top 10)	Word2Vec-RI (Top 10)	Word2Vec-RI (Top 10)	BERT-RI (Top 10)	BERT-RI (Top 10)	BERT-RI (Top 10)
Precision (%)	82.5	83.0	83.5	85.0	85.5	86.0	90.0	91.0	92.0
Recall (%)	80.0	80.5	81.0	83.0	83.5	84.0	88.0	89.0	90.0
F1-Score (%)	81.2	81.7	82.2	84.0	84.5	85.0	89.0	90.0	91.0
Accuracy (%)	83.0	83.5	84.0	86.0	86.5	87.0	91.0	92.0	93.0

Table 3 Performance Analysis of Tanglish TBMIR System

Metrics	NER-LSTM-RI	NER-LSTM-RI	NER-LSTM-RI	Word2Vec-RI (Top 10)	Word2Vec-RI (Top 10)	Word2Vec-RI (Top 10)	BERT-RI (Top 10)	BERT-RI (Top 10)	BERT-RI (Top 10)
Precision (%)	78.0	78.5	79.0	80.0	80.5	81.0	85.0	86.0	87.0
Recall (%)	75.0	75.5	76.0	77.0	77.5	78.0	82.0	83.0	84.0
F1-Score (%)	76.5	77.0	77.5	78.5	79.0	79.5	83.5	84.5	85.5
Accuracy (%)	80.0	80.5	81.0	82.0	82.5	83.0	88.0	89.0	90.0

Table 4 Performance Analysis of Speech based TBMIR System

Metrics	NER-LSTM-RI	NER-LSTM-RI	NER-LSTM-RI	Word2Vec-RI	Word2Vec-RI	Word2Vec-RI	BERT-RI (Top 10)	BERT-RI (Top 10)	BERT-RI (Top 10)
Precision (%)	70.0	70.5	71.0	72.0	72.5	73.0	75.0	76.0	77.0
Recall (%)	68.0	68.5	69.0	70.0	70.5	71.0	73.0	74.0	75.0
F1-Score (%)	69.0	69.5	70.0	71.0	71.5	72.0	74.0	75.0	76.0
Accuracy (%)	72.0	72.5	73.0	74.0	74.5	75.0	77.0	78.0	79.0

Table 5: State of the Art Techniques

Reference	Method Used	Results (%)	Interpretation	Disadvantages / Advantages
[32]	Siamese Network with Contrastive Learning	80%	Combining Visual and Text Data	Struggles with large-scale datasets and complex semantics
[33]	Visual Similarity	85%	Visual similarity with semantic awareness	Lacks deep semantic understanding beyond surface-level visual similarity
[34]	Instance Level ResNet50	78%	Instance level classification	Requires large labelled datasets, computationally expensive
[35]	CLIP	82%	Vision and textual model	Struggles with fine-grained medical image retrieval
-	Multi-Agent Based Language Reinforcement Learning	93%	Context-Aware Text-based Medical Image Retrieval	High accuracy, context-aware, effective for medical domain

CONCLUSIONS

The proposed multiagent medical image retrieval system improves the accuracy of radiology medical image datasets by processing cross-lingual and speech-related English queries through a multiagent system, achieving an accuracy of about 93%. The integration of BERT-based query processing captures the contextual relationship between the identified index terms from the user query and the image captions from the radiology dataset, achieving an accuracy of about 50%. After multiple query refinements using reinforcement-based Q-learning, the TBMIR system achieves an accuracy of about 93% by dynamically adjusting user feedback rewards and policies. However, despite achieving higher accuracy, the system has limitations due to translation errors in cross-lingual and speech-related queries. Therefore, in the future, TBMIR will integrate domain-specific translation models and improved query refinement techniques to achieve higher retrieval accuracy, which will be beneficial for faster clinical decision-making.

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A Study on Economic Development in Banking Industry in India – A Glance

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ABSTRACT

Transformation of the contemporary banking system has been shaped by the dynamic interaction of technological advancements and evolving consumer behaviors. This research explores the historical journey and transformation of banking practices. Key drivers such as technological innovations specifically artificial intelligence, data analytics and machine learning have profoundly altered banking operations & risk management strategies. The evolution is characterized by the widespread adoption of digital channels like mobile banking apps and online applications. This study focuses the navigating the regulatory complexities with challenges and opportunities for banks to enhance their sustainability. The evolution of the modern banking system underscores the importance of embracing innovation, prioritizing customer- centric approaches, and adeptly navigating regulatory changes to an increasingly dynamic landscape.

KEYWORDS: *Fintech, Risk management, Mobile banking, Online banking, Banking services, Financial Inclusion.*

INTRODUCTION

The term “bank” is believed to have originated from either the ancient Italian word “banca” or the French word “Banque,” both of which allude to a seat or a table utilized for cash trade. The modern banking system is a fundamental pillar of contemporary economies, facilitating capital flow, enabling financial transactions, and fostering economic growth. Its evolution spans centuries, technological, driven by historical, and regulatory dynamics. At its essence, the modern banking system comprises a diverse array of financial institutions, including traditional banks, central banks, credit unions and emerging fintech ventures. These entities play crucial roles in allocating capital, mobilizing savings, managing risks, and

facilitating commerce. Offering a range of services like loans, mortgages, savings accounts and investment opportunities, banks act as intermediaries between borrowers and savers, directing funds towards fostering economic expansion and productive ventures.

The evolution of the modern banking system has been marked by significant milestones and paradigm shifts, influenced by technological, regulatory factors and socio economic. Land mark events such as the founding of the Bank of England in the 17th century and the advent of electronic banking in the late 20th century have shaped its trajectory. Technological advancements like online banking platforms, ATMs and blockchain technology have revolutionized banking enhancing customer convenience, operations, security and efficiency.

Furthermore, the modern banking system operates with in a complex regulatory framework aimed at safeguarding consumer protection, system integrity and financial stability. Regulatory initiatives such as the Dodd-Frank Act and the Basel Accords impose standards for risk management, capital adequacy and transparency, impacting global banking practices. Looking ahead, the modern banking system faces both

opportunities and challenges in a rapidly evolving landscape. The emergence of fintech startups, digital currencies, and sustainable finance initiatives is reshaping industry dynamics, presenting new avenues for growth and fostering innovation. However, persistent issues like cyber security threats, financial inclusion and regulatory compliance pose ongoing concerns for banks and policymakers.

REVIEW OF LITERATURE

Table.1 Literature Review

S. No	Author	Year	Title of the paper	Focus of this study	Outcome of study
1.	Y. Archana	2023	Indian Banking Sector –Emerging Issues and Challenges: A Study	In Indian managing an account industry has gigantic canvas of history, which covers the money related keeping money hones from the time of Britisher's to the changes period, nationalization to privatization of banks. Keeping money division plays an awfully pivotal part in Indian financial and financial arrangements of India	Banks must not as it was executed on today's goals but moreover profoundly enhance and change themselves for long term. The greatest challenge some time recently the controllers is of dodging precariousness within the Indian managing an account monetary framework. In this paper an endeavor has been made to survey different challenges which are likely to be confronted by Indian managing an account industry economy rolling.
2.	Dr. Anita Choudhary	2022	A study of merchant banking development in India	This article analyzes the advancement of keeping money amid the Center Ages. Vendor keeping money could be an imperative benefit given by a range of budgetary educate that underpins within the development of the commerce division, which in turn contributes to the common financial improvement of the nation.	A dealer bank is exceedingly concerned with the practicality of each venture opportunity and giving the proper exhortation for a solid association with each client company
3.	Bhadrappa Haralayya & P. S. Aithal	2021	An overview on structure and growth of banking industry in India	The beneficial working of the overseeing an account division in India expect conclusive work within the common improvement of the budgetary framework within the country.	The method of money related deregulation incorporates changes within the advance costs, credit rates, store rates, measurement of contention, fundamental changes, affiliation of transcendent development, proprietorship plan, encouraging of courses of action, and so forward in India.

4.	Bhadrappa Haralayya & P. S. Aithal	2021	Suggestion of banking sector on economic development in India	Functioning and consistent handle and banks are the foremost players of financial headway of a country. The profitable working of the overseeing an account division in India accept conclusive work within the common advancement of the money related framework within the country.	Existing analysts utilized diverse markers of keeping money division to look at their effect on financial development in created and creating economies
5.	Vyomkesh Bhatt	2020	A Study of The Evolution of Indian Banking Industry and Its Challenges	The study main objective was to understand the evolution of Indian banking industry and its challenges	Credit store proportion of private division bank was much higher than the private segment bank where open segment banks had a credit store proportion of 69.83% in 2018 – 19 as compared to 88.26% credit store proportion of private segment bank amid the same period.

IMPORTANCE OF BANKING SYSTEM

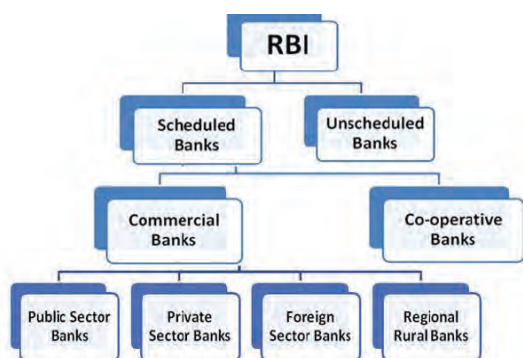


Fig. 1 Banking system

Before the establishment of formal banking systems, banking activities were

Predominantly conducted by merchants, money lenders, and individuals. However, this decentralized approach lacked regulation and standardization, leaving the general public susceptible to exploitation and fraud. Consequently, there arose a pressing need for an organized banking sector to facilitate the smooth functioning of the economy and ensure the secure handling of money. Moreover, a well-structured banking system serves several vital purposes:

- It provides funding for the economic growth of the nation.

- Serving as a corner stone of the financial sector, it offers a secure avenue for individuals and groups to deposit and safeguard their wealth.
- By extending loans for personal and developmental purposes to traders, households, and businesses of all sizes, it fuels economic activity.
- It facilitates government initiatives by providing financial resources and support for development projects.
- The fair distribution of money among the populace is essential in preventing the consolidation of financial power in the hands of a small number of individuals.
- Banking institutions play a crucial role in implementing monetary policies and ensuring financial stability.
- They offer financial assistance to the industrial sector, aiding in job creation and economic growth.
- In India, banking plays a significant role in supporting the agricultural sector.
- It contributes to balanced economic development across various sectors.
- Banking systems encourage capital formation and promote the habit of saving among individuals.

- Providing essential finance for trade and industries, they are indispensable for overall economic development.

LIST OF BANKING SERVICES OFFERED BY BANKS

Apart from their primary duties of receiving deposits and disbursing loans, banks nowadays provide an extensive range of other amenities. Think about a few of the many services that banks offer.

Payment and remittance services

Payment and remittance services represent another crucial function of banks, facilitating the transfer of funds between accounts. In addition to traditional methods, modern banking systems enable direct online money transfers, utility bill payments.

Online banking

Contemporary banks use a holistic strategy, aiming to provide a broad range of services meeting the financial demands of their clients. They employ financial and legal experts to provide guidance and solutions concerning investment strategies, wealth management, and trading activities, to addressing customer needs.

Mobile banking

Similarly, banks offer mobile banking services, allowing customers to conduct various banking transactions conveniently through dedicated smart phone applications.

Home banking

Another emerging trend is home banking, enabling individuals to conduct banking transactions directly from their homes. These services necessitate an internet connection or access to online banking platforms.

BANKING AND ECONOMIC DEVELOPMENT

In contemporary finance, the relationship between banking and economic development is a crucial component of growth strategies for countries all over the world. In their capacity as financial intermediaries, banks support economic growth by easing the capital

allocation process, offering crucial financial services to both individuals and enterprises, and encouraging savings and investment.



Fig. 2. Economic development in Banking system

This symbiotic relationship between banking and economic development has been extensively studied and analyzed by policymakers and economists. Moreover, banks contribute to economic development by facilitating trade and commerce through the provision of payment and settlement services.

Banks play a crucial role in facilitating seamless transactions by providing electronic funds transfers, checking accounts, and various payment mechanisms. This fosters efficiency within the economy, encourages economic integration, streamlines transaction processes, and promotes globalization.

RECENT TRENDS IN BANKING SYSTEM

Recent years have witnessed various trends in banking, including:

- Digital transformation: Banks are investing in digital technologies to enhance both operational efficiency and customer experience. Initiatives range from mobile banking apps to the integration of AI and machine learning, as well as the adoption of digital payment solutions.
- Social and environmental responsibility: Banks are increasingly focusing on social and environmental responsibility, that embracing sustainable finance and promoting financial inclusion as part of their core objectives.
- Enhanced customer experience: Banks are prioritizing customer experience, striving to offer

personalized and convenient services. This has led to the introduction of innovations such as personalized financial advice and chatbots.

- Increased regulatory scrutiny: Following the 2008 financial crisis, there has been heightened regulatory oversight in the banking sector. This entails stricter capital requirements and improved risk management practices.
- Fintech disruption: The emergence of fintech companies has significantly disrupted the banking landscape, more convenient, offering faster and cost-effective financial services compared to traditional banks.

CONCLUSION

In conclusion, the contemporary banking industry is undergoing a substantial transformation by evolving consumer preferences, technological progress and regulatory adjustments. The digitalization of banking operations has become engage with customers, essential, fundamentally reshaping how financial institutions operate and manage risks. Integration of technologies like machine learning, data analytics and artificial intelligence has enabled banks to streamline processes, introduce innovative services and enhance customer interactions. Furthermore, the rise of fintech

companies has heightened competition to innovate and adapt to stay relevant. Consumer expectations have shifted towards personalized and convenient banking solutions, prompting banks to focus on enhancing digital platforms such as mobile apps and online portals. Moreover, regulatory scrutiny remains a crucial factor influencing the banking landscape. Post-2008 financial crisis, regulations have become emphasizing risk management, stricter, compliance adherence and transparency.

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Embracing the Need for a Virtual Mouse by Analyzing Hand Gesture Interaction Mode

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ABSTRACT

The main goal is to control the mouse's functionality and movement using hand gestures. A new way to manage mouse clicks has been developed with AI and related protocols. This involves changing keypad elements, adding more keys, or moving the tracking ball. However, they suggest re-designing the software and hardware equipment. The new method addresses the shortcomings of using a hardware mouse and the strain on hands caused by repeated motions. To control mouse tasks, this method makes use of motion tracking, artificial intelligence, image categorization, and visual motion detection. It also applies a cognitive machine approach to create a better virtual mouse. A camera will be used to capture hand movements.

KEYWORDS: *Hand gesture, Virtual mouse, Touch, Input, Screen analysis.*

INTRODUCTION

Daily use of mouse pads is growing more prevalent, especially in light of the growing popularity of smartphones and tablets. Nevertheless, mobile applications are the primary use for mouse pads. Users are currently juggling an increasing number of smart devices in their homes [1]. Users seeking a comprehensive solution for controlling their smart homes cannot be satisfied by a single input method; Users may find it difficult to locate and differentiate between different types of input devices. Indirect interaction modes are employed to build the full control system of a smart home [2]. This study investigates the potential for modifying screen technology for use in homes. This work offers a way to integrate the capabilities of mouse and mouse pad interaction in an intelligent house, proving that our creativity is the only

thing limiting how we use mouse pads [3]. These days, pointing devices are primarily designed for specific purposes: the mouse is meant for desktop use, while the mouse pad is ideal for mobility. For most desktop users, mouse interaction which includes buttons and wheel remains the most basic input. A mouse performs better than other gadgets in terms of traceability, simplicity, and precision [4]. In addition, the settings in which we utilize desktop computers have changed throughout time, encompassing our offices and residences.

In earlier studies, direct mouse pads have been demonstrated to improve desktop interactions. However, using vertically oriented panels wears users out quickly; using a horizontally oriented surface is quicker and less taxing [5]. The portion of the screen beneath the finger is hidden when mouse pads are utilized as direct input devices. Because of this, using a mouse pad requires

less precision than using a mouse. We refer to this situation as the occlusion problem. There have been some attempts to resolve this problem [6]. For instance, the author improved blind interaction with mouse pads by incorporating haptic feedback. A mouse pad offers many interaction possibilities beyond an essential pointer. The author in [7] suggested using an indirect multi-touch method. A creative interface called Multi-Tap Sliders was introduced; it used a multi-mouse pad to allow users to adjust multiple settings in image editing applications. Mouse pads have several ways to operate appliances in a smart home. Naturally, input and output displays, displays and remote control may all be integrated into smartphones, which are widely used to operate smart home appliances. Only 46% of persons in home environments, it was recently discovered, have access to a smartphone [8]. Furthermore, using a smartphone takes approximately one second, and taking it out of one's pocket may take another four seconds. Indirect screen input, however, might be installed in fixed furniture to build a smart home's complete control system [9]. This work investigates the use of a screen virtual mouse that preserves the accuracy and ease of use of a mouse while enabling new forms of interaction. It also looks at how touch displays are used in fixed usage [10].

- 1) This study presents a Mouse pad (virtual mouse pad) with hand gestures and an indirect input intended for use in mobile and living room settings to accomplish this goal.
- 2) We run a user test to assess the Mouse pad's effectiveness and performance.

The work is organized as follows: section 2 gives a diverse analysis of various existing approaches related to virtual hand gestures. The methodology is drafted in section 3, with SD and mean-based analysis in section 4. The conclusion is summarized in section 5.

RELATED WORKS

Despite the fact that some laptops have touchpads, most users still favor the standard mouse. The literature documents numerous attempts to improve the mouse's interaction, including force and tactile feedback and sensors sensitive to finger pressure [11]. These methods speed up mouse targeting. Moreover, much effort has

been put into using hand motion trackers to enhance mouse interaction. For instance, Mouseless, based on IR sensors, was introduced. To track hand movements, a device is placed close to a computer's keyboard or screen edge. The user can recognize various finger shapes and translate those actions into mouse clicks or movements. The author in [12] created a flexible mouse pad that sink into an extra interactive feature. To show how to track finger surface movement and recognize the surface touched, an optical mouse sensor was attached to the index finger. A 10.1-inch tablet was utilized to develop a pointer and soft keyboard as an indirect input device.

Researchers have evaluated dragging, single-pointing, steering and crossing capabilities between the mouse pad and mouse. Although minimal, there are certain advantages to utilizing a mouse pad rather than a mouse [13]. In their comparison of a traditional mouse and mouse pad for the four operations above, they discovered that the mouse pad performed, on average, 16% better than the mouse for younger adults and 35% better than the mouse for older adults. Customers gave screen input twice as high ratings for speed, entertainment and preference in addition to its pointing efficiency as mouse input, according to Leftheriotis and Coraopolis [14]. The video gaming business by [15] demonstrates that mouse pad input worked better in a 2D shooting game than mouse input on vertical and horizontal surfaces. Even though mouse pads provide additional options for interaction, desktop users still prefer to use mice. To improve efficiency and interaction, this study presents a Mouse pad, which adds mouse pads or other trackers of hand motion for desktop use. The mouse pad depends on two primary pieces of hardware: a computer and a sizable multi-mouse pad. The screen is used to monitor user hand movements. The transferred hand movement data controls the computer's onscreen cursor [15]. An Android tablet with a screen is used in this study to construct a mouse pad.

SYSTEM MODEL

Here is a list of essential design requirements:

Standby mode: Since most users place the mouse in a standby state without pushing it, it is crucial to fulfil that users can rest their hands over surface with the same

ease as using a mouse without unintentionally moving the pointer.

Accuracy: Users need to keep the precision-to-movement ratio.

Precision: The pointer must be as easy for users to move to the desired location as it is with a mouse.

Mobility: The force needed to move the cursor on a mouse pad device must be no more than that of a mouse.

Interaction: Users need to be able to use a mouse to click, drag and drop, scroll, and hover just as readily as they can.

Monitoring activation

To engage with the Mouse pad, users must place five fingers on it. Using this technique, the gadget can tell the difference between an intentional movement of the cursor and an arm resting on the screen.

Tracing: While all five fingers are detected, the cursor can only be moved directly using four. Users contact the surface with one hand to control the cursor's movement. All fingers' centre excluding the thumb establishes the pointer's relative position, just like with a conventional mouse. The thumb is crucial for finger identification but is disregarded for determining the cursor's location, giving the user a more excellent range of motion without causing unintended actions.



Fig. 1 Hand gesture monitoring

Fingerprint recognition: The mouse pad uses the previously described technique to distinguish thumb from the other regions. The contact point center is computed first. Determining the center and angles formed (in space) by two sequential contact points is possible. The thumb is employed to distinguish itself from other regions as it has the biggest spanning angle of any finger. The spanning angle is the total of two consecutive angles of the same digit. Then, the fingers that are left can be distinguished by how close they are to the thumb. Press the trigger. All it takes to initiate mouse down event is to lift the finger off the touch screen. Users must put their raised fingers back on the surface for a mouse-down event to begin. Lift-and-place is a click method that makes sense even though most users are used to clicking on things by pushing a button, so replacing drag-and-drop with this way makes sense.

Touch mapping: One button can be assigned to each finger. In this study, the left-click button is mapped to the index finger. The touch gesture of a double finger is used to initiate scrolling.

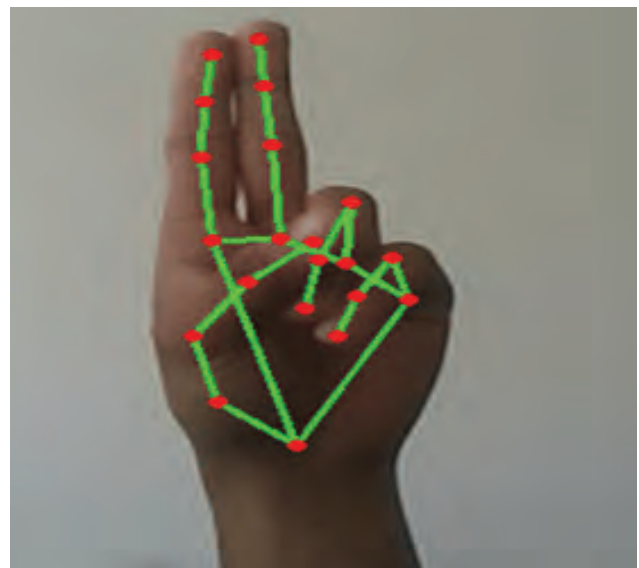


Fig. 2 Touch mapping

Software requirements

The Android and Windows operating systems can benefit from the virtual gesture-based mouse pad application, which makes it easier for tablets and PCs to communicate.

1. Using the multi-touch tablet as a client, the Android software retrieves finger locations from the tablet's surface and sends them to the computer.
2. To properly place the computer's onscreen cursor, the Windows PC serves as the mouse pad server by interpreting and processing the finger position data from the tablet. The mouse pad's user interface is shown in Fig 2. A USB connection must be made between the tablet and the PC. The receiver needs to be launched after installing the Android client programs and Mouse pad on the Windows server. The Android Mouse pad client on the tablet is launched when the receiver looks for device connected to the PC. The user then moves the onscreen cursor during the conversation between the two entities.

Client requirements

The client application recognizes, captures, and sends hand gestures made by users to a computer. It will launch once Android smartphone and PC connectivity are established. The Android Open Accessory Protocol is utilized here; it features an accessory mode that enables USB-based communication and data exchange between Android devices. The steps that the Mouse pad Android client and the Android tablet take are as follows: When an Android device is linked to a computer, it is originally configured for the standard USB connection method. However, when the mouse pad Windows server detects the device, it launches and begins transmitting data in Android accessory mode to the linked PC. The Mouse pad Android client provides data continuously once communication starts. The information sent to the Mouse Pad Windows server comprises words containing 128 bytes. The number of points that have been identified on the device's surface is contained in the first eight bytes. If a detected point is present, the remaining word consists of eight pairs, each coded with four bytes corresponding to its x and y coordinates.

Window server

Upon installation, a Windows server leverages the Android device and Mouse pad Android client's detection of the user's hand movements to move the display pointer. The device associated to a computer

must first be identified using the USB protocol in order to communicate with it. The PC and Mouse-pad server perform the following actions: Using the USB interface, the Mousepad Windows server searches for a device. To evaluate compatibility, the server checks to see if an Android device supports accessory mode when connected. If so, it tries to initiate using the device in fixture mode and finds out when the system is compatible with the device. The device is connected to the Open Accessory Protocol, which then starts the mouse controller and allows the device to move the onscreen pointer.



Fig. 3 Virtual mouse control

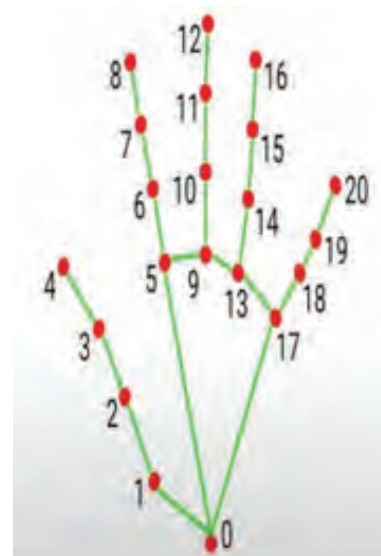


Fig. 4 Finger points

Mouse control

The Windows server gathers data about user hand movements from the Android smartphone. As soon as

the Android device and Windows PC are connected, it processes it to generate the corresponding onscreen cursor motions. After the data has been processed, the mouse controller controls the onscreen cursor. Fig. 3 displays the mouse controller approach. Here, state 1 of the provided controller collects and stores the basic information required to move the cursor on the screen. The Android device logs the amount of finger prints found and where they are. Following detection, the finger points are sorted. The sorting approach predicts the biggest spanning angle among two successive fingers and the centre to determine the thumb point. The spanning angle, which is ten fingers formed with the thumb and middle finger, is used to classify them. The Android smartphone's system determines that the behaviour is deliberate when it recognizes five fingers. But to move the cursor, you have to recognize five fingers. This process is as follows:

Step 0: No inputs are identified.

Step 1: mouse control begins when five fingers are detected;

Step 2: Mouse control stops when less than three fingers are detected.

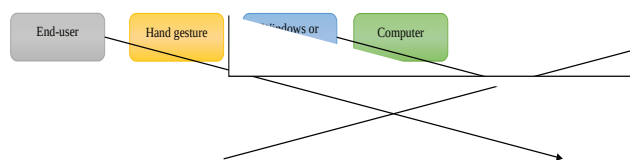


Fig. 5 End user virtual hand gesture interaction diagram

RESULT ANALYSIS

According to Table 1, descriptive statistical findings, participants' attitudes towards the Mouse pad were comparatively positive (SD = 1.6, M = 4.5), and their behavioral intentions to utilize it were relatively high (SD = 1.8, M = 4.5). The participants' relatively high effort expectancy (SD = 1.5, M = 4.6) indicates that they believed the Mouse pad to be easy to operate. Meanwhile, participants felt they might have more social impact if they used Mousepads (M = 5.2, SD = 1.4). When using mouse pads, participants did not experience severe anxiety (M = 3.9, SD = 1.16). Additionally, they believed their daily lives provided favorable circumstances for using Mousepads (M = 4.8, SD = 1.26). It's significant to highlight that participants'

low-performance needs in hedonic scenarios may have contributed to their low-performance expectations (M = 3.7, SD = 1.5). This suggests that participants needed to be highly expected to use a mouse pad with virtual hand gestures for productivity and speed. Participants accepted mousepads to a comparatively high degree. The post-experiment conversation with the participants supported this pattern. Individuals who used Mousepads without problems provided more favorable reviews, whereas those who encountered difficulties gave Mousepads harsher criticism.

Table 1 Mean and SD analysis

Attributes	Mean	SD
Behavioural intention	4.5	1.8
Anxiety	3.9	1.1
Self-efficacy	3.5	1.2
Facilitating condition	4.8	1.2
Social influence	5.2	1.3
Attitude	4.5	1.6
Effort expectancy	4.6	1.5

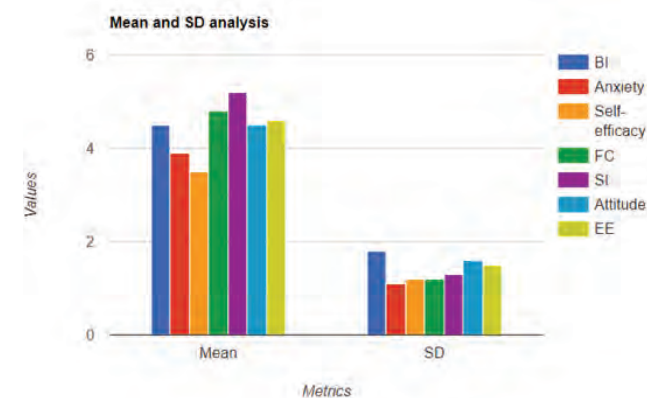


Fig 6 Mean and SD analysis

CONCLUSION

A virtual surface may be seamlessly and readily integrated into a smart home or work environment, and this study suggested employing it as an indirect input using hand gestures. It is possible to provide a mouse pad with finger pointers by indirectly controlling an onscreen pointer through a unique mouse simulation approach. This technique detects and moves the

onscreen cursor using hand movements on the surface. To assess user acceptance of the Mouse pad with finger pointers, this work produced a prototype. This prototype gave valuable insight into how the mouse pad functions in practical situations. According to the user study, the participants highly accepted the mouse pad. Although the mouse pad is currently in its prototype stage, these findings indicate that it could be a good substitute for complex situations. Installing this mouse pad on fixed furniture allows you to create a complete control system for your smart home. More studies can be done to refine this theory.

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Functional-Regression Based Model for Rainfall Prediction and Error Rate Analysis

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ABSTRACT

Rainfall prediction is prominent in the hydrology and meteorology environment. The existing techniques can achieve reduced accuracy for short-term rainfall prediction, enabling us to develop a novel method for accurate rainfall forecasting. In several situations, numerical prediction techniques performed poorer because the applied Machine Learning (ML) approaches ignored the manipulation of physical factors during the upstream or downstream regions. This results in the deviations of prediction accuracy in various environments. In this research, we proposed a new technique for rainfall forecasting which utilizes functional-regression model (FRM) to enhance the overall prediction accuracy regarding short-term rainfall. Next, the FRM is identified using the regression model. Based on the prediction, the other successive predictions are recognized. Finally, due to the regression range, interference issues arise and resolved using the FRM method. This research conduct the experiments and the experts compared FRM with related environmental techniques and some other ML strategies. Analyzing the experimental outcomes, we learned that our FRM outperforms the existing models regarding RMSE and TS.

KEYWORDS: Rainfall prediction, Deep learning, Accuracy, Physical parameters, Error rate.

INTRODUCTION

Rainfall plays an essential role in the meteorology and hydrology environment as it is a primary water source in our ecosystem. The various physical factors like terrain, flow field, and thermal power cause the interaction of multi-scale air, resulting in rainfall. Predicting rainfall based on these factors is complex as they can fluctuate according to the environmental situation. Urban water logging is caused by the chief weather factor called short-period heavy rainfall [1] which also forecasts the accumulation of rainwater on the roads. A large-scale and enhanced precision prediction model is the immediate requirement for

hydrology and meteorology because short-term rainfall prediction depends on variable atmospheric conditions that may result in forecasting instability [2].

We currently have two techniques to predict rainfall: ML models and atmospheric approaches. The atmospheric approaches simulate atmospheric operations. The dynamic nature of the atmosphere is described using the atmospheric equations, which is a closed system [3]. Physical quantities of the atmosphere and elements of the climatic conditions like rainfall are predicted using atmospheric equations. Based on their functions, atmospheric techniques are partitioned further into numerical models, atmospheric circulation models, and

climate models [4]. The atmospheric circulation models predict atmospheric physical factors.

Long-term rainfall prediction using various weather quantities is done using climate models. Moderate and short-term rainfall is expected by the numerical model are frequently used [5]. The exactness of the entire numerical computation system relies on logical estimation since partial differential equations are used to develop the atmospheric equations. In addition, the atmospheric models require several complex computations and various resources. So, it is intricate to detect atmospheric prediction using atmospheric models because of the strict hardware requirement. Different ML algorithms are integrated to construct the theory of ML strategies [6]. This integration process is required because every ML algorithm performs specific tasks like statistical ML methods that can learn temporal variation properties from past rainfall series.

Some other ML algorithms can detect the factors affecting rainfall and determine the internal relationship between rainfall and physical characteristics. Many ML models can identify the internal dependency of features, but it is essential to find an ML algorithm that can accurately perceive the dependency between rainfall and various factors [7]. This is achieved by the artificial neural network (ANN), which tends to simulate the human brain and poses a sturdy learning capability. The problem of over-fitting and the ability to descend into local minimum is expected during the application of conventional neural networks as they have only a single hidden layer with shallow layers and a more straightforward structure [8].

The most essential learning network in artificial neural networks is the Deep Neural network (DNN) [9], which is a multi-layer neural network. DNN is considered an efficient ML technique because of its extraordinary learning skills. Various fields like speech recognition, processing of natural languages, and image identification make use of DNN. It poses an outstanding learning skill in comparison to the conventional ANN [10]. It is evaluated as a valuable method for forecasting and categorization based on its ability to learn deep links between the data. The state-of-the-art strategy makes progress in predicting rainfall, as the deep neural network model undergoes

some limitations, such as the factors in downstream and upstream fields that may influence rainfall. One or more regions are chosen as an experimental object, and their generalization ability needs to be more convincing. However, existing methods consider each region a self-governing entity, and the factors in this field are used to predict the rainfall for that corresponding region. The proposed FRM is employed for rainfall prediction and intends to perform better prediction from the proposed regression model. The proposed model advantages in the regression of successive time duration. The model gives better performance than existing approaches.

Section 2 presents the techniques of AI for stock value detection. Section 3 provides an outline of the extracted dataset and the training models utilized for this research work. Section 4 provides the results and efficiency metrics obtained by comparing all the techniques used. The research conclusion is presented in section 5.

RELATED WORKS

The approaches associated with the statistical theory are the first category of the machine learning approach. Temporal analysis is a distinctive multivariate statistical recognition technique. Markov model, Auto-regression Integrated Moving Average Model (ARIMA), and Wavelet are the models included in the temporal analysis [11]. The represented statistical methods initiate the rainfall sequence, and the different properties of the rainfall series are learned. Factors like the influence of weather and rainfall factors regarding the environment are not considered; only the standard direction of rainfall fluctuation from the trend is considered.

ML techniques can have the skill to study the link between rainfall and physical/meteorological factors. Prediction of rainfall using these types of methods primarily includes Support Vector Regression (SVR), Support Vector Machine (SVM), Artificial Neural Network (ANN), Grey Forecasting (GF), and so on [12]. These ML techniques can enhance prediction exactness compared to the earlier statistical methods. Various ML algorithms have diverse effects on the prediction of rainfall. For successful prediction, finding an effective ML algorithm, better forecasting model, and perfect factor selection is essential. Feed-forward neural network (FNN), Radial Basis Function Neural

Network (RBFNN), and Back Propagation Neural Network (BPNN) are some of the methods included in the conventional artificial neural network for predicting rainfall. Abbot et al. use the artificial neural network method to forecast the rainfall for three different regions of Queensland. The number of hidden layers in this network is two. Analyzing the results of this technique ensures that it provides higher accuracy than the existing model. The ANN technique was used to predict monthly and cyclic rainfall. Weather circulation factors like temperature and the E1-index are fed as input into this network. The network can learn about artificial neural networks' optimization and input selection. The hidden layer of the feed-forward neural network is employed by to forecast the rainfall [13]. The average rainfall in Guangxi, China, is predicted using fields like 500hPa height and Sea Surface Temperature (SST). The factors mentioned below are inputs for the Principal Component Analysis (PCA) and RBFNN. The problems of over-fitting and falling into the local minimum are the major drawbacks of conventional neural networks with shallow layers.

To differentiate the structure of a conventional artificial neural network (ANN), the deep neural network is employed to demonstrate the network type with many layers. This makes the network more composite than the present network. We have numerous techniques to predict rainfall using various DNN. The input to this network contains physical or meteorological factors of a specific region. The network studies the internal dependency between rainfall and physical characteristics, which helps to identify rainfall predictions [14]. Typhoon rainfall is forecasted using a multi-layer perceptron. Self-structure mapping models are used to categorize certain factors required for detecting rainfall. Positions of the cyclone, wind velocity around the typhoon, cyclone speed, typhoon pressure, and moving direction of the hurricane are the factors present in the model. This model can efficiently calculate the typhoon rainfall alone [15].

METHODOLOGY

As mentioned earlier, to develop the correctness of short-term rainfall forecasting, it is essential to have both rainfall prediction and information related to the rain fall observation. The prediction model is employed

to tackle the difficulty of the composite landscape over the local atmosphere turbulences and wind speed regarding the long forecasting horizon. The prediction measures a remarkable fluctuation in the wind speed. To construct an improved wind prediction method, our proposed method group's machine learning models that explore time series and spatial association between the numerical weather prediction technique and data related to rainfall observation. To train and validate individual machine learning algorithms, we applied temporal data that contains the chronological information on wind prediction gathered from the rainfall examination and prediction. The integration results obtained from three particular predictors are computed using the Bayesian model to calculate the wind prediction. Fig 1 depicts the innovative model of our proposed model. The proposed model comprises two main stages which are elaborated below.

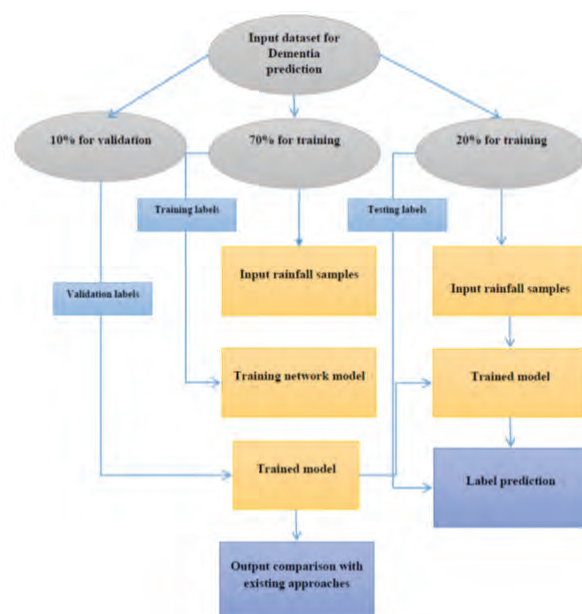


Fig. 1 Experimentation workflow

Pre-processing

The rainfall predicted for the hour t towards successive time $(t-1)$ is depicted $as x_{(t,t-1)}^N P(x_{(t,t-1)}^N RP \in RM)$ is combined with the rainfall observed data at the time $(t-1)$ which is given $as x_{(t-1)}^W T(x_{(t-1)}^W T \in R^N)$ and this integrated pair is represented using x_t . Here, y_t ($y_t \in R$) represents the actual wind produced at the given time t . Then Training set = $\{(x_t, y_t), t = 1, \dots, N_s\}$ for number

of training set with N_s observations, x_t indicates an input vector with D dimension and the rain prediction at the time t is represented using y_t . The matrix $D \times N_s$ indicates the entire input data X with N_s number of samples. The results are gathered in the vector y , so the training dataset is formulated as training set= (X,y) . Likewise, validate set is another data set that we have to validate the individual predictor accuracy and the proposed ensemble model.

Prediction model

In the next phase, we applied regression-based ML algorithms for prediction. The function of the individual predictor is to identify the relation between y_t and x_t and it is represented as P_s ($s = 1, \dots, S$),

$$y_t = f_{p_s}(x_t) + \varepsilon_t; \text{ for all } P_s \quad (1)$$

Where, f_{ps} indicates the mapping function for $R^D \rightarrow R$ for the applied predictor P_s , the process noise or undefined method is depicted as ε_t . The entire prediction accuracy relies on the ensemble model with proper base algorithms, so it should be selected appropriately to satisfy the requirements for enhanced overall performance. At first, the individual prediction method should be executed satisfactorily. Next, the predictors' diversity should be maintained to avoid correlation. In the literature, we have numerous prediction models based on temporal data, and they are categorized into three kinds: machine learning, parametric and nonparametric. As rainfall prediction is stochastic, the details of the temporal prediction from predictions are unknown, and its relationship with regression model that may vary over time. Based on the ability to handle non-stationary and non-linear data, our proposed model is designed with regression-based ML algorithms.

Regression

As regression relies on kernel function, it is considered a non-parametric model widely applied for regression problems. The training dataset is represented as training set = (X,y) , where X indicates the multivariate set of N_s observations, and x_t is represented with the examined response value y_t . The equation to identify the linear function is given as follows:

$$f_{\text{regression}}(x_t) = x_t^T \beta + b \quad (2)$$

Make sure that it is as even as possible, i.e., to determine the function of regression $f_{\text{regression}}(x_t)$ with the most negligible norm value. This issue is resolved as a convex optimization to reduce:

$$J(\beta) = \frac{1}{2} \beta^T \beta \quad (3)$$

Subject to all residuals having a value less than; or, in equation form:

$$|y_t - (x_t^T \beta + b)| \leq \epsilon; \text{ for all } t \quad (4)$$

Once the training phase is done for a given input x^* , the SVR point prediction is generated as:

$$f_{\text{regression}} = (x^*)^T \beta + b \quad (5)$$

NUMERICAL RESULTS AND DISCUSSION

Windows PC with Lenovo Intel Core i3-2330M CPU 8G random access memory is the platform used for this experiment; Windows 7 is the OS utilized, and MATLAB 2013a is the implementation platform. This implementation environment is employed for both the data and image processing. The following indexes can evaluate the prediction outcomes.

RMSE: In statistics, RMSE is a generally applied in accuracy calculation index. Since RMSE is predefined, we are employing this in our system.

Threat Score: It is a standard approach used for computing skill scores of prediction outcomes. In Meteorological business, the TS technique is mainly applied to calculate skill scores. The quality of the prediction result is also evaluated using the threat score value in our experiment. Threat score is specified as a short-term rainfall prediction capability calculation technique by the meteorological administration. The threat score is calculated in three phases: threat score TS_1 computes the proportions of samples that are predicted exactly, which contains both precipitation and no precipitation prediction. At the same time, TS_2 can compute only the proportion of samples with exact rainfall prediction. The mean values of threat scores one and two are calculated and illustrated as TS_3. With all these calculations, TS can be explained as follows:

$$TS_1 = \frac{N_1 + N_2}{N_1 + N_2 + N_3 + N_4} \quad (6)$$

$$TS_2 = \frac{N_1}{N_1 + N_3 + N_4} \quad (7)$$

$$TS_3 = \frac{TS_1 + TS_2}{2} \quad (8)$$

Here, N_1 indicates the sample count used to forecast accurate precipitation, and N_2 indicates the accurate sample count for predicting no rainfall. N_3 indicates the sample count that predicts no precipitation, but actual precipitation occurs. N_4 specifies the sample count that forecasts rainfall, but no precipitation happens. Some ML algorithms such as ARIMA, BPNN, MLP, SVM, DBN, and RBFNN evaluate the prediction accuracy such as. The RMSE distribution of the above mentioned ML approaches is shown in the Fig 3. The abscissa indicates the 56 prediction locations and the ordinate indicates the RMSE of a specific location. The results show that the root mean square error (RMSE) is higher than the root mean square of multi-level perceptron and DBN. The threat score distribution of the six methods is represented. Threat score (TS_1) of ARIMA and SVM is the lowest compared to the threat score of the other four approaches. The threat score (TS_2) distribution of the ML approaches is presented.

Table 1 Performance comparison

Approaches	Threat score-1	Threat score-2	Threat score-3	RMSE
ARIMA	0.85	0.38	0.36	16.5
BPNN	0.86	0.45	0.46	3.5
MLP	0.88	0.45	0.47	2.7
SVM	0.86	0.42	0.42	2.5
DBN	0.69	0.40	0.76	31.7
RBFNN	0.71	0.73	0.40	3.1
FRM (proposed)	0.96	0.90	0.91	1.50

By analyzing the Fig 2, we learned that there is a drastic change in the TS_2 values of SVM and ARIMA. The TS_2 of MLP and BPNN are more extensive than the RBFNN and DBN. Based on the details obtained, it is clear that FRM is better than ARIMA and SVM, somewhat better than BPNN and DBN, and better than RBFNN. Accuracy rates between two numerical models, six ML methods, and DRCF are given in Table 1. TS_1 and TS_2 represent the mean values of various locations. It is found that MLP works better in

predicting precipitation among the diverse approaches. The mean value of DRCF and RMSE is the lowest among all the methods. Subsequently, the prediction accuracy of two atmospheric techniques, MLP and DRCF are compared. The prediction interval is taken as three hours. This interval facilitates simplicity when comparing the accuracy of various models. The specific countries produce the data related to the two atmospheric methods. The data of the predicted results are provided in the form of a lattice pattern. An area's latitude and longitude data are incorporated in the text document, which the models extract for prediction. Fig 3 depicts the root mean square error (RMSE) allocation of FRM with other approaches. Threat score (TS_1) distribution is given in the Fig 2. The threat score (TS_2) distribution is given in Fig 2. Comparing the results, it is clear that the prediction capability of FRM model is better than that of the MLP. However, in terms of accuracy rate, MLP and two atmospheric models can produce lower results than DRCF. Table 1 illustrates the mean RMSE of existing models. Analyzing all the above results, functional-regression is reasonably acceptable with a convincing prediction level.

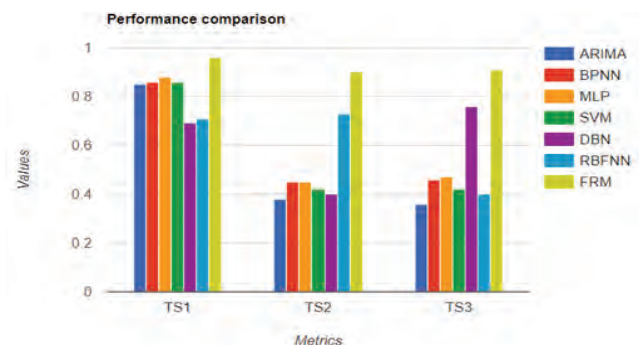


Fig. 2 Threat score comparison

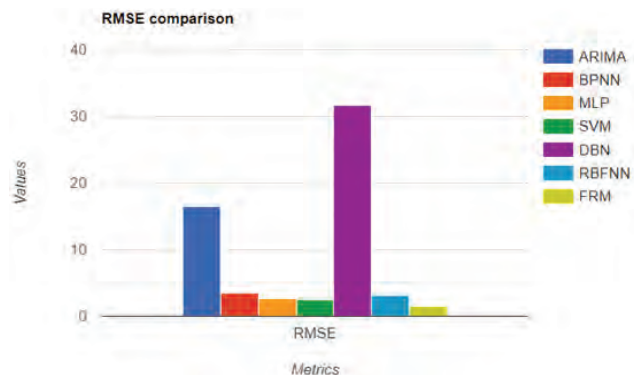


Fig. 3 RMSE comparison

CONCLUSION

A novel technique of deep functional-regression (FRM) is enhanced to resolve the restrictions of present rainfall prediction approaches. The experimental outcomes depict that the prediction accuracy of FRM facilitates better results compared to the other existing techniques. The research should concentrate on the rainfall prediction interval in the proposed system. It is recommended that the prediction interval be increased. The proposed model can also be enhanced to provide a global optimal framework as it decides on the optimal framework of the regression model. It is still worth learning about the selection of functional-regression model for better prediction. The model provides superior results compared to other approaches.

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Prediction of Stock Price Estimation Using Task-Based Belief Learning

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ABSTRACT

Stock price estimation is a trending subject in the current scenario. Conventional practices for the prediction of stock prices are generally done through econometric and statistical approaches. However, these traditional models will not work well when handling non-stationary time series data. The ever-growing social media popularity, comments on it, news and fast-growing attention on the internet directly affect the attitudes and emotions of investors regarding stocks. A massive amount of essential data is present in the internet content, which can be applied to estimate stock prices. Our work aims to create a methodology to forecast stock prices using the provided dataset. This novel prediction technique uses DL technology, which feeds the stock price prediction model with conventional index variables and text features as inputs. This research utilizes task-based belief learning (TBL) to create extensive text feature vectors. Lastly, the stock value is predicted using the learning method. The experimental outcomes depicts that the anticipated method acquires enhanced outcomes compared to the benchmark methods and can effectually forecast stock prices. The proposed study uses a deep learning methodology to present a novel stock price prediction methodology that integrates text and conventional financial features.

KEYWORDS: Stock prediction, Estimation, Deep learning, Accuracy, Price prediction.

INTRODUCTION

The stock market falls under a financial product; it carries high returns, flexible trading options and high risk, which is made possible by numerous investors. They gain huge returns by predicting the stock price accurately and trend [1]. Multiple scenarios directly affect the stock value, such as significant economic and social events, company managerial decisions, investors' preferences, macroeconomic situation and market conditions. Hence, there is always a high focus and interest in stock price estimation, and it is also a challenging research subject [2]. Econometric and statistical models generally focus on the conventional

practice of predicting stock prices [3]. Still, in the present-day stock market, these features could be better as they have to deal with a complex and dynamic environment. With the exponential growth of computer technology, researchers have utilized ML technology to estimate the fluctuations and prices of stock, thereby assisting investors in developing investment tactics to increase returns and minimize risk [4]. The typical characteristics of the stock market are that they are very dynamic and have an incredibly intricate time series scenario [5]. Stock trading will happen dynamically once the stock market is open; according to it, the stock price will vary.

Furthermore, numerous unexpected aspects will influence the stock price, developing non-stationary stock price data [6]. So, the prediction is the most challenging of all prediction types. Researchers have taken numerous perspectives to study the prediction of stock prices [7]. The two vital factors among them are prediction model improvement and model feature selection [8]. Previous studies mostly employed econometric models like ARIMA and ARCH-ARIMA for the prediction of stock price. However, in conditions where other factors have assumptions regarding data and influence the fluctuations, the econometric models need help to cope [9]. So, in present times, numerous methodologies with the ML approach have been employed widely in the prediction of stock prices. Numerous research works have discovered that DL is more effective than other methodologies and that the discriminant and regression model neural network methods perform well. The model includes the link between the stock value and new features, like the investors' sentiment, political factors, macroeconomic factors, etc., for the feature-selecting procedure [10].

With the help of DL technology, an innovative stock price prediction scheme is presented in this study to overcome the above issues. For accurate forecasting of the stock value, we can utilize the text information present by extracting the features. It will give us the investor's emotional tendency, influencing the stock price. Initially, the factors used for prediction are classified into two kinds: financial features and the other is text features. DL technology is used to mine text feature contents for which a commonly employed financial features approach is adopted. Then, to acquire the vectors for the text feature, the task-based learning approach trains the original documents. The task scheme retains the document's semantic data and association among the words, so the disadvantages of traditional text feature mining approaches can be eliminated. Thirdly, the text feature vector's dimension is minimized by adopting a belief network; it will balance financial features and the feature's dimension. Then, a belief network is utilized to eradicate the series stock value data noise and to change the end variable, i.e., stock price. Finally, as input features, extracted stock features and text features are fed and task-based belief learning (TBL) is adopted to estimate stock price.

Section 2 presents the techniques of AI for stock value detection. Section 3 provides an outline of the extracted dataset and the training models utilized for this research work. Section 4 provides the results and efficiency metrics obtained by comparing all the techniques used. The research conclusion is presented in section 5.

RELATED WORKS

Finding and upgrading the prediction models is vital in predicting stock price study. Generally, ML models and econometric schemes are utilized to predict stock value. The models mentioned above undergo constant refinement to make them better compatible with financial data processing over the intricate stock market [11]. The ARIMA approach is used in the econometric scheme for stock price estimation, which uses six variables: lag factors and macroeconomic factors. This method's outcomes exhibited that those six variables highly influence the exactness[12]. It is observed that standard (short-memory) stochastic volatility models, generalized ARCH (GARCH) and ARCH were not well fitted for accurate prediction of stock price. They proposed an innovative time series prediction method named the long memory stochastic volatility model, which can handle conditional variances and proved comparatively superior. Through the differential information, an improved ARIMA-GARCH model is introduced. The capability to predict the change in the stock price can be enhanced by including the differential information of stock price alteration trends and the dependent variable lag [13].

Unlike conventional prediction models, researchers use modern ML technology to forecast stock values accurately. The author utilized a RNN to build a prediction model. They chose recursive neural network factors as the iterations count, and the neuron count is also optimized. To forecast the fall and rise of the price, the author used numerous stock analysis pointers and employed the LSTM methodology. LSTM model's experimental outcomes exhibited improved performance when compared to other non-time series schemes and conventional ML models. Diverse combinations of parameters were tried in the LSTM methodology by [14]; his main focus is on financial time series data preprocessing techniques like normalization on the data, wavelet denoising and interpolation. It is

identified that enhanced prediction accuracy is attained with little computational complexity when the approach is optimized. Vo et al. evaluated and compared the outcomes of the gated recurrent unit, Bi-directional LSTM and LSTM as a stock value prediction process. The comparison outcomes indicate that the data is read one extra time in a backward direction by the Bi-LSTM methodology. This step significantly improved the correctness of prediction, predominantly in sequential data forecasting like financial time series data. ML and econometric schemes are the most frequently utilized methods in predicting stock value. However, dealing with nonlinear time series issues by econometric schemes is challenging because conventional ML models typically use only one period of data as a trial and many vital data emerging over time are ignored. A novel and emerging DL technology can effectively process multi-period and time-series data [15]. In stock price prediction, the main breakthrough happened when a combination of numerous models was used instead of a sole model to achieve improved performance.

METHODOLOGY

The main components utilized in our approach, like decision-level data fusion and task-based belief learning, are detailed in this portion. Restricted Boltzmann Machines (RBMs) are stacked to form a belief network. Then, an unsupervised algorithm is utilized to train them greedily. An undirected graphical model named RBM is illustrated in Fig 1, and it has no association with hidden (h) or visible (x). The RBM is constructed based on each layer's bias energy and the inter-layer interaction energy. The below equation defines the RBM's energy function:

$$E(x, h) = -b^T x - c^T h - h^T W x \quad (1)$$

Here, the bias vectors are c, and the hidden layer's bias vectors are represented as b; the weights among the hidden and visible layers are W. The parameters W, c and b are denoted by θ . It defines a distribution where hidden units are elevated. From the energy function, the distribution of observing a specific hidden and visible unit's configuration is provided as:

$$P(x, h) = \frac{e^{-E(x, h)}}{Z} \quad (2)$$

Here, the partition function is represented as Z. The detecting set distribution of visible units through Eq. (3) is provided below:

$$P(x) = \sum_H (x, h) = \exp \frac{-F(x)}{Z} \quad (3)$$

Here, the energy is termed as F(X); it is presented as given below:

$$F(x) = \exp \left(c^T x + \sum_{j=1}^H \log(1 + \exp(b_j + W_{(j,:)}x)) \right) \quad (4)$$

All training points ($t = 1, \dots, T$) average negative log-likelihood (NLL) function has to be diminished to train an RBM. The below-given equation below provides the NNL function:

$$NLL = \frac{1}{T} \sum_t l(f(x^{(t)})) = \frac{1}{T} \sum_t -\log P(x^{(t)}) \quad (5)$$

Using the stochastic gradient descent algorithm, the negative log-likelihood function is then enhanced concerning θ ; the following equation defines the optimization outcomes:

$$\frac{\partial -\log P(x^{(t)})}{\partial \theta} = E_h \left[\frac{\partial E(x^{(t)}, h)}{\partial \theta} \mid x^{(t)} \right] - E_{x, h} \left[\frac{\partial E(x, h)}{\partial \theta} \right] \quad (6)$$

An exponential sum over x and h must be computed in the equation's right-hand side in the second term, which is challenging. So, to solve the issue, the proposed contrastive divergence algorithm is used. Based on Eq. (6), Gibbs sampling has to be performed to evaluate the $P(x|h)$ and $P(h|x)$ condition distribution.

$$P(h|x) = \prod_i P(h_i|x) \quad (7)$$

$$P(x|h) = \prod_k P(x_k|h) \quad (8)$$

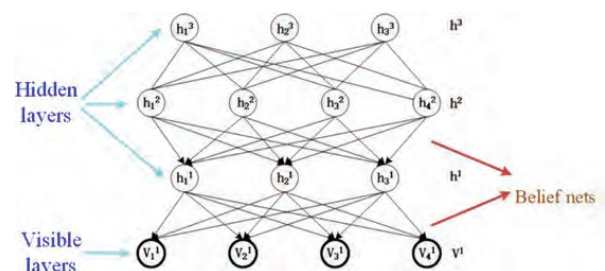


Fig. 1 Task-based belief learning

The given equation applies if h_i and x_k are binary units:

$$P(h_j = 1|x) = \frac{1}{1 + \exp(-(b_j + W_{(j,:)}x))} \quad (9)$$

$$P(x_k = 1|h) = \frac{1}{1 + \exp(-(c_k + h^T W_{(:,k)}))} = \text{sigm}(c_k + h^T W_{(:,k)}) \quad (10)$$

In Eq. (10), the point estimate of the expectation is calculated after the sampling of negative sample $x(k) = \tilde{x}$ as given below:

$$E_h \left[\frac{\partial E(x^{(t)}, h)}{\partial \theta} | x^{(t)} \right] \approx \frac{\partial E(x^{(t)}, \tilde{h})}{\partial \theta} \quad (11)$$

$$E_{x,h} \left[\frac{\partial E(x, h)}{\partial \theta} \right] \approx \frac{\partial E(\tilde{x}, \tilde{h})}{\partial \theta} \quad (12)$$

This algorithm is productive for unsupervised training with sampling step, $k = 1$. From Eq. (13), the RBMs parameter θ is updated through the equation given below:

$$\theta^{(t+1)} = \theta^{(t)} - \alpha (\nabla_{\theta} (-\log P(x^{(t)}))) \quad (13)$$

All the parameters b, c and W 's updated equations are presented as follows:

$$\theta^{(t+1)} = \theta^{(t)} - \alpha (\nabla_{\theta} (-\log P(x^{(t)}))) \quad (14)$$

$$W^{(t+1)} = W^{(t)} - \alpha (h(x^{(t)})x^{(t)T} - h(\tilde{x})\tilde{x}^T) \quad (15)$$

$$b^{(t+1)} = b^{(t)} - \alpha (h(x^{(t)}) - h(\tilde{x})) \quad (16)$$

$$c^{(t+1)} = c^{(t)} - \alpha (x^{(t)} - \tilde{x}) \quad (17)$$

Where, $h(x) \equiv \text{sigm}(b + Wx)$. Once training is completed, the parameters are employed to initialize the networks. It is trained through back-propagation algorithm. The network employed in this research are trained to study numerous tasks simultaneously. Traffic flow prediction for every task will happen for all the roads.

NUMERICAL RESULTS AND DISCUSSION

The performance improvement verification is carried out by merging the financial and text features. The TBL model's performance is tested without and with text features. The proposed model denote the TBL model with no text features. Table 1 shows the outcomes of the

experiment. The outcomes indicate that our approach works better than the TBL model using R2, MAE and RMSE financial features. This method expresses that mining valuable text data in social media is crucial in improving the prediction model's performance. Also, a dedicated time series prediction scheme is presented to test the robustness and convergence of the methodology proposed. The presented data is separated into ten different clusters. A T-test is performed, and data is paired and predicted for every group. Table 1 depicts the outcomes of the experiment, which prove the efficiency of the proposed method.

$$MAE = \frac{1}{m} \sum_{i=1}^m |y_{true}^{(i)} - y_{predict}^{(i)}| \quad (18)$$

$$RMSE = \sqrt{\frac{1}{m} \sum_{i=1}^m (y_{true}^{(i)} - y_{predict}^{(i)})^2} \quad (19)$$

$$R^2 = 1 - \frac{SS_{residual}}{SS_{total}} = 1 - \frac{\sum_i (y_{true}^{(i)} - y_{predict}^{(i)})^2}{\sum_i (\bar{y} - y_{true}^{(i)})^2} \quad (20)$$

Additionally, various models like CNN, RNN, and DNN were used to compare the outcomes. Since the CNN, DNN, and RNN models behave well in time series problems, considering the data's time dimension, the outcomes were chosen to be compared. RNN and CNN models use a twenty-one-dimension text vector combination trained directly by financial features and Doc2Vec, whereas the DNN model uses only the financial features. Fig 2 to 3 and Table 1 demonstrate the outcomes of the experiment. It expresses that the fitting is meagre in the DNN model. It needs to process the non-stationary time series data better. Since models like CNN and recursive NN models simultaneously consider a time dimension and various significant factors, they can fit the test data properly. Compared with existing models, the TBL approach provides better outcomes (0.957 of R2, 0.110 of RMSE and 0.019 of MAE). Fig 3 shows that the TBL approach converges with the natural curve more closely than others, demonstrating that the projected approach can effectively predict stock price fluctuations. Compared to one stand-alone model, the task-based belief model combination produces

improved results, as presented in Table 2. Anyhow, over-fitting issues occur due to the high generation of the vector dimension and undesirable noise. To overcome this issue, a belief network can be introduced. The performance improvement in the prediction outcomes of RMSE and MAE after employing an auto-encoder to process the text vector is presented in Table 2. Based on TBL, the prediction model's text features are derived and with features to formulate the prediction model's feature matrix.

Table 1 Parameter selection

Parameters	MAE	RMSE	R ²
m=100	1.6	1.65	95.7
m=200	1.20	1.55	90.8
m=300	1.14	1.60	91.2
m=400	1.30	1.70	92
m=500	1.55	1.96	93
m=600	1.30	1.80	94.1

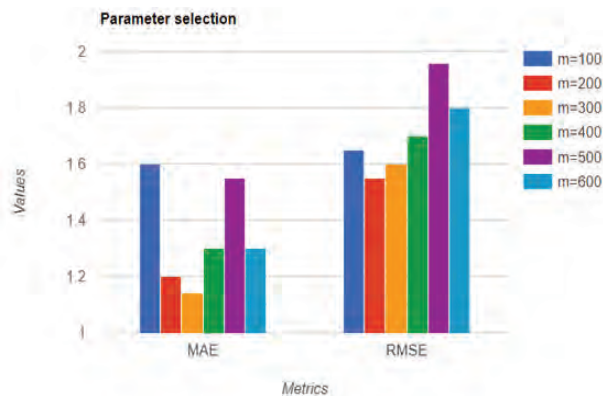


Fig 2 MAE and RMSE parameter selection

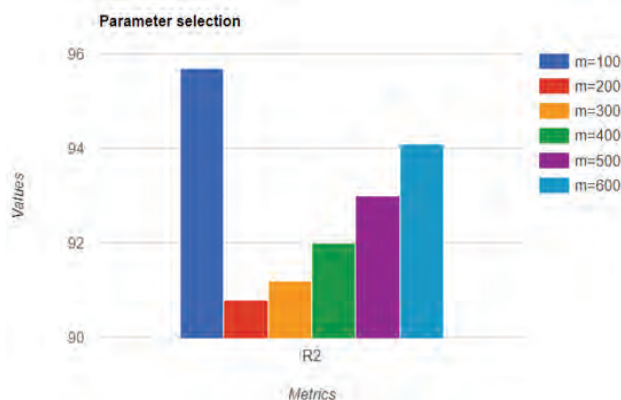


Fig 3 R2-based parameter selection

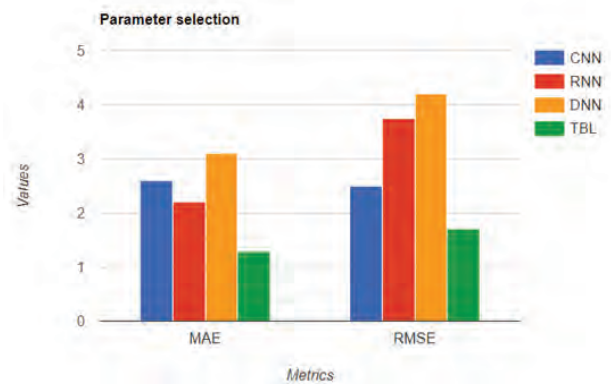


Fig. 4. MAE and RMSE parameter selection based on proposed vs. existing

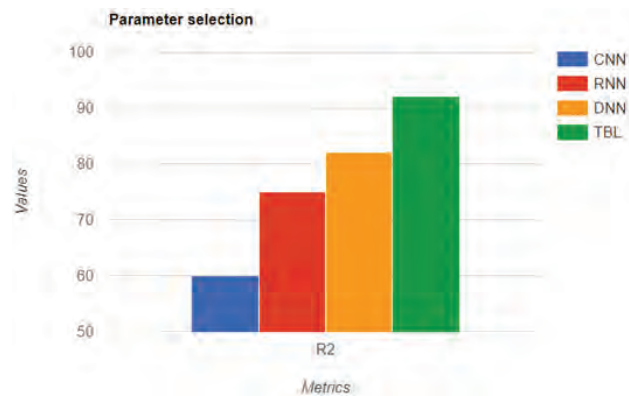


Fig. 5 R2 based parameter selection of proposed vs. existing

Table 2 Performance comparison with existing approaches

Parameters	MAE	RMSE	R ²
CNN	2.6	2.5	60
RNN	2.2	3.75	75
DNN	3.1	4.2	82
TBL	1.3	1.7	92

First, we separated text data into three portions chronologically, i.e., the training set takes up the initial eighty percent of data. The validation set uses the middle 10% of data, and the test set uses the final 10%. The parameters are adjusted with the validation set. Finally, the model's performance is verified using the test set. Long short-term memory is selected as the prediction model for the proposed prediction method, and we also need to identify some parameters. Epochs, batch sizes, optimizer, dropout, number of neurons and hidden layers are the most frequently employed TBL

parameters. Depending on the machine's computing power and experience, the hidden layer is fixed to one to three layers. Generally, values from 0.2 to 0.5 are fixed as dropouts. The hidden layer's neuron count is twice the input dimensions. Lastly, the TBL's parameters are adjusted, and the ideal combination of the parameters are two hidden layers, 0.5 dropouts, 85 neurons, Adam optimizer, 50 epochs and 4 batch sizes.

CONCLUSION

The proposed work presents its chief contribution in two parts. Initially, a novel method for predicting stock price, combining text features by improving the conventional method's performance. The available online dataset presents valuable stock information. The stock index variables specifies stock price's development; but the investor's feelings describe the stock price's potential trend. The conventional prediction methodology usually neglects this factor. The DL approach, known as task-based belief learning (TBL), is utilized in the projected model for feature extraction, which will help advance the prediction model's performance significantly. Then, the belief network is used to resolve the issues of unbalanced text and stock features. This will help enhance the stock price prediction accuracy. The prediction method proposed uses the TBL approach to diminish the feature's dimension. This approach will retain the primary data to the maximum extent and minimize the data's dimensionality.

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Predicting Diabetic Retinopathy using Integrated Retinal Tissue Network with Multi-Tier Deep Learning Network Model

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ABSTRACT

The powerful device for fundus screening is the wide-field fundus colour imaging tool. The manual screening method is laborious, work-intensive and biased. The hybrid RTNet with MT-DLM is a screening method for predicting early fundus disorder developed. Various types of fundus disorders, retinal detachment, retinal tear, diabetic retinopathy and pathological myopia can be diagnosed by the RTNet with MT-DLM, which contains a sub-system for irregular fundus screening and disorder prognosis sub-system. The structural components incorporate two standard classifiers and a perfect deep-layered network model. Extracting required features from the provided images using the depth method is ineffective because the contrast of ultra-wide field images employed in the research is low. As a result, low sensitivity and high specificity of forecasting results have been a constant issue in research. An image pre-processing method is implemented to handle this difficulty, and the outcomes of the forecasting accuracy of fundus irregularity and diverse fundus disorders are learned. Several experimental analysis techniques are applied to estimate the validity and consistency of the algorithm. The learning capability of the scheme can be enhanced by the pre-processing models and accomplish better specificity and sensitivity. RTNet with MT-DLM has valuable application assessment for fundus fitness screening and advances the workflow without an ophthalmologist.

KEYWORDS: Fundus image, Diabetic retinopathy, Prediction, Deep learning accuracy.

INTRODUCTION

Visual disorders caused by high glucose levels (diabetes) that affect the nerve cells in the retina are defined as diabetic retinopathy (DR). Generally, DR is a significant cause of blindness, affecting nearly 191 million patients [1]. Earlier research used diabetic retinopathy categorization with the help of retinal fundus images. Present techniques concentrate on recognizing isolated lesions but have a limited structure for recognizing entire lesions in the image [2]. Earlier research focuses on initial-phase attributes like haemorrhages, aneurysms,

blood vessels, and exudates, along with multi-phase lesions like venous beading, diffuse intra-retinal haemorrhages, cotton wool spots, vigorous intra-retinal microvascular abnormalities (IRMA), retinal pigment epithelium (RPE) injury, highly activated microglia, and capillary deterioration [3] – [4]. The severity stages in the diabetic retinopathy fundus images are classified through a deep neural learning strategy with the help of ResNet and GoogleNet methods related to the adaptive particle swarm optimizer (APSO) [5]. This is done to enhance the feature extraction from the images

to recognize the disorders accurately. The hybrid technique acquires the required features using various ML techniques like linear regression, random forest, support vector machine, and decision tree methods [6]. By analyzing the experimental outcomes, the proposed hybrid structure works better than the various enhanced methods with an outstanding accuracy of 94% on the standard dataset [7].

This model can potentially improve performance metrics like precision, F1 score, recall, and accuracy for several stages of diabetic retinopathy severity [8]. Vision harmless originates from diabetes mellitus that results from the micro-vascular consequence of DR. Approximately 33 percent of the 463 million patients with increased glucose levels are infected by this DR disorder [9]. The International Diabetes Federation (IDF) presented that the amount of diabetes patients is predicted to increase from 552 million (2035) to 642 million (2040) [2], [3]. The number of patients infected with diabetic retinopathy is about 158.2 million, which is expected to increase to 191 million by 2030 [10]. Diabetic retinopathy is considered to be a significant threat to global blindness. Increased risk factors are possible for patients with increased diabetes levels. Standard classifications of progressive diabetic retinopathy (DR) comprise typical, proliferative diabetic retinopathy (PDR) and non-proliferate diabetic retinopathy (NPDR) [10]. Reduced speed in the network of retinal bleed vessels and steady deprivation of the cell walls in the blood vessels are the significant features resulting from non-proliferate diabetic retinopathy (NPDR). Depending on the seriousness of the disorder, non-proliferate diabetic retinopathy is categorized into three kinds: mild (gentle), moderate (reasonable), and severe (harsh). Restricted feature mining reduces the identification of features containing disorders [10]. To overcome this problem, enhanced feature extraction models should be developed to increase the classification and detection accuracy. Having retinal fundus images as a training dataset, this proposed model creates a modern method for automated prognosis and classification of DR. The chief objective of this study is to facilitate a contemporary approach to predicting diabetic retinopathy, which necessitates subsequent procedures.

* Data pre-processing procedures are employed to ensure the smooth distribution of captured images to extract features where initiating feature collection and mining methods that aim at optimizing the identification performance for each level of DR,

- Developing a well-organized technique for recognizing and classifying diabetic retinopathy with a hybrid feature-related method known as RTNet with MT-DLM is proposed in association with different ML techniques for detecting DR, which ensures better accuracy and performance.

The work is organized as follows: section 2 gives a diverse analysis of various existing approaches related to DR. Section 3 drafts the methodology, followed by the method in results in Section 4. The work summary is given in section 5.

RELATED WORKS

The deep learning approach is emerging vigorously for the research of ophthalmology. Recently, one of the conventional fundus imaging modes, colour fundus imaging, has also been using deep learning to screen retinal disorders. Few frameworks of deep learning are trained with scratch to organize the colour mode in the image [11], but enhanced forecasting accuracy is acquired by networks trained through a transfer learning approach [12]. The author introduced a deep neural learning technique for recognizing glaucomatous optic neuropathy. This method is trained using 48,116 images and provides an increased specificity of 92% and sensitivity of 95.6%. IDX-DR is the most critical artificial intelligence-based diabetic retinopathy (DR) screening scheme, which was authorized by the FDA and applied practically in April 2018 [1]. The primary issue with this structure is that it cannot be wholly identified and classified by automated recognition methods, as it needs to observe peripheral locations. Ultra-wide field imaging solves this difficulty because it can detect large imaging ranges and is also a dominant device for fundus screening in individuals. UWF technique gradually modifies management and classification for specific fundus disorders. Recognizing branch retinal nerve blocking using deep neural learning technique proves to be better by the expert Ohsuqi et al. with the dataset of 466 images. To identify Age-related

Macular Degeneration (AMD), Matsuba introduced a deep learning model with an increased 100 per cent sensitivity and specificity of 97.1 per cent using 364 ultra-widefield images. Glaucoma disorder is identified using the DL system by the scientist Hiroki et al. using 1399 images of UWF, and the results show that the area under the ROC curve is 87.3% and 93.5%. All of those researches are mainly focused on discovering specific fundus ophthalmopathy.

Progression of new retinal nerves that can obstruct the regular blood flow is generally caused by increased diabetic retinopathy (PDR) [14]. Images of the retinal fundus are consistently captured during fundus screening. A detailed examination of these images is required to determine the disorder, which should be done with the help of an ophthalmologist. This process is time-consuming and expensive as they need financial resources. Nowadays, experts recognize irregularities in fundus images using a variety of methods. The research in the past concentrated on acquiring symptoms like exudates, retinal nerves, microaneurysms, and haemorrhages [15]. Some other symptoms like blood vessel degeneration, activated microglia, cotton wool spots, retinal pigment epithelium (RPE), highly diffused intra-retinal haemorrhages, and severe intra-retinal microvascular abnormalities (IRMA) are neglected. Even though numerous machine learning (ML) techniques are available in the literature for recognizing diabetic retinopathy (DR), no methods can extract the features from the captured images.

METHODOLOGY

The entire pipeline of the multi-tier dense, layered network (MT-DLN) depicted in Fig 1 comprises four significant steps: 1) instruct retinal tissue (RTNet) and gather infected tissues; 2) cluster the gathered patches depending on their pathological behaviour; 3) construct a standard diagnosis structure and morphology related diagnosis model; 4) integrate the characteristics of both the constructed model to get resulting prediction model. The patches obtained from the cancerous spot are observed to train the aggregated model called MT-DLN. This technique analyzes the entire feature of the retinal issues spot to forecast diagnosis. An individual sample has the potential to obtain hundreds of patches that are highly related to tumours. A more robust network can

be trained with this model, and enhanced image features can be constructed. The densely integrated layered networks (DLN) are incorporated in the multi-tier prediction concept of RTNet. Every layer is associated directly with all the adjacent layers in the DLN structure; this helps to transfer all the output features to all other successive layers. The data flow between the layers is increased through the DLN technique. This framework can successfully improve the flow of image-related data among the layers and enhance the feature extraction from the images. Image feature $E \in R^{s \times s \times 3}$ is specified as input to MT-DLN for the patch p , where the patch length is represented as s . The resulting feature map of the initial layer for m^{th} MT-DLN is given as:

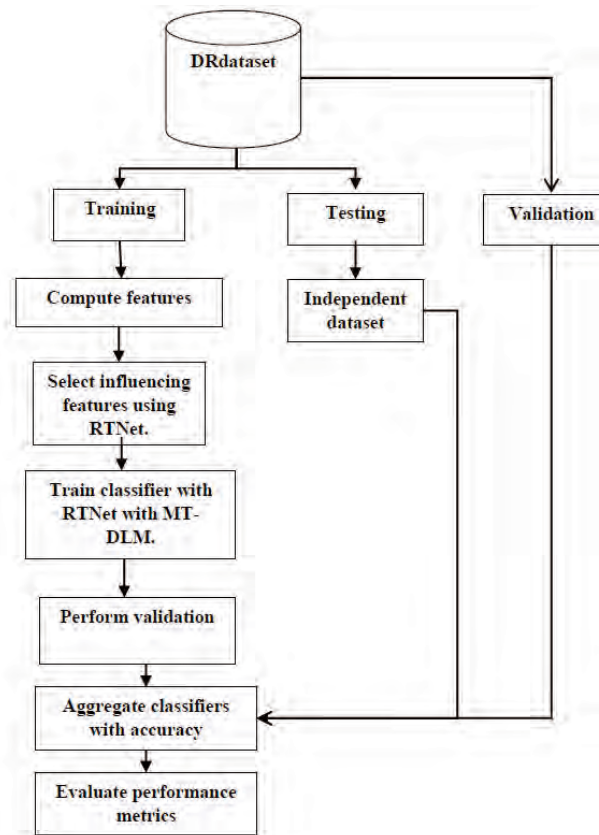


Fig. 1 Flow diagram of the proposed model

$$h_1^m = \alpha_m (W_1^m E^m + b_1^m) \quad (1)$$

Where the input features are indicated as E^m , the weight matrix is known as W_1^m , the bias term for the initial layer is given as b_1^m , and the non-linear activation function is given as α_m for the m^{th} of DLN. The integrated features

of the preceding layers are provided as input to the DLN block layer, which could increase the image data flow in the network. The resulting i^{th} layer feature map in the m^{th} block of DLN is computed as follows:

$$h_1^m = \alpha_m (W_1^m [E^m, h_1^m, \dots, h_{i-1}^m] + b_1^m) \quad (2)$$

Where the feature produced by the $(i-1)^{\text{th}}$ convolutional layer for the block m is specified as $h(i-1)^m$, N indicates the entire number of layers in the dense block, $W_i^m \in R^{K \times K \times D_i}$ here D_i indicates the filter count in the layer i . The MT-DLN achieves enhanced performance if it contains three DLN blocks. The k-means clustering technique is used to distinguish individual patches. The function of the K-means clustering technique is to obtain k groups from N observations and lessen the sum of squares in the group. A set of patches ($p_1, p_2, \dots, p_n$) is given, and a feature vector with 50D represents each patch. We apply the K-means algorithm to split n patches into k sets $F = \{F_1, F_2, \dots, F_k\}$. The main goal is to determine:

$$\arg \min_s \sum_{i=1}^k \sum_{x \in F_i} \|x - \mu_i\|^2 \quad (3)$$

In the above equation, x indicates morphological features with fifty dimensions and the average of points in the i^{th} set is represented as μ_i . We are assuming the k value as 5. Depending on their morphological characteristics, the patches will cluster into various groups during this phase. The tissues in the WSIs are grouped into tumor-infected and non-infected spots using RTNet. Next, the patches from the tumour regions are utilized for training MT-DLN; this process is expected to forecast diagnosis from the standard stage. Since MT-DLN are gathered from the cluster of patches with various pathological frameworks, they are used to classify the pathological cells at the morphological stage. The characteristics of patches contain various illustrations in two methods and can benefit each other potentially. Finally, we integrate the subject-level attributes in the two-stage models with the given equation. The retinal feature produced is the ordinary level feature of an individual, the morphological features generated by the MT-DLN are multi-tier, and the symbol describes the summation operation $\oplus$. At last, the Cox proportional hazard technique is adopted to forecast individual risk factors

depending on the resulting features. This survival intends to detect the range of the patient's death event. Severely infected patients are in the survival process to boost their life span beyond the follow-up range. Conventional regression and classification loss cannot identify the censored data. Eliminating specific samples of censored subjects would restrict the information required for network expansion. To crack this difficulty, the Cox loss function is utilized for survival analysis of model optimization. By reducing the negative log partial, it is possible to optimize the parameters are given as:

$$l(\beta) = - \sum_{i=1}^n \delta_i (\beta^T x_i - \log \sum_{j \in R_i} \exp(\beta^T x_j)) \quad (4)$$

Here, the training sample count is represented as n , a set of samples that have no experience of the event before the i^{th} sample is referred to as R_i , an indicator δ_i to verify whether the survival instance is an issue or not, value 1 indicates the unaffected sample and 0 indicates affected sample.

NUMERICAL RESULTS AND DISCUSSION

The implementation platform is chosen as Keras and executed on NVIDIA Tesla K40 GPU simultaneously and independently. The dimensions of the images are 299×299 to decrease the computation cost. The training dataset is enhanced with pre-processing subsets. There are significant divisions in the training subset: actual data, pre-processing model-generated data and augmented data. The essential experts utilize a small batch of training samples from 5 to 8 images. RMSprop optimizer is applied in the screening model with $2e-5$ as a learning rate. In the detection mechanism, SGD is employed for optimization with 0.01 as a fundamental learning rate and 0.9 as momentum. It is necessary to gradually decrease the learning rate to $2e-10$ with a stable step value of 0.1, and early stopping is used to interrupt the system training after ten passes if it is not possible to avoid loss on the validation. Various metrics are used to determine the exactness of the model in terms of effectiveness and reliability. The amount of samples with exact classification is referred to as accuracy. The fraction of accurately identified positive samples is referred to as precision and is related to imbalance

in the class. The safety measures for individuals during the screening process are called sensitivity and specificity, influencing the individuals required to be referred. The degree of consistency is computed using kappa measures acquired by consequent testing under

a similar situation. The balance between the specificity and sensitivity is graphically represented by the ROC curve parallel to the area under the curve value. The F1-score is the mean value of sensitivity and precision, considered an excessive imbalance.

Table 1 Comparison of proposed with existing approaches

Method	Accuracy	Sensitivity	Specificity	Precision	Kappa	F1-score	Youden
ResNet	88	80	90	89	88	88	76
DenseNet	87	85	96	87	75	87	75
Inception V3	89	81	98	90	79	89	79
Xception	90	82	92	92	81	90	81
Inception + ResNet	90.8	83	95	90	80	91	84
MobileNet	93	82	96	93	82	92	83
RTNet+MT-DLM	98	97	99.5	98.5	96	96	95

Here, β gives the weighted mean value of the F1 score. The Youden index intends to validate the complete system's diagnostic accuracy. Table 1 demonstrates the specificity and sensitivity of the diagnostic model for the provided dataset, which is specified as 90% and 91%; for the ZS dataset, it is given as 90% and 91%.

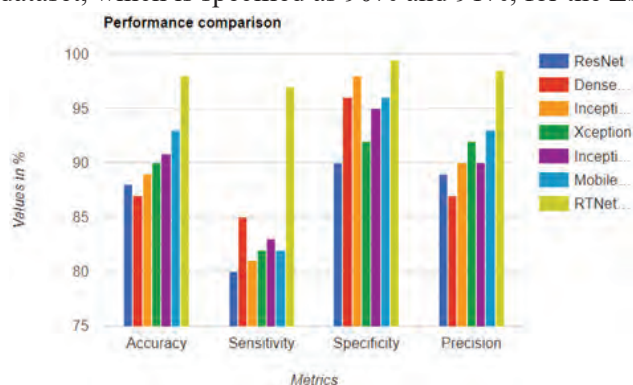


Fig. 2a Performance comparison

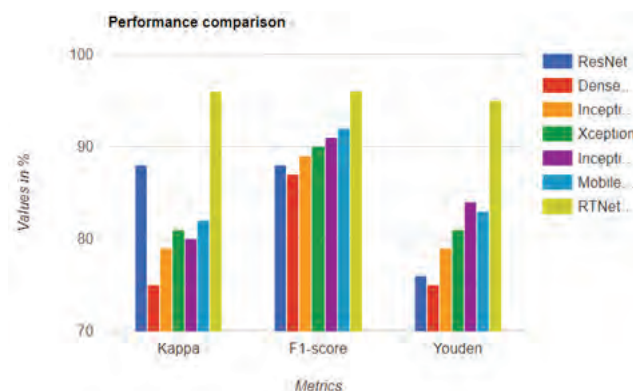


Fig. 2b Metrics comparison

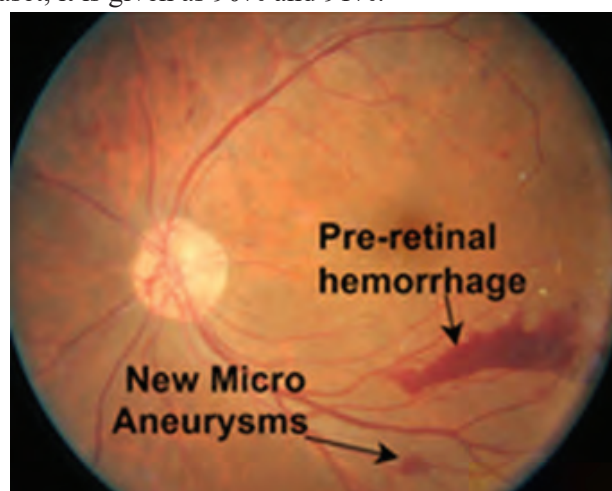


Fig. 3 Pre-retinal hemorrhage

Even though the model's effectiveness based on these two datasets was turned down, it is still in use because of its generalization capability. The main reasons for using these datasets are 1) the irregularity count in the fundus image is higher in ZS and SP datasets than in the PE training dataset; 2) the restricted dataset, the diversity of images captured by various cameras, finally, the difference between ultra-widefield photographers will influence the model's performance. If further data from various sources are included in the training procedure

of the diagnosis system, it may enhance the model's generalization. It is crucial to have pre-processing techniques in the algorithm to improve the sensitivity and reduce the specificity. Two key reasons are there to include the pre-processing system: 1) the restricted number of the datasets with 12.9%, 19%, and 4.8% if the abnormal data; 2) the dark spots in the actual images are not precise enough to recognize the abnormalities on that region. The proposed method can accomplish better consistency with the pre-processing techniques. For instance, pre-processing using Gamma can enhance the screening precision of the algorithm, but few images are misdiagnosed as diabetic retinopathy. The reason behind this miscalculation is that RT&RD is a diabetic retinopathy complication. Myopia is easily screened by the pre-processing method, but high myopia is wrongly recognized as regular. The primary reason for this misidentification is the limited number of training datasets related to pathological and myopia features. Gamma enhances the sensitivity by about 10% for the proposed algorithm. During the primary phase, diabetic retinopathy is miscalculated as RT&RD, owing to the algorithms that do not have complete knowledge of DR. Finally, the screening system accomplishes nearly 98% accuracy.

CONCLUSION

A hybrid RTNet with MT-DLN technique is applied in this study to detect the early level DR by gathering the features from fundus-captured images with the learning model. With the application of the provided dataset, the collected features are provided into different classifiers for recognizing diabetic retinopathy. The performance of the networks is enhanced by integrating two models for DR screening, and thus, overall model accuracy is improved. The proposed system ensures the prior identification of diabetic retinopathy (DR) in assisting ophthalmologists. The outcomes emphasize the effectiveness of incorporating a DLN alongside RTNet classifiers, facilitating quick and highly accurate results. Remarkably, present multiclass and binary DR screening methods outperformed the hybrid technique with 98% accuracy.

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Establishing A Secured and Reliable Cryptographic Authentic Signature Model for Canteen Management

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ABSTRACT

The emergence and expansion of electronic business on the Internet has recently been seen. Several companies are expanding their business with the help of the Internet. This allows the organizations to attain more consumers cost-effectively and conduct business quickly and efficiently. On the other hand, transmitting sensitive data through the network must meet the principles of integrity, authentication, non-repudiation, and privacy. Companies are employing different infrastructures to enable authentic electronic business transactions. Several guidelines and protocols are proposed and used to facilitate secure and reliable exchanges between transactions. These structures accumulate local computer cryptographic keys that can be pirated or misused. In this study, we develop a 16-bit secured RSA with authentic signature (SRSA-AS) based intelligent card framework that facilitates partners in carrying out safe transactions over the canteen management portal. Smart cards are used by the proposed model to store cryptographic keys and execute the algorithm.

KEYWORDS: *Cryptography, Management portal, Authentication, Signature, Security, Privacy.*

INTRODUCTION

The trust-lack towards e-business users is the major obstacle to expanding electronic commerce. Data transmitted through public networks may easily be compromised. Organizations must seek ways of authenticating suppliers, consumers, partners, and distant offices while assuring the confidentiality of transactions and responsive data [1]. Some solutions are designed to secure electronic business transactions and protect responsive data using various techniques [2]. Many companies are constructing public key infrastructure (PKIs) to resolve business security problems. However, more is needed to implement PKI. Cryptographic keys, digital verification, and certificates

should be secured just as passports and credit cards are protected. By storing digital certificates on local area networks and the computer, it is relatively simple for hackers to copy the certificates and then utilize them to imitate an authorized user. Smart cards are perfect storage devices for safe storage [3]. The research proposed electronic business architecture based on e-cards. The proposed smart card contains details of the security measures like cryptographic keys, electronic signatures, and certificates. The electronic card also performs encryption on the board. Another benefit of this application is the portability of the digital card, which enables the users to conduct transactions from any system in the network [4]. With electronic cards, the storage of numerous certificates, identities, passwords,

and private keys for encryption and decryption, as well as electronic signatures on digital cards, solves privacy and protection issues [5]. The sensitive data stored on the card is verified and secured by the PIN. The consumer enters PIN to open the card and permits access secured data (identities, passwords, enciphering keys, and digital certificates). The consumer no longer needs to enter a user ID or password that could compromise transaction privacy [6]. Card-generated session keys secure communication between cards and client programs. An attacker's surveillance of the encryption technique implemented by the card is almost impossible. Before beginning transactions, users, servers, and third persons involved in electronic business transactions must be verified for authentication. The RSA is a cryptography system proposed by [7] in a security application. The author suggested that the scheme proposed by Chan et al. does not facilitate complete security and is susceptible to malicious attacks. The author also defined the approach as being unable to withstand attacks by consumer imitation and proposed minor changes to protect from this threat. Enhanced protection is provided by the previous technique [8], slightly modifying the Yang et al. model. This approach can resist malicious attacks and also facilitate mutual authentication. Researchers have proposed several authentication schemes based on RSA [9]. The security of RSA cryptography depends on factors that are difficult to factor large primes. In this research, experts project a two-factor distant consumer security approach that provides RSA-based consumer anonymity and mutual authorization with a security key agreement [10]. Additionally, specialists apply the logic of the BAN to prove the effectiveness of the proposed plan. This system has the following benefits:

- 1) It contains a practical registration stage, where an unauthorized input can be detected rapidly.
- 2) It contains an effective and user-friendly password modification system that allows users to alter without server support.
- 3) Provides anonymity for the user with a 16-bit secured RSA with an authentic signature (SRSA-AS).
- 4) Supports mutual authorization and private key agreement.

5) Calculation and communication costs are comparable to various suitable systems.

6) It assures all the preferred security features.

This study presents an electronic business structure based on digital cards. The second section provides a model of e-commerce transactions and the required stages to facilitate safe and reliable transactions. Section 3 describes the framework of the projected electronic business architecture. Section 4 elaborates on the instalment of prototype methodology. In conclusion, we declare a few plans for further study.

RELATED WORKS

The critical tool the previous two protection enhancements utilized is executing an authenticated program or authorized computing [11]. Abstractly, this indicates that every program must be effectively authenticated before implementation. The verification system (Central Processing Unit) calculates the hash value of the program. It evaluates this self-computing value with the pre-computing value as follows: in addition to the program (as the authorization code), the respective program's digital signature (marked by the system's private key) is supplied. The authentication system verifies the authenticity of the digital signatures using the system's public key [12]. The critical point of protection is that asymmetric cryptography keys should be unalterably linked to the authentication system. Otherwise, an attacker's modification of public keys, choice of alternative private keys, and signature of programs using their private keys will be trivial. To comprehensively examine authentic computation, refer to [13]. Assuming that the RSA and the essential hash function are safe, the above mentioned technique looks entirely bulletproof since attackers cannot modify signatures without knowing the system's private cryptographic key.

However, this conversation does not describe the physical threats that may alter the invariable asymmetric keys connected to the authentication system. We can then declare that this can be proven using the Riemann hypothesis much better in the most straightforward and most realistic error model [14]; we need to concentrate on why attackers are involved in such one-time attacks. Imagine a global symmetric key or key code block

embedded in an authentication machine that breaks once it runs everywhere, and its asymmetric access is secured by a highly secure manufacturer's RSA authentication procedure. In addition, systems vulnerability requires attackers to have a unique victim tool (and very standard hardware understanding and inexpensive hardware devices), as explained in the research work [15]. The RSA security approach protects the secret keys of precious objects.

METHODOLOGY

Some existing works proposed a graphical authentication architecture to facilitate device-specific authorization and verification methodologies for network data equipment. The constructed architecture avoids device spoofing and controls malicious device access on the further ubiquitous system. The architecture cannot control all transition privacy and is restricted to protecting transactions between devices and consumer programs. The author proposed an incorporated approach based on hash, a simple ensemble authorization and access management solution. However, this system is susceptible to malicious attacks and is restricted to an authorization admission control system based on the Hash function. The researcher proposed server consumer verification and key agreement approach with digital card. Some models restrict to provide authentic password keys in the multi-server security environment. An extensive network authorization architecture based on electronic cards was proposed. This extended framework incorporates digital cards into the authorization process for a realistic transaction scenario. The model does not consider the privacy and safety difficulties associated with the transaction.

So, to overcome this shortage, we proposed an e-commerce structure that allows transactions to be authenticated, validated, and encrypted using the private key stored on digital cards. The anticipated transaction model is described. It elaborates on a privacy protocol among parties included in business transactions. It permits clients and customers to execute secure transactions with the server (i.e., supplier). Safe transactions ensure the integrity, dependability and privacy of information exchanged between clients and the servers during the transaction process. In the succeeding session, we assign the client's name

to recognize the parties beginning the transaction (consumer and partner) and the server that receives the transaction demand, like merchants and suppliers. The initiating user and the server should have the same asymmetric key to complete the transaction. This server identifies the password sent by the user through the public key. The electronic business architecture is based on private and public key encryption techniques. Electronic business transactions are carried out in successive stages: authorization, integrity and security phases. Electronic card transactions among clients and servers must begin with two-way authorization. Mutual authentication represents that every party, whether a user or server, should validate the opposite party.

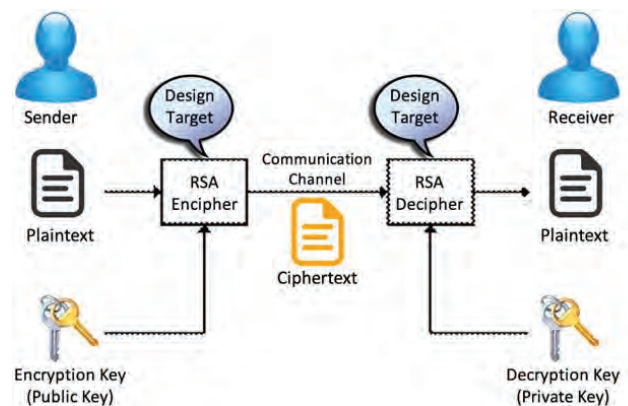


Fig. 1 Secure authentication mechanism

Authentication mechanism

To ensure the security of electronic business transactions, every client or server must authorize the other side party. The authorization system provides a user's detailed access rights already defined and saved in the dynamic database. The validation procedure begins by authorizing the customer (client) and the merchant (server). The key reason for authorizing clients is to decide on access control. Many present mechanisms facilitate single-time verification; the servers authorize the clients, but the clients do not allow the servers. The client cannot guarantee the server party's details in this case. The client still determines whether they interact with a trusted or malicious server. The client may send private data without being sure it will be passed on to a trusted third party. Consequently, customers must authenticate to the merchant before any transaction begins. After successful authentication,

secure socket layer (SSL) sessions among clients and servers are opened. The verification process is relies on asymmetric key encryption.

Asymmetric keys are used for verification purposes and are signed and authenticated by symmetric and public key elements. Rivest, Shamir, and Adleman (16-RSA) algorithms are utilized to sign and verify information. The third party invokes Certificate Authority (CA). The certificate authority provides a certificate to confirm that clients and servers authorize the keys. The asymmetric key and user identities are connected by a certificate authorized using CA, certifying the link exactness. The certificate authority sends certificate using private key of the CA and signs the user or server's public key. Eq. (1) to Eq. (2) show the signing and authorization process. The public key of CA is utilized to authenticate the certificate of both clients and servers. Client certificates and security key pairs are saved in electronic cards. The server certificates and the security key pairs are saved in the dynamic data repository.

$$\begin{aligned} &16\text{-bitcertificate} & (1) \\ &= \text{authentication}_{\text{sign}}(\text{public} \\ &\text{-key}) \{ \text{privatekeywithcertifiedauthority} \} \end{aligned}$$

$$\begin{aligned} &16\text{-bitpublickey} & (2) \\ &= \text{authenticverification}(16 \\ &\text{-bitcertificate}) \{ \text{publickeywithcertifiedauthority} \} \end{aligned}$$

The user visits the server network and request permission to log in. To initiate the plug-in on the client side, web server sends back web page containing the plug-ins. The server uses its symmetric key private key to sign a randomly generated number R, as given in Eq. (3):

$$\text{server}_1 = \text{authentication}_{\text{sign}}(\text{random}) \{ \text{privatekey}_{\text{server}} \} \quad (3)$$

The client receives the random and signed S1 from the server. The electronic business model's suggested authentication method is shown in Fig 1. Using a public key server stored on the digital card, the client plug-in program confirms the signature. Eq. (4) defines the authorization algorithm, which the digital card computes.

$$\text{Random}' = \text{authenticverification}(\text{server}_1) \{ \text{publickey}_{\text{server}} \} \quad (4)$$

The signature is effectively authenticated, and the server is verified if the values of R' and R are the same.

Eq. (4) illustrates that using the client private key client, the client calculate selectronic signature (server 2) of arbitrary number it recovered from the web page.

$$\text{server}_2 = \text{authentication}_{\text{sign}}(\text{random}) \{ \text{privatekey}_{\text{client}} \} \quad (5)$$

The plug-in demands the insertion of a digital card and the PIN entry to recover the certificate and security key pair saved over electronic card. The client sends the first digital signature, a second electronic signature, and the client's public key to the server. After receiving these plug-in details, the server authenticates the digital signature using Eq. (6) and Eq. (7).

$$\text{publickey}_{\text{client}} = \text{verification}(\text{certificatecard}) \{ \text{publickey} \} \quad (6)$$

$$\text{Random} = \text{verification}(\text{server}_2) \{ \text{publickey}_{\text{client}} \} \quad (7)$$

Suppose the computed terms of the client's public key and the random number are similar to those sent by the user's public key and a random number. In that case, the server ensures user verification and starts a fresh session.

Privacy policy

Maintaining data reliability is an essential protection requirement for many applications, especially in the financial sector. Our primary concern is stopping any action that leads to illegal data tampering. This covers both the insertion and deletion of data and its modification. Asymmetric key cryptography can be used to ensure the integrity of the message. The information is enciphered using the client's symmetric key and deciphered by the receiver's related asymmetric key. The electronic card stores the secret key, which is secured by PIN. This will stop the card's secret key from being accessed or used by the malicious user who stole the electronic card. One needs to possess the actual card and be aware of the PIN to use the card. Maintaining the confidentiality of the information shared amongst the parties to the transaction is a crucial requirement that needs to be satisfied. Data transmission and storage in a secure manner are both related to the term privacy. The secret and symmetric keys must be protected from compromise using a cryptographic mechanism. The two parties exchange data, which must be secured from hackers. The data contents should not be accessible to unauthorized parties. The parties encrypt their interactions using secret-key cryptography to overcome

this difficulty. The digital card contains the key, which is PIN-protected. The key is read only if the appropriate pin is entered. The integrity and decryption check of the received message comprise the second phase after the verification procedure. The computation procedure among clients and servers is described in the privacy phase.

Pseudocode:

- 1) Evaluate the hash function that is transferred to the server using 16-bit RSA;
- 2) Perform signature with private key based on 16-bit RSA;
- 3) Provide document signature;
- 4) Encrypt the document with a public key using 16-bit RSA;
- 5) Encrypt the key with the receiver public key using the proposed algorithm;
- 6) Once the key is received, the server performs the inverse computation from the client side.
- 7) It performs decryption with private key (receiver);
- 8) Perform signature verification with a public key using the proposed algorithm;
- 9) Perform the verification process to generate the signature;
- 10) Evaluate the hash message and evaluate the hash function in the prior step

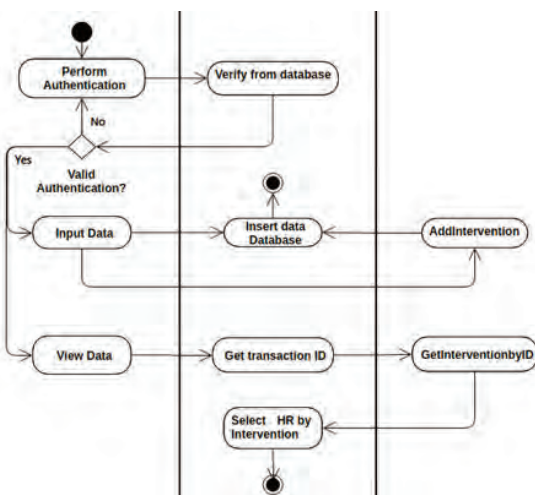


Fig. .2 Authentication diagram

The electronic card computes the hash functions onboard and cryptograms for signatures and verification. The smart card also stores the private, secret, and asymmetric keys, all pin-protected. The client requests the consumer to insert the card and impose the PIN to complete the transaction. Access is granted by the PIN, which also enables the plug-in to take keys out of the card. The security and protection authentication is successful only if $H_1 = H_2$; otherwise, the process fails.

NUMERICAL RESULTS AND DISCUSSION

This section compares this proposed system's security and accuracy measures with other techniques. We declared the projected method's interaction cost, computation expense, and related systems. The sum of the computation load of our technique is $16T_h + 3T_E$, where T_{he} time required in the protected single-way hash function and the time utilized in the modular exponentiation process is T_E . To evaluate the interaction overhead, we use some facts and assumptions, password, random nonce, output, and identity of secure single-way function with a length of 160 bits. The size of one of the blocks in the advanced encryption standard is 128 bits, and the modular exponentiation process takes 1024 bits. The interaction overhead of this approach is calculated as $160 \times 6 + 1024 = 1984$ bits. Table 1 depicts the various authentication functionalities compared between the proposed model and other related methods. The proposed model is safer against many malicious attacks than other techniques.

Table 1 Performance comparison

Comparison	[13]	[14]	[15]	Proposed
Communication cost	2848	2528	2208	1982
Cost computation during the login phase	$2T_h + 2T_E$	$1T_h + 2T_E$	$2T_h + 2T_E$	$5T_h + 2T_E$
Cost computation during the authentication process	$3T_h + 2T_E$	$6T_h + 2T_E$	$3T_h + 2T_E$	$11T_h + 2T_E$
Total computational cost	$5T_h + 2T_E$	$7T_h + 2T_E$	$5T_h + 2T_E$	$16T_h + 2T_E$

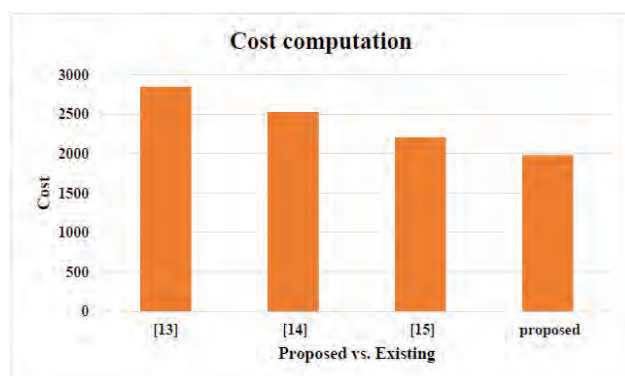


Fig 3 Cost computation

CONCLUSION

This research introduces a digital card structure that enables partners to conduct electronic business transactions. Advanced cryptographic calculations are used to ensure the security of the e-commerce transactions. Using credentials like certificate authority and keys are preserved in the card; an intelligent card handles the computations on the client side. The users cannot access these credentials because they are PIN-protected. The card's key pairs are also used to construct a safe session between the client and the server during the transaction. The smart card for electronic business transactions must be customized by loading keys and creating a password. The client executing the transaction is granted access by the server based on his privileges as stored in the dynamic database repository, following authorization with the credentials stored in the directory. For this reason, a prototype smart card was created. The suggested 16-bit secured RSA with authentic signature (SRSA-AS) framework served as the basis for implementing the prototype. The recommended framework can be used to implement the client side in any electronic business system. Only the user side is addressed by the developed prototype. We created a lightweight version of the server to test our prototype and utilize the framework. Considering the future work, we intend to execute the server side by storing and using credentials and privileges through the active directory.

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An Associative Auto-Encoder Model and Integrated KI Divergence for Skin Cancer Diagnosis

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ABSTRACT

In general, skin-related issues are prevalent in diseases affecting humans. Skin colour is a crucial indicator of this condition in computer vision applications. This method diagnoses the type of skin cancer based on data gathered from skin imaging. The skin is separated using the essential pre-processing steps. The pre-processed images are provided to the proposed associative auto-encoder model (A^2E) as input. The intermediate features were gathered during this study as supplied to the output layer. The obtained outputs are categorized and evaluated with various learning approaches. The integrated auto-encoder model (A^2E) classifier outperformed the other classifiers. The model gives 96% accuracy, 95% sensitivity and 94.5% specificity.

KEYWORDS: Skin cancer, Prediction, Deep learning, Auto-encoder, Associative model.

INTRODUCTION

Cells grow abnormally and spread to other regions of the body are what cause cancer. Skin cancer is among the deadliest and most severe forms of the disease. Only when skin cancer is discovered in its early stages is it curable? Skin is a vital part of the human body that covers every part of the body, including the muscles and bones. The skin is essential since even slight variations in its function affect all body systems [1]. The technical term for the affected skin area is a lesion area. There are numerous distinct types of skin lesions. They are grouped based on the type of skin cells that give rise to each lesion. Melanocytic lesions are created by melanocytes, just like melanoma, and are essential to producing the protein pigment referred to as melanin. Lesions that are not melanocytic originate from different kinds of skin cells, like squamous or basal cells. The absence/presence of several

dermoscopic indicators like pigment network, could be used to distinguish visually between the two types of lesions. The next stage is determining the type of lesion, whether it is a benign lesion or a malignant neoplasm. The lesion is then categorized into one of the various skin lesions if it falls into the latter category. A collection of dermoscopic features is also considered when making these assessments [2]. The primary clinical indicators of skin conditions such as basal cell carcinoma, melanoma, and seborrheic keratosis are skin lesions. Some people acquire noncancerous (benign) skin growths called basal cell carcinoma as they age [3]. The two most common forms of skin cancer are non-melanoma and melanoma, both of which are potentially fatal and less common. Melanoma is a cancer that primarily affects white individuals. It usually affects the trunk of males and the lower limbs of women, though it can also appear in other body areas.

The treatment of skin cancer continues to be the primary focus in modern healthcare, with over twelve million cancer sufferers globally. Early identification of skin cancer is facilitated by computer-aided detection. To diagnose illnesses, doctors usually employ the biopsy process to identify them. The skin gets cut off or detached during the biopsy technique, and these skin samples are subjected to several laboratory tests [4]. This makes the process both painful and time-consuming. Skin depigmentation can manifest as globules, multiple brown spots, multiple blue-grey dots, a blue-white veil, scars, pigmented networks and pseudopods [5]. Typically, a standard digital video or camera is used to capture macroscopic images, which are referred to as such. These images are typically utilized to perform computer analysis [5]. The clinical pictures include some issues, including low quality and objects like shadows, skin lines, hair and replications that are present in the pictures. These issues make it very challenging to examine skin lesions [6]. Skin cancer diagnosis using the computational method involves several procedures, including image segmentation, pre-processing, feature deduction, classification and feature extraction. Every stage of the skin cancer detection process is covered in this paper, along with related techniques. PNN, Random Forest, SVM, and the combination of RF and SVM classifiers are utilized for the classification [7] – [10].

This research proposes a strategy using dermoscopic images to identify lesions and skin illnesses. To correctly identify the categorization, the skin disease classes discussed in this study include solar lentigo, lentigo simplex, melanocytic nevi, nevus, melanoma, seborrheic, blue nevus and basal cell carcinoma. Seborrheic keratosis is a condition that typically affects the back, shoulders, and chest in older adults, though it can affect any area of the body. It can grow slowly, either alone or in groups. The texture can be rough or smooth, and the colour can range from light tan to brown or black. They are small, no bigger than 1 inch across, and adhere to the skin. Sometimes, it could be confused for warts or moles. Tumours, also known as basal cell carcinoma, arise when the skin is exposed to excessive sunlight. While it can spread to the underlying tissue and the bone below the skin, the possibility of this kind of cancer spreading from the skin to other body areas is low. Little, glossy pimples that commonly form on the

face or nose but can sometimes emerge in different body parts constitute the beginning stage. Usually, it grows quite slowly and only shows itself later. The proposed model adopts the novel A²E for prediction purposes, where the model gives promising outcomes.

The work is drafted as follows: section 2 provides a detailed analysis of the various approaches related to skin cancer prediction. Section 3 shows the A²E model explanation with the integrated KL divergence, and section 4 graphically represents the experimental outcomes. Section 5 gives the work summary.

RELATED WORKS

Affi et al. [11] created an enhanced embedded SVM classifier with a low-cost handheld device to aid in early skin cancer identification. Using an SVM classifier on an FPGA, the scientists presented a hardware/software approach for melanoma detection on a chip. Ultra-fast High-Level Synthesis is the suggested design technology. This method provides melanoma categorization on a successful chip. A technique was presented by [12] that filters and eliminates excess noise from images by pre-processing the images. The skin lesion is segmented, and characteristics are extracted based on several factors, including colour, diameter, asymmetry, and irregularities in the border, all determined by applying the ABCD rule. Automatic ABCD lesion monitoring was implemented to differentiate benign lesions from malignant melanoma. The authors retrieved the geometrical properties for evaluation. The median filter eliminates artefacts, and Gabor filters of various frequencies and orientations are used to identify dense hair. Using the hair mask as a basis for linear interpolation fixes the image. The segmentation of lesions is done using GAC. The fundamental element of A is its asymmetry in shape, luminosity, and colour. The characteristic has significantly enabled the analysis of lesions' geometrical aspects, networks, and blue-white veil structures [13].

The author segmented the dermoscopic image using Ant Colony Based Segmentation. Shape, Color, and Texture are the features that have been retrieved. The authors classified the lesions using two different techniques: k-NN and ANN. The author developed an advanced diagnostic system considering Sequential Floating Forward Selection and CASH characteristics. For the

segmentation, enhanced Dynamic Programming and thresholding are employed. According to the extracted features, Asymmetry, Border, Color, Differential structures and Irregularity of the lesions are classified using the SVM classifier [14]. The author suggested employing diffusion filter and SVM classifier to predict the skin lesions and reduce the image noise under consideration for execution. A method for the automatic segmentation of skin lesions was presented. After removing the noise and unwanted hairs, the lesion's colour and texture properties are extracted using a region-growing segmentation technique [15]. SVM and k-NN classifiers are combined to classify the retrieved features. A skin cancer detection technology was proposed. They employed the watershed method to segment the lesion, and the GLCM and ABCD rules were utilized to extract the characteristics. KNN, Random Forest, and SVM are used to classify the retrieved features.

METHODOLOGY

Dataset

Skin cancer diagnosis involves several steps. In the pre-processing phase, the image quality captured for detection is enhanced. All unwanted image noises bubbles and hairs that have been removed at this point because these noises will result in inaccurate classification. The literature uses a variety of filters, including mean, median, adaptive median, adaptive wiener and Gaussian filters, to reduce noise in images. These filters can denoise against noise types such as Poisson, Gaussian, speckle, salt, and pepper noise. The median filter is employed to eradicate image noise. The median filter eliminates bubbles that are present in the lesion. The bubbles could interfere with the colour and asymmetry intensity measurements. The image's bubbles and thin hair are reduced in impact by using the $[3 \times 3]$ median filter. The median filter's size was determined through experimentation. Achieving the two objectives of reducing the amount of bubbles and avoiding fuzzy edges determines the size.

Prediction model

A particular class of auto-encoder is called associative auto-encoder (A^2E) and is derived from probabilistic and Bayesian graphical models. Instead of producing

a fixed latent vector, the A^2E encoder approximates the posterior probability $p_{\phi}(z|x)$. Next, the decoder selects samples from the distribution to determine the reconstruction probability $p_{\theta}(x|z)$. In this case, ϕ and θ are the encoder's and decoder's respective parameters. Let N be the total number of samples, X' be the A^2E output and X sample vector forms with certain conditions known to exist. The total of all observed instances of marginal log probability, or the marginal likelihood of the A^2E model, can be stated as follows:

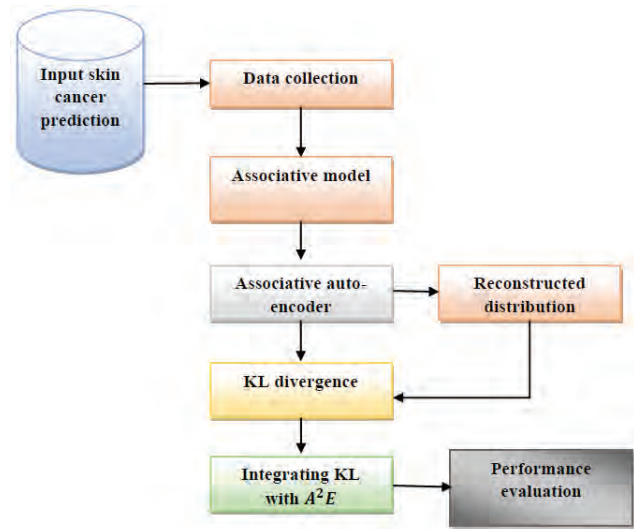


Fig. 1 Block diagram of the anticipated model

$$L(X, X') = \sum_{i=1}^N \log P_{\theta}(x_i) \quad (1)$$

Where N specifies number of previously identified associations or training samples, x is defined as x_i to keep things simple. For each sample, the marginal log probability is as follows:

$$\log P_{\theta}(x_i) = D_{KL}(q_{\phi}(z|x) || p_{\theta}(z|x)) + L(\theta, \phi; x) \quad (2)$$

Where the KL-divergence of $q_{\phi}(z)$ from actual posterior (first term), the variational lower bound of $\log p(x)$ is the second component in the expression. As, KL term represents non-negative, it is redefined as follows:

$$\log P_{\theta}(x) \geq L(\theta, \phi; x) = -D_{KL}(q_{\phi}(z|x) || p_{\theta}(z)) + E_{q_{\phi}(z|x)} \log p_{\theta}(x|z) \quad (3)$$

The previous distribution is denoted by $p_{\phi}(z)$. The reconstruction probability of x is the second term, and the first term can be utilized as a regularization. Due

to the stochastic property of generating sample z from $q_{\phi}(z|x)$, $A^2 E$ provides a reparameterization method that directly optimizes the loss function Eq. (4) using stochastic gradient techniques. $A^2 E$ re-parameterizes z in the following way by applying a deterministic transformation $g_{\phi}(\epsilon, x)$:

$$z = g_{\phi}(\epsilon, x) \text{ with } \epsilon \sim p(\epsilon) \quad (4)$$

The transformation function, denoted by ϕ , is $g(\cdot)$, and the auxiliary noise variable is represented as $\epsilon \sim N(0,1)$. Assume that the associative approximate posterior is a multivariate Gaussian $q_{\phi}(z|x) = N(z; \mu, \sigma^2 I)$ and that the prior is $p_{\theta}(z) = N(z; 0, I)$. Here's another way to write z :

$$z = \mu + \sigma \cdot \epsilon, \text{ where } \epsilon \sim N(0,1) \quad (5)$$

Where $(\cdot)$ denotes the product of Hadamard elements. Finally, the marginal log-probability lower bound has the following expression:

$$L(\theta, \phi, x) = -D_{KL}(q_{\phi}(z|x) || p_{\theta}(x)) + \frac{1}{L} \sum_{l=1}^L \log p_{\theta}(x|z^l) \quad (6)$$

Where L is the sample count (z), using the existing approach, we can determine the first RHS term. Given that our experiments employ mean squared error, the successive RHS item is considered to lower the reconstruction error.

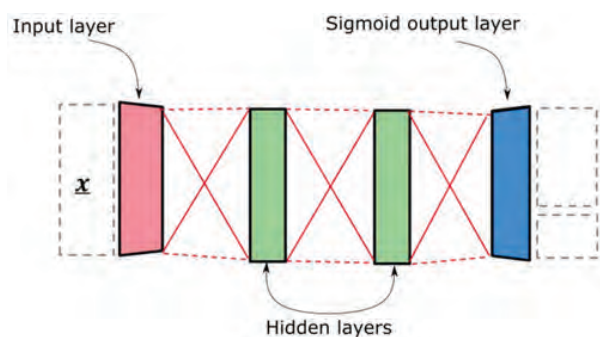


Fig. 2 Generic view of $A^2 E$ classifier mode

Numerical results and discussion

The proposed $A^2 E$ classifier is employed over ISIC dataset. For the experiment, an overall of one thousand images were captured. Here, 10 CVs were used to train and assess each sample. This work has completed four distinct skin lesion categorization tasks. The lesion is categorized to identify and differentiate it from benign

lesions, melanoma, basal cell carcinoma, and seborrhea keratosis. Metrics including accuracy, sensitivity, and specificity are used to assess the performance of the classifications utilized in this study. The False Negative and Positive, True Negative and Positive are represented by the FN, FP, TN, and TP in Eq. (7) to Eq. (9):

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} * 100\% \quad (7)$$

$$sensitivity = \frac{TP}{TP + FN} * 100\% \quad (8)$$

$$Specificity = \frac{TN}{TN + FP} * 100\% \quad (9)$$

Table 1 Classification-based performance evaluation

Methods	Accuracy	Sensitivity	Specificity
ANN	63	61	59
RF	76	74	72
SVM	87	85	83
DT	89	88	87
$A^2 E$ (proposed)	96	95	94.5

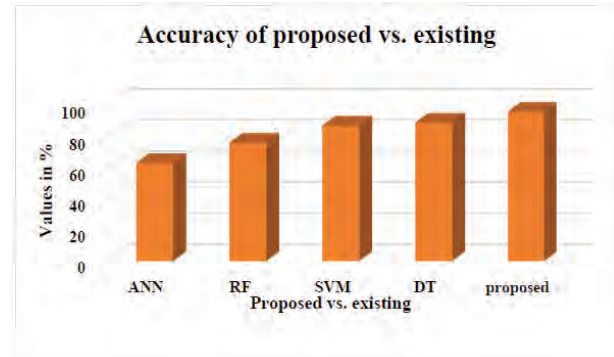


Fig. 3 Accuracy of proposed vs. existing

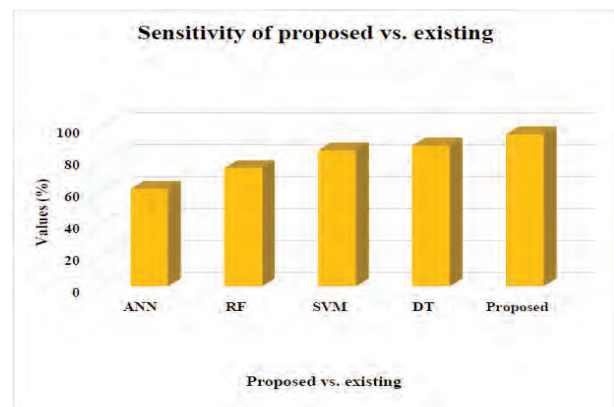


Fig. 4 Sensitivity of proposed vs. existing

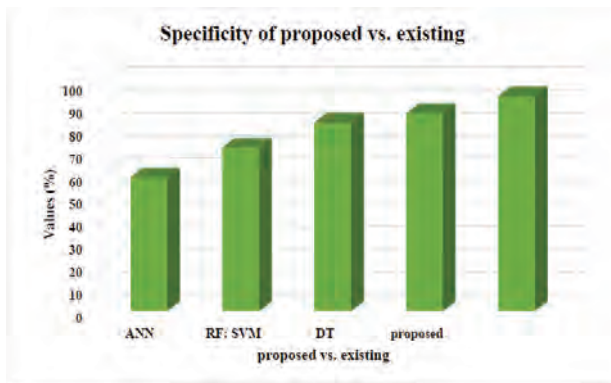


Fig. 5 Sensitivity of proposed vs. existing

The three metrics used to assess the classifier's effectiveness in identifying cancer are sensitivity, specificity, and accuracy. The findings clearly show that, compared to the other classifiers employed in this work, the suggested A² E classifier can achieve the highest specificity, accuracy and sensitivity levels. The proposed model likewise maintains a high score when the A² E classifier is used to compare it to the other classifiers. For the Moment Invariant feature, the accuracy of this fused classifier is 84.63%; for the attained feature, it is 90%; and for the higher dominant feature, it is 87%. This outcome is primarily attributable to advances in border detection and the rational selection and utilization of several operational and discriminative characteristics.

CONCLUSION

Compared to the standard biopsy procedure, this study proposes an image-processing-oriented skin cancer detection system with higher diagnostic accuracy. Computer-based skin cancer detection is much better for patients. In doing so, patients can save time and be better prepared for treatment by accurately and quickly diagnosing skin cancer. The diagnosis approach in this work makes use of an image-processing methodology. The discovered skin region is pre-processed using the median filter before using the A² E technique to segment the affected region over the healthy skin. The features are hauled out using the intermediate layers. To diagnose skin diseases, the features that have been extracted are categorized utilizing A² E. In this case, compared to the previous classifiers, the A² E classifier does better.

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Analyzing the Effect of Cyber-Bullying using Integrated Learning Model

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ABSTRACT

Due to its increased prevalence and easy dissemination through communication technologies, cyberbullying poses a severe threat to modern society. It has a profoundly detrimental effect on those who are targeted. To decrease the suffering of the victims, it is crucial to recognize instances of cyberbullying on social media platforms as soon as feasible. This article investigates several approaches that consider the delay associated with cyberbullying detection on social networks. Researchers utilize threshold and dual models, the distinct early detection model known as Integrated Poisson and Gaussian Process (IPGP), in conjunction with a supervised learning approach. The former requires two machine learning models and uses a simpler approach. This is the first study that we are aware of that looks into early detection of cyberbullying. Precisely for this topic, they provide two sets of characteristics and two early detection techniques. It initially performs various evaluations penalizing late detections, then does an extended evaluation using an actual world dataset. Our findings indicate that baseline detection models can be enhanced by up to 42%.

KEYWORDS: Cyber-bullying, Machine learning, Prediction, Integrated model, Detection.

INTRODUCTION

A group or an individual that frequently and persistently engages in hostile, purposeful behaviour directed towards a victim who is unable to protect themselves is known as bullying [1]. Cyberbullying is aggressive behaviour through information technologies (IT) like the Internet. Because online communication and social media are constantly expanding, Cyberbullying is recognized as a significant issue and a public health concern [3]. Because of the increased use of social media, mobile devices, and IT by kids and teenagers, the percentage of people who have at some point in their lives experienced cyberbullying has doubled, from 18% in 2007 to 36%. This trend is

only predicted to increase. Traditional bullying and cyberbullying have similar negative consequences [4], but because of the increased frequency and high dispersion made possible by technology, cyberbullying may even be more harmful. Research has established a connection between cyberbullying and detrimental impacts on mental and physical well-being, education, sadness and an increased likelihood of contemplating suicide. Therefore, it is imperative to spot cyberbullying as soon as it starts on social media to minimize its adverse effects on its victims. Furthermore, as cyberbullying is recurrent, it is imperative to find the offenders and assist the victims by quick identification and termination of cyber-aggression [5].

Researchers hope to investigate several strategies that consider the appropriate time required for cyberbullying to be detected in social networks and its actual incidence. To the best of our knowledge, we look into methods expressly meant to detect cyberbullying early. Several and varied papers have been published in the literature that examine various approaches to identifying cyberbullying on social networks [6]. Much like earlier works, we take a supervised learning strategy yet concentrate on two distinct early detection techniques: threshold and dual. Should the latter call for two machine learning models, the former takes a more straightforward method. We also suggest two novel feature groups tailored to this particular issue. The first group looks for textual parallels between remarks made utilizing the Bag-of-Words (BoW) model [7] and repeating time features captured on the comments in the second group [8]. An extensive evaluation is conducted on an actual dataset by researchers using a time-aware technique that penalizes late detections [9] – [10]. By using the threshold model, baseline detection models can be improved by 26% and the dual model by 42%, according to our findings. The following briefly describes the primary contributions of this work:

Our findings define and characterize the challenge of early identification of cyberbullying.

The study presents two distinct machine learning models based on the Integrated Poisson and Gaussian Processes (IPGP). It examines the impact of feature sets (BoW features) on performance enhancement in addressing cyberbullying early detection.

Our analysts conduct comprehensive tests with a real-world dataset, proving the performance gain over baselines through a time-aware evaluation.

The book is arranged as follows: part 2 offers a thorough examination of the numerous methods that are now in use. The methodology is described in detail in Section 3. The numerical results are covered in Section 4, and Section 5 concludes.

RELATED WORKS

By using novelty-based features, Qin and colleagues aim to improve the early identification of rumors on social media, taking into account the greater prevalence of unverified information in messages compared to reliable

sources of information [11]. Compared to today's real-time and early detection baselines, their suggested technique performs noticeably better, according to their testing utilizing data gathered from the Chinese social media platform Sina Weibo. Furthermore, grouping tweets according to the possibility that they genuinely include a contested factual claim offers a rumour detection technique. The evaluation conducted by the authors takes into account the earliest detection time by gauging the ability of a method to identify a rumour within an hour of batch processing. More recently, at the Conference, on the social media platform Reddit, a session on early risk prediction on the Internet (eRisk) addressed a range of subjects including the diagnosis of depression, anorexia, and self-harm. Using linguistic Meta-information extracted from participant papers, a recurrent neural network classifier was developed using one of the most effective techniques for early depression identification [12]. Frequency within the class, significance inside the class, and significance of terms between the classes are the three-word statistics used in the word-based strategy described to evaluate risk. Regarding cases of depression and self-harm, this strategy has shown encouraging results. Additionally, by creating particular learning models (such as dual and singleton), researchers have examined early depression diagnosis on social media, thus improving the performance of past studies.

To find cyberbullying in a multimodal social media environment, the authors of [13] identify several textual, aural, and visual elements. Their findings imply that audio-visual components could improve the effectiveness of merely text-based cyberbullying detection tools. Additionally, Van et al. investigate the automatic identification of posts in both Dutch and English on social media connected to cyberbullying. The suggested model outperforms the analysis baseline and detects erroneous positive results about implicit cyberbullying or offences involving irony using six natural language processing features (topic models, term lists, character n-grams, and word n-grams). The authors look into several machine learning models' applications in detecting Vine social network cyberbullying. AdaBoost and Random Forest yielded the best results. The researchers focus on identifying instances of cyberbullying on the social media platform

Instagram. They employ SVM and Naïve Bayes classifiers [14], which achieve the most outstanding results by combining media session data and multimodal text and image features. Some other publications focus on the traits that identify cyberbullying. These characteristics include, but are not limited to, the analysis of user social network structure, features related to profanity, geographic features, sentiment analysis or the combination of text and image analysis algorithms. The author offers a careful review of available research on cyberbullying automated identification. Globally speaking, the majority of works use textual features, which are followed by sentiment traits. Social and user characteristics, factors like age, gender, and the quantity of followers or friends are also commonly taken into account [15]. Remarkably, only a few studies incorporate temporal variables into their models to accurately represent the repeated and temporal components of cyberbullying. Regarding F1 and Area Under the Curve (AUC), the based prediction model outperforms cutting-edge models thanks to the inclusion of a time interval prediction. The authors model the time dynamics of cyberbullying in online sessions and show how incorporating these temporal aspects increases cyberbullying detection efficacy.

METHODOLOGY

Dataset

Our goal is to investigate the issue of cyberbullying early identification by utilizing a publicly available dataset gathered via the Vine social media platform. Using a snowball sampling technique, the dataset was collected by selecting user *u* as the seed and then gathering users who follow '*u*'. This work assures the social network's representativeness and offers a thorough investigation.

Prediction model

One can project the system's quantitative behaviour using a mathematical model. Comparative analysis of quantitative findings from mathematical models with empirical data helps determine the model's merits and drawbacks. Hence, a mathematical model is proposed to identify DDoS attacks in this part. Throughput and bandwidth are the two most important factors in identifying assaults. Throughput measures the quantity of data successfully transported from the source to

the destination, while bandwidth indicates the amount of data that can be carried across a communications channel. Eq.(1) provides the bandwidth depletion probability, the foundational formula used to determine the correlation between throughput and the inter-arrival period of demands.

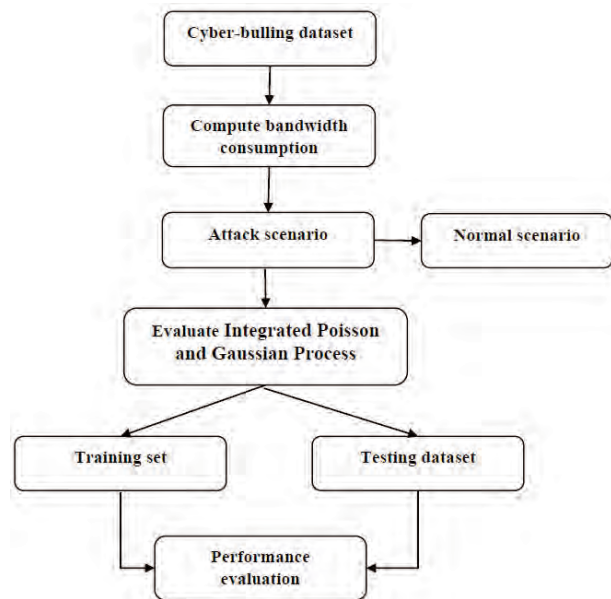


Fig. 1 Activity diagram

The derivations from Eq. (1) to Eq. (3) show inverse relatedness between inter-arrival time and throughput. Eq. (4) is utilized to compute throughput. The following provides the likelihood of computing bandwidth consumption:

$$P_{BC} = (\alpha^c / c!) / \sum_{i=0}^{c_i=0} \alpha^i / i! \quad (1)$$

$$\beta_{AB} = TP_A / I_{AB} \quad (2)$$

$$\beta_{LB} = TP_{LB} / I_{LB} \quad (3)$$

in which $\alpha = (\beta_{AB} + \beta_{LB}) / \beta_{total}$. Here, *C*: The quantity of available or underutilized bandwidth. In both attack and regular traffic scenarios, let's assume that the packet size remains constant, i.e.

$$TP_A = TP_{LB} = T_B \quad (4)$$

$$\alpha = \frac{T_B}{\beta_{total}} \left[\frac{1}{I_{AB}} + \frac{1}{I_{LB}} \right] \quad (5)$$

Following are some inferences that can be drawn from Eq. (4) to Eq. (5):

$$\alpha = K^* 1/I_{AB}, K = T_B/\beta_{total} \quad (6)$$

$$\alpha = \frac{1}{I_{AB}} \quad (7)$$

$$P_{BC} \propto \frac{1}{I_{AB}} \quad (8)$$

$$P_{BC} \propto \frac{1}{I_C} \quad (9)$$

Inter arrival time, the difference between two consecutive data packets, is used to identify assaults based on the conclusions drawn from Eq. (9). Using a sliding window of ten seconds, one looks at this arrival time. The average inter-arrival time is determined using the formula in Eq. (10):

$$Arrival_{mean} = \frac{1}{N} \sum_{i=1}^n IP^{arrival\ time} \quad (10)$$

Here $IP^{arrival\ time}$ displays the inter-arrival time between IP addresses inside a 10-second sliding frame. Attack packets are distributed using Poisson processes, whereas regular clients are distributed using Gaussian processes. The CAIDA datasets from 2007 are employed in this work for real-time estimation by concurrently examining the attacks and the typical scenario's throughput and inter-arrival periods. Eq. (11) shows the formula used in this procedure.

$$T_h = \text{transfer packet}_{size} / \text{Inter-arrivaltime}_{attacker} \quad (11)$$

The throughput, arrival frequency, and inter-arrival time are examined for attack and normal conditions. In the corresponding tables, a portion of the datasets are visible. Table 1 summarizes the attack scenario and includes information regarding protocol, source and destination IP addresses, frequencies, throughput, and data packet inter-arrival times. The median value determines the criterion for throughput. Throughput below the cutoff is viewed as low and assigned the standard categorization; throughput beyond the threshold is deemed high and classified as an attack. The mathematical model allows a Miss Rate of 0.0025. What is known as a false negative is the likelihood that the mathematical

model may overlook a true positive. Miss Rate: $FN / FN + TP$. Real-time CAIDA 2007 datasets, particularly those with information on denial of service, are used as input for mathematical models. Mathematical models predict which data is standard and which is under attack by analyzing the throughput and frequency of that specific information. It's similar to how higher throughput equates to more processing time. Still, more processing time prevents legitimate clients from taking charge, fulfilling their processing needs, and allowing their requests to wait in line indefinitely. Validation in terms of miss rate is also carried out to assess whether the mathematical model is accurate.

Table 1 Description

Notation	Details
1	Probability of bandwidth consumption
2	Attack-based bandwidth consumption
3	Bandwidth consumption
4	Total bandwidth
5	Transferred attackers' packet
6	Transferred legitimate packet size
7	Attackers arrival rate
8	Legitimate arrival rate
9	Bandwidth not used

NUMERICAL RESULTS AND DISCUSSION

To evaluate the performance, the dataset is split 80 percent for training and 20 percent for testing. The dataset is split into social media sessions, each containing all the postings. To help the models generate predictions, the posts are sent sequentially and chronologically. Computed at the 95% confidence level and shown are confidence intervals. It will consider two measures as assessment metrics: latency-weighted F1-score, developed primarily to address the issues of early detection, and early risk detection error, which was applied in a different context. They were utilized in both situations to gauge an individual's performance in terms of early depression identification based on postings they made on social media. Typically, as a parameter provided, measured at a particular time point, the metric needs k comments to generate a final forecast. After analyzing k-comments, it is defined as

follows for a given session. False optimistic or false pessimistic forecasts increase the error by one in the latter instance and proportionately depending on the number of positive examples in the former.

$$Performance\ metrics\ (s_i, k) = \begin{cases} \frac{\sum_{s_i \in S^{b_{s_i}} true}}{|S|} & \text{if } FP \\ 1 & \text{if } FN \\ 1 & \text{if } TP \\ 1 - \frac{1}{1 + e^{k-0}} & \text{if } TN \\ 0 & \end{cases} \quad (12)$$

$$F_{latency}(s_i, k) = F1 \cdot \left(1 - \text{median}_{s_i \in S^{b_{s_i}} true} \left(-1 + \frac{2}{1 + e^{-p(k-1)}} \right) \right) \quad (13)$$

The required number of postings should surpass the measuring point; a true positive could have a negative effect, but a genuine negative wouldn't increase the error. The author proposes the latency-weighted F1, sometimes called F1-latency, as a replacement for the performance measure considering accuracy and latency. The F-latency measure is defined as follows: The standard F-measure is computed as the harmonic mean of precision and recall; p is a parameter controlling the penalty's growth rate. It is designed to attain half of the delay penalization at the middle item count. Since ERDE is an error metric, values around 0 are preferable, and values near 1 indicate successful latency results. It will depend more on latency because the metric has been found to have certain limitations. The latency parameter (p) is set to 0.22788 by default, and the performance findings are displayed at a low time point ($o = 5$). It will also present the precision and recall conclusions from the initial studies as complementing values.

Table 2 Comparison of the proposed model based on various feature sets

Metrics	Threshold model	Boosting model	Vector model	Regression model	Proposed model
Profile-based features					
Error rate	0.175	0.168	0.161	0.2054	0.1589
Latency	0.141	0.136	0.267	0.275	0.105
Precision	0.190	0.333	0.411	0.180	0.565
Recall	0.121	0.090	0.212	0.727	0.829
Comment-based features					
Error rate	0.160	0.174	0.159	0.196	0.1600
Latency	0.288	0.046	0.278	0.219	0.3000
Precision	0.400	0.125	0.466	0.162	0.4789
Recall	0.242	0.030	0.212	0.393	0.4040

BoW features					
Error rate	0.165	0.171	0.172	0.171	0.1426
Latency	0.048	0.119	0.048	0.166	0.050
Precision	0.166	0.200	0.166	0.307	0.667
Recall	0.030	0.090	0.030	0.121	0.1818

Profile feature-set based comparison

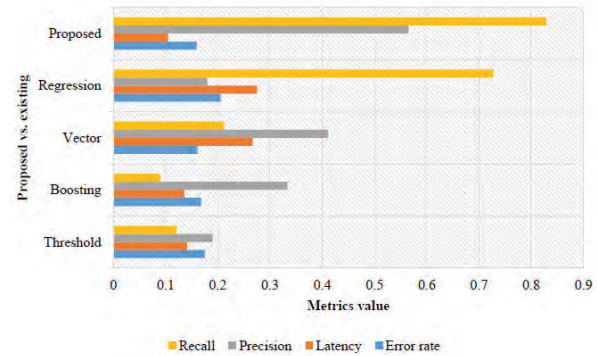


Fig. 2 Profile feature set-based comparison

Comment feature set based comparison

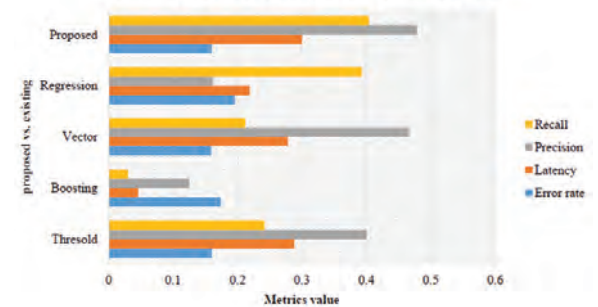


Fig. 3 Comment feature set-based comparison

BoW feature set based

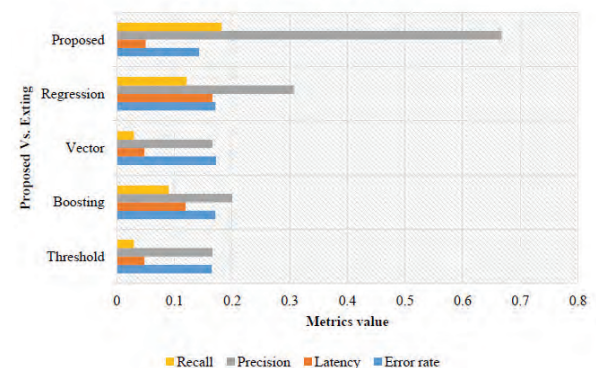


Fig. 4 BoW feature set-based comparison

To evaluate performance, twenty per cent of the dataset is used for testing and eighty per cent for training. Social

media sessions have been created from the dataset, with every session comprising all of its postings. The models are given the posts sequentially and chronologically to forecast what will happen next. The 95% confidence level is used to construct confidence intervals when reporting them. The performance of the baseline models is verified in the first series of trials. After processing five comments, they first report the results for baseline models in Table 2. The way the characteristics taken into account in this work behave is where we will begin our investigation to see which can perform better in early cyberbullying detection. For completeness, precision and recall are also provided in Table 2, with the findings for each feature discussing the metrics and latency as early detection tools. The initial five sets of features align with the findings published. The comment features yield the highest metrics (0.15 ± 0.0035) and F-latency (0.33 ± 0.0048) performance. This is driven by comments focusing on knowledge that shifts throughout the session while other components are presented. Notably, the performance obtained with media session characteristics, which is substantially lower than the performance with comments features, yields the second-best results (0.2881 ± 0.0046 and 0.1599 ± 0.0037 , respectively).

BoW has high precision ratings; the former is tied for second place with comment features, while the latter gets the best score. Based on BoW features, some features will identify terms that appear repeatedly in cyberbullying comments. Still, many false negatives result (see the low recall value). These terms will also show up in regular comments. The accuracy of the time values confirms that there is typically a shorter time interval between cyberbullying remarks; nevertheless, some average comments may also exhibit this characteristic, leading to low recall scores. In summary, the features that have been suggested are anticipated to be an excellent supplement, despite this, they are not any more effective at early detection than baseline traits.

CONCLUSION

The goal of this research is to create a model that addresses the issue of early detection and provides problems related to cyberbullying. Additionally, we created a distinct Integrated Poisson and Gaussian Process (IPGP) model that is used in our evaluation to

confirm how well they worked. Based on a real-world dataset from the Vine social network, researchers used a variety of performance metrics to guide the experimental evaluation. Our results suggest that the IPGP model can significantly outperform the baseline detection models by 30% compared to the existing model; the IPFP model can further increase this by up to 45%. The best results are also obtained by employing IPGP, where features like profile owner, media session, comment and video are coupled with the proposed features. The proposed model mostly shows that it performs consistently better for early cyberbullying identification. This is so because the negative model uses more straightforward data (such as profile owner attributes). In contrast, positive case identification depends on all features, and low thresholds provide early detection.

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Poisson Process based Stroke Prediction for Elderly People using EEG Signals

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ABSTRACT

Stroke disease frequently results in death or profound impairment. Thus, early detection of prognostic indicators and active primary prevention are essential. There are two forms of stroke disorders: ischemic and hemorrhagic. Both should be treated with emergency coagulant or thrombolytic therapy as soon as feasible. Precursory symptoms of a stroke might vary from person to person, so it's essential to recognize them in real-time before seeking professional assistance within the treatment window. Rather than identifying predictive markers for stroke, prior research has concentrated on modelling acute care protocols once the disease has occurred. According to recent studies, prognostic indicators in stroke patients can be found and predicted with great assistance using methods for image analysis like MRI and CT. These approaches have drawbacks, such as lengthy test times and high testing expenses, and they are challenging to detect early and in real time. Our objective was to develop a method known as Poisson-based binomial cumulative distribution model (PBCDM) to generate a real-time walking stroke disease prediction system. The recommended method considers how comfortable the data are for older adults. The experiment results showed that the prediction model gives 96% recall, 94.6% precision, 95% accuracy and 95.3% F1-score. Additionally, the proposed PBCDM model was shown to predict with a reasonable CV of 96.5% for 5-fold CV, 94.6% for 10-fold CV and 95% for 15-fold CV utilizing raw EEG data. Consequently, high prediction performance and accuracy were concurrently demonstrated in the senior stroke patients' real-time prediction.

KEYWORDS: EEG signal, Stroke prediction, Machine learning, Poisson process, Distribution.

INTRODUCTION

Ischemic and hemorrhagic strokes are kinds of strokes that arise from the rupture of a blood vessel or the severing of an artery carrying blood to a particular part of the brain [1]. That is a neurological condition resulting from injury to a specific brain region. Since strokes can result in deficiencies in both the body and mind, such as dementia, hemiparesis, ataxia, impaired eyesight, and, in extreme cases, speech impairment (aphasia), they are regarded as one of the most dangerous disorders

in modern society [2]. The World Health Organization (WHO) released its 2021 Causes of Death Report. It states that the top 10 causes of mortality accounted for approximately 55 million deaths in 2021, or 56% of all reported deaths. With 6 million deaths, cerebrovascular illness was the second leading cause of death among them [3] – [4].

A stroke is defined as a cerebrovascular illness diagnosed based on data gathered on neurological diagnosis and severity by a medical team. Brain MRIs

and CT scans are the main neurological diagnostic methods for diagnosing strokes [5]; however, further studies have demonstrated the potential utility of bio-signals, including electrocardiograms, brain waves, and muscles, for diagnosing and preventing strokes [6]. Furthermore, the prevalent causes of stroke are being identified by the use of echocardiography, single photon emission computed tomography (SPECT), ultrasonography evaluation, and cerebral angiography. While imaging methods like CT and MRI have become more commonplace in recent years for the detection of strokes, there are still limitations with these modalities in terms of evaluation and diagnosis of radiation exposure, claustrophobia in small spaces, and hypersensitive reactions resulting from contrast agent drug penetration. Since test results could contain inaccuracies, decisions should be based on accurate information and the professional medical understanding of the medical personnel, it is believed. The National Institutes of Health in the United States released the NIHSS is utilized as a research tool to assess early disability in stroke patients and avoid recurrence [7]. Even if stroke patients' initial impairment is assessed using the NIHSS approach, there are still issues with real-time initial impairment detection and challenges with clinical and psychological evaluations. One of the primary risk factors for stroke is atrial fibrillation, and recent research has demonstrated that ECG can be used in a variety of ways to predict and prevent stroke disorders. Atrial fibrillation (AF) has been shown in patients with hypertension to have a more significant than a five-fold increase in the risk of cerebral infarction, making it a significant risk factor for stroke on its own. In an earlier study, clinical trials were used to identify risk factors for stroke diseases, high blood pressure, smoking, diabetes, and obesity, according to the findings [8]. As a result, a method for helping the elderly assess their unique stroke risk factors and identify any potential illness early and in real time is required. Recent research has attempted to circumvent these constraints by employing statistical or machine-learning approaches to predict stroke illnesses while considering specific risk variables. The drawback of these approaches is that they also produce forecast data in black-box format, which makes them challenging to understand. Heuristic techniques and partial analytical

methods can be coupled for decision tree methodologies [9]. However, at the moment, research on prediction and systems that can incorporate earlier research methods and consider the potential for semantic interpretations and growing sickness is particularly desirable [10].

The proposed model is applied in studies using machine learning methods based on EEG signals. This is a crucial contribution since it provides medical professionals access to semantic analysis outcomes, allowing for active application in objective diagnosis and therapy prediction. The stroke monitoring and prediction approach presented in this paper has been experimentally proven useful for low-cost everyday health care services and prognostic indicators of stroke sickness predicted in real-time. The data used in this investigation are EEG signals captured as older adults 65 years or older were strolling. Using twenty key features and a variety of machine-learning algorithms, the prediction accuracy of the Poisson-based binomial cumulative distribution model (PBCDM) was 95%. Furthermore, the PBCDM learning model demonstrated strong performance for the stroke disorders prediction system, confirming a 95% prediction accuracy that is considered satisfactory.

The work is organized as follows: section 2 gives detailed examination of existing research approaches for stroke prediction among older adults. Section 3 elaborates on the methodology with the PBCDM model. Section 4 shows the numerical outcomes, and section 5 provides a summary.

RELATED WORKS

A skin-attached electrode and accompanying apparatus measure a bio-signal called an electrocardiogram, used to examine the heart's electrical activity over a certain amount of time. The electrocardiogram (ECG) bio-signal is a commonly used biopotential signal that varies in amplitude and frequency. It is utilized as a significant nonvascularized diagnostic tool for the condition of the heart [11]. Cardiovascular disease, pacemaker, heart size and location, and other cardiac modulators are among the cardiac modulators that can be recorded using an electrocardiogram (ECG) in addition to rhythm and heart rate. In addition to X-rays, a vital diagnostic test is an electrocardiogram (ECG), the best way to determine a

cardiac arrhythmia or irregular heartbeat. Several heart-related illnesses, such as cardiomyopathy, dilatation, atrial or ventricular hypertrophy, pulmonary circulation problems, anomalies in electrolyte metabolism, and medication interactions, can be diagnosed with an electrocardiogram (ECG) [12]. An advantage of this non-vascular test is that it may be performed easily again without causing patients any pain.

A recent preliminary study found that most ECG investigations target the detection of arrhythmias, such as AF. Previous studies that used ECGs to identify and categorize arrhythmia or AF include the following: Three key physiological and clinical parameters of AF were used in a survey to separate the ECG's AF features [13]. They specifically examined the three traits of atomic activity, irregular heart rate, and absence of P waves. They discovered they have a sensitivity of 96.09% and a specificity of 93.80%. These findings support the fairly accurate distinction of AF symptoms. The author [14] built and examined sixteen-layer 1D CNNs based on deep learning to identify ECGs, including AF. These are methods for avoiding layer-to-layer interlayer connections. Additionally, it has been noted that the transmission speed and training duration of the connecting layer weight values could be increased.

Additionally, studies have demonstrated that in less than 0.01 seconds, accurate diagnosis could be made between regular and irregular rhythms, like AF. For instance, the author [30] investigated a novel method called Kardia Band (KB), which enabled recording rhythm strips using an Apple Watch made in Cupertino, California. To ascertain if 12-lead ECG and KB recordings can reliably distinguish between AF and sinus rhythm that are evaluated by medical experts, an investigation was conducted using an app that offers automatic atrial fibrillation detection. Electro-physiologists assessed the 57 KB of unintelligible data and found that AF was identified with 100% sensitivity, 80% specificity, and a 0.74 K coefficient. These experimental findings suggest that medical personnel can use KB to identify and reliably differentiate between sinus rhythm and AF. According to the study [15], accurately diagnosing patients before choosing cardio-version could be beneficial.

An experiment discovered that the augmentation index and the aortic pulse wave's speed were independent predictors of adverse cardiovascular events, such as death. Additionally, they conducted experiments to confirm that diastolic pressure and tightened central elastic arteries dropped in hypertension and ageing, resulting in higher central systolic and pulse pressures. These symptoms led to a notable increase in left ventricular (LV), pulse pressure amplification and pulse wave velocity (PWV). Consequently, the arterial pulse wave is unbalanced, which promotes ventricular hypertrophy due to the rise in both the left ventricular burden and the myocardial oxygen demand. Therefore, timely and precise treatment and diagnosis are crucial study issues [15]. The onset of atherosclerosis and irregularities in the arterial pulse wave are precursors of cerebral infarction, stroke, and cardiovascular diseases.

METHODOLOGY

Preictal, Interictal and ictal periods that occur in an order of EEG signal from the channel obtained from a patient. An EEG signal, for instance, is separated into distinct time intervals or epochs to determine an ictal, interictal, or preictal period. The phase correlation evaluates the fluctuation among present and subsequent epochs. The relative change shows that there is a signal transition from the ictal to the interictal phase or from the interictal to the preictal phase. Features are derived from the changes among epochs. Fig 1 shows the schematic of the suggested global feature extraction. Assume that, r and c specifies the current and past (epoch) of the input signals respectively that comprises of all values within the given time window. It is found that the equivalent converted signals R and C are as follows. After the reference and current epochs are subjected to Fast Fourier Transformation (FFT):

$$R = \varphi(r) \quad (1)$$

$$C = \varphi(c) \quad (2)$$

Where, φ specifies FFT function. Next, utilizing transformed signals, the phase correlation μ of r and c is found by applying the shift FFT and inverse FFT functions:

$$\zeta = \vartheta |\varphi^{-1}(e^{j(<R-<C)})| \quad (3)$$

Where $\mathcal{F}$ represents shift function (FFT) and $\angle$ denotes the angle. Next, the following formula is used to determine the displacement between two epochs:

$$k = \max_{\arg t} (\zeta(t)) - \pi \quad (4)$$

Where π represents epochs location and t is any sample location inside it.

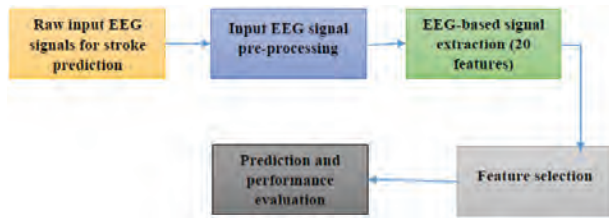


Fig. 1 Block diagram

The stroke prediction system based sensitivity level must be computed to assess its performance. The optimal timing for the alarm to sound during a seizure is shown. This indicates that the alarm should sound at the beginning of the preictal period and continue to sound throughout the entire preictal period. Another good seizure prediction is seen, where preictal classification or alarm begins later and lasts until the seizure starts.

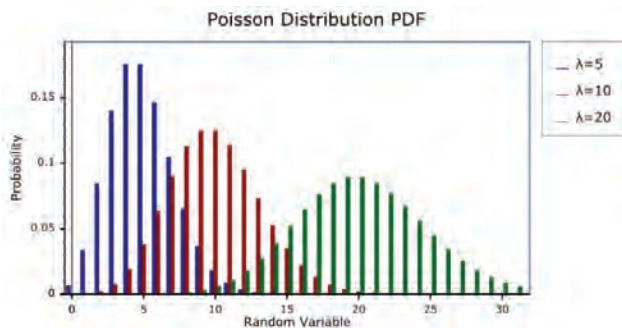


Fig. 2 Poisson distribution

An incorrect seizure prediction is shown where the preictal categorization is stopped before the seizure occurs in the third row. Measuring chance level sensitivity is crucial to confirming the effectiveness of the suggested prediction technique. According to [11], the probability level sensitivity Sen is:

$$sen = 1 - \exp(-l w^{\mu} w + (1 - e^{l w^{\mu} w_0})) \quad (5)$$

Here, Poisson rate $\ell_w = \left(\frac{1}{\mu_w}\right) \ln(1 - \eta_w)$ In Eq. (5), is the warning length of SPH which denotes the detection

interval and proportion of time under warning. The p-value represents the improvement in sensitivity above the chance level, which may be used to quantify this.

$$\rho = 1 - \theta(\lambda_p - 1, \lambda_a, sen) \quad (6)$$

The variables show the number of seizures represents λ_p , the anticipated number is λ_a , and the binomial cumulative distribution function is θ .

NUMERICAL RESULTS AND DISCUSSION

This section explains the gathering and pre-processing of multimodal bio-signals like EEG (https://figshare.com/articles/dataset/EEG_datasets_of_stroke_patients/21679035). These signals are then utilized to predict stroke disease using deep learning and machine learning and for in-depth analysis and verification. EEG data that are monitored and gathered in real time are the bio-signals employed in the tests carried out in this work. The EEG bio-signals resemble a wavy line during strokes, representing the electrical current that travels through the contraction and relaxation. EEG records signal variations in response to the brain in the peripheral areas, electrical pathways, and brain signals. Major stroke due to hypertension can be found by looking at the EEG signals. As a result, we used the clinical data from this study to demonstrate how anomalies in the sympathetic and autonomic nervous systems can emerge from stroke prognostic signs. Scholars endeavoured to forecast the prognostic indicators associated with stroke illness and explain their implications using professional medical judgment and diagnostic findings of bizarre symptoms such as stroke arrest. Furthermore, using the EEG signals where the model was applied to assess predictive tests for stroke in elderly patients.

Performance evaluation

This section assessed the system's performance, and the EEG signals accurately predicted stroke prognostic symptoms. This work employed four performance evaluation indicators, each described in full in the equations Eq. (7) to Eq. (10). The portion of the total correctly classified older stroke victims as such and seniors in good health, as usual, is known as accuracy. The percentage of stroke patients that tested positive for remembrance is the F1-score, representing the precision and memory harmonic means. To sum up, the percentage

of people who test positive for stroke constitutes precision. False positive (FP) is the total records for people with stroke were mistakenly classified as usual; false negative (FN) is the total records in which older people with normal were correctly predicted to be elderly (TN); true positive (TP) is the total records of people with stroke were correctly predicted to be elderly with stroke.

$$Accuracy = \frac{TP + TN}{TP + FN + FP + TN} \quad (7)$$

$$F1 - score = 2 * \frac{Recall * precision}{Recall + precision} \quad (8)$$

$$Recall = \frac{TP}{TP + FN} \quad (9)$$

$$Precision = \frac{TP}{TP + FN + FP + TN} \quad (10)$$

Table 1 Metrics comparison

Methods	Recall	Precision	Accurate	F1-score
SVM	91%	91%	89%	89.1%
C4.5	71%	75%	72%	72.2%
NB	88.7%	74%	90%	17.2%
MLP	90.2%	89%	92%	90.4%
RF	76.8%	92%	92%	95.3%
Boosting	77.1%	76%	77%	89.4%
PBCDM	96%	94.6%	95%	95.3%

Table 2 CV comparison

Methods	5-fold CV	10-fold CV	15-fold CV
SVM	90	91.6	92.7
C4.5	71	71.9	72.5
NB	71.5	71.2	71.5
MLP	88	91.4	92
RF	87	90.1	86
Boosting	90	77.2	74
PBCDM	96.5	94.6	95

When it comes to the categorization and prediction of diseases in the medical and healthcare industries, misdiagnosing a patient as having an illness when they are a general practitioner without that illness may be able to have severe consequences and even endanger

the patient's life on the other hand, misclassifying a general patient who does not have a particular condition as having it could result in wasting money on unnecessary tests and treatment. Thus, this research uses all four performance evaluation indices to validate older people's predictive capacity for stroke situations thoroughly. This led to the experiment being focused on identifying and evaluating a model that could predict stroke prognosis with a low rate of false positives and excellent accuracy.

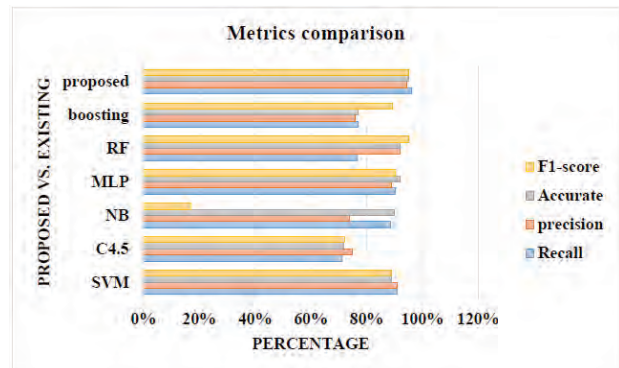


Fig. 3 Performance metrics comparison

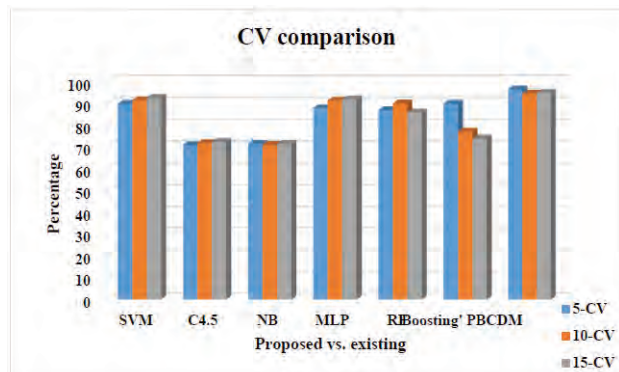


Fig. 4 CV comparison

CONCLUSION

In this work, scientists describe a system that uses several biological signals, including EEG, PPG and ECG, that people walk around with regularly to provide the disease analysis in the elderly. In addition to gathering numerous real-time EEG signals, the suggested method has the potential to quickly identify and forecast prognostic signs of stroke in older persons. Many signal data sets were used in a study that employed a machine learning-based prediction model and a

Poisson-based binomial cumulative distribution model (PBCDM). This model divides the signal waveform into many segments, yielding predictions and semantic interpretations that are comparatively accurate. This work demonstrated experimentally how the suggested traits allow prognostic symptoms of stroke patients to be predicted with over 95% accuracy using only the collected EEG signals. Researchers have shown that they can accurately forecast 92% C4.5, 92% RF and MLP with 91%. The outcomes of the experiment and verification are summed up in these conclusions. This work describes a device with tremendous academic significance because it can effectively anticipate prognostic signs and stroke onset. It is inexpensive, easy to wear, and capable of measuring EEG daily.

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Cloud-Based Trust Analysis to Evaluate Security Issues Encountered in E-Health Cloud System

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ABSTRACT

Information and Communication Technology (ICT) is a novel development worldwide, enhancing various environments' services. IT (Information Technology) mainly innovates the health sector by maintaining electronic health (e-health). To utilize the entire and admirable advantage of IT, it is indispensable to implement it in a cloud-related platform. Although e-medical records (EMR) present in the cloud memory facilitates numerous benefits, there still exists an issue related to confidentiality and security. This research concentrated on a broad review of existing literature on different models and systems applied to conserve the protection and privacy of electronic healthcare documents. Experts provide a suitable and standard explanation of electronic health. We also took some action to categorize cloud-based techniques. As appealed by the e-Health-based Proxy model, we put an effort into focusing on security and confidentiality requirements. Observations and suggestions were prepared based on the review process and future enhancements interrelated to the security and confidentiality of e-health in cloud computing, and those results are provided for evaluation. As a final point, experts developed a protected and reliable structure for e-health that promises privacy, consistency, efficiency and standard architecture for maintaining health data.

KEYWORDS: *Health care, Cloud, Proxy model, Security, Confidentiality.*

INTRODUCTION

The emerging Information and Communication Technology enhanced the common strategies used for healthcare practices around the medical field. The enhancement is evident in medical prescriptions, where paper-based prescriptions are transferred to electronic versions in many developed regions [1]. The necessity of association and incorporation of different health data acquired from various fields like health insurance corporations, hospitals, and clinical research directed to electronic personal medical records (e-Health) requirements. The data linked to the patient's health is

processed, shared and manipulated using the information technology framework and e-commerce services [2]. Since various domains request medical records while examining health-interrelated information, it is critical to supply the requested data effectively, which led to the progression of cloud storage across several administrative platforms [3]. Cloud environment can facilitate the sharing of requested data for a specific domain. There are a lot of benefits presented by the cloud environment, among which is that extracting and sharing users' health records is considered crucial. It also focuses on supervising the framework of healthcare facilitators and supplying sufficient space to gain

knowledge about information technology providers [4]. Cloud computing provides several advantages, such as reliability, cost efficiency, and rapid record retrieval for the mutual distribution of data and resources [5]. Despite its benefits, it is essential to focus on the protection and security threats to enhance its efficient usage and large-scale utilization [6]. Cryptographic and non-cryptographic techniques are employed in the cloud computing location to assure the safety of user health information. The secrecy in e-health records is achieved through well-organized and subject-centric access control approaches. This research reviewed different security measures to accomplish confidentiality in e-health information. We also exposed the various methods for and against. Steps are taken to facilitate better strategies to sustain the e-health records [7].

There needs to be more than the current confidentiality-preserving approaches to assure infallible security in the electronic medical data in the cloud. The primary threat to the cloud-stored e-health records is the internal hacking of cloud servers by the users with authentic permission to access information within the institute [8]. Here, the hackers are none other than database administrators and chief executives; these kinds of attacks are more vulnerable than external attacks. The advantages and difficulties of the current approaches are evaluated for security and confidentiality related to electronic health data, which includes several sensitive and private data ranging from the subject's financial information, such as details about credit cards and social security ID [9]. Hacking these details not only results in economic loss to the users but also affects the fundamental right of a consumer, which is the right to privacy [10]. The significant research contributions are provided below:

The initial phase of this research starts with a selection learning process to ensure the accuracy of the data request and retrieval procedure. The selection learning approach is applied to lessen the search area and extract the required data from e-records associated with healthcare and computer science.

It takes less time to gather relevant experimental facts related to specific areas to acquire the models to achieve results and conclude the research.

This part performs a definite learning process for

confidentiality and security to compare and evaluate the study's root, ensuring the understanding of personal health records as a component of the qualitative examination of data.

The work is demonstrated in section 2, which demonstrates an analysis of existing approaches. Section 3 gives the methodology and results, and section 4 gives the conclusion.

Related works

In the present significant information epoch, data propagation requires redistributing healthcare documents to on-demand servers. Despite the incredible benefits of the cloud, it also involves hazardous threats to protecting and securing healthcare information. Data disclosure, malicious software injection violence, collusion attacks [11], Denial of Service threats (DoS), spoofing, and man-in-the-middle points are some cryptographic threats in the cloud's memory. Cloud providers and various other government organizations recommend different security measures and protocols to ensure and develop the assurance of individuals and organizations. The Health Insurance Portability and Accountability Act (HIPAA) is the initial measure presented by the US Congress for their healthcare organization. Cloud servers comprise three main varieties: trusted, untrusted, and semi-trusted. In the first type, a trusted server is a completely trusted server without any data disclosure, and internal chief directors are specified to be the only threat to the fitness-associated data [12]. Without any confidential preservation techniques, untrusted servers are not confidential and are susceptible to attacks from outside and internal adversaries. Semi-trusted servers are truthful but curious to obtain health records by planning with malicious hackers.

The critical necessities for protection and security in electronic clinical records are as follows: 1) Data privacy-declares that malicious users are prohibited from accessing the responsive health document. Enciphering fitness documents is the most considerable technique to guarantee data confidentiality. 2) Accountability-the compulsion to be accountable and validate users' or industries' actions and judgment. 3) Data integrity-declares that any hacking entity has not modified the fitness-related data. 4) Authenticity- assures that the certified and genuine authority can access the responsive

health information. 5) Audit- monitoring and preserving health information by tracing the activity log and facilitating guaranteed assurance to individuals linked with information privacy and security is essential. 6) Anonymity- assures that the subject's identity can be made unspecified so that the cloud servers cannot access the identity of the accumulated health information. 7) Non-repudiation- indicates the non-contradiction of authenticity of dispatcher and recipient. Individuals or clinicians cannot repudiate the misappropriation of health-related information [13].

The emerging healthcare idea of an e-health structure utilizes electronic processes and data communication. A systemized integration of subjects' e-health records is called EHR in the e-health model [14]. Entire health-related data are linked in the records, and the details contain medical history, laboratory data, billing details, demographics, medications, radiology images and some other sensitive patient-related data. Both healthcare providers and subjects are offered a better service by the on-demand server, which also facilitates cost-effective processing, storage, and revising of health-related data with improved quality and accuracy. Since all the information is on multiple servers, the users can access the required data. The on-demand server can provide clinical records, improve healthcare value, and deliver some clinical flaws rapidly. At the same time, the confidentiality of the users is also protected by identifying improper permission requests and EHR information misuse [15]. So, it is vital to concentrate on privacy and protection during data distribution and data storage by the users in the cloud.

METHODOLOGY

The expansion of communication and information technologies has developed the traditional method of healthcare services worldwide. The extension of novel techniques is recognized by the limited abandonment of written prescriptions to e-version, specifically in well-developed countries. The requirement for the association and integration of e-health records gathered from various environments like hospitals, health insurance industries, and clinical research centres has enhanced the electronic health (e-health) scheme. With the application of the information technology framework, e-health can be implemented for healthcare data processing,

distribution and operation. It is found to be tricky to manage the cloud-based server, which encourages the mutual sharing of data between various management domains associated with clinical information sharing. Utility computing has numerous advantages, as it can deliver the requested data promptly and distribute clinical information flawlessly. The severity involved in the framework administration is also relieved, and it facilitates them with sufficient chance to be publicized among the information technology service distributors. The developed cloud computing system offers scalability, agility improvement, collaborative resource distribution, and cost-effectiveness. Still, some privacy and security issues exist despite its different benefits, which immediately deserve extreme concentration in understanding its performance and unlimited usage. Cryptographic methods and non-cryptographic strategies are utilized to ensure the conservation of cloud-computing privacy and the protection of health data in different situations. Additionally, well-constructed and user-centric access control applications are often used to achieve e-health confidentiality. This research focused on evaluating several safety measures to secure information. The benefits and drawbacks of the security measures are also presented. Additional efforts are applied to facilitate enhanced opportunities for protecting e-health data.

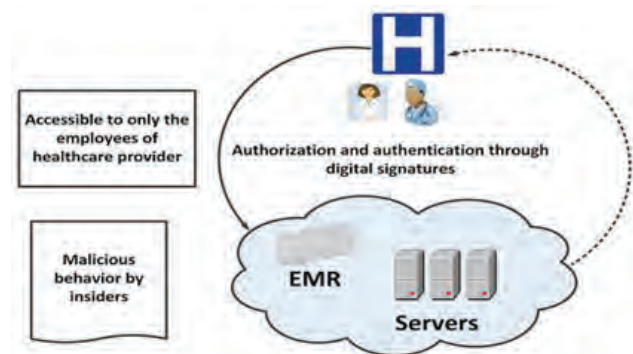


Fig. 1 E-Health record monitoring

Some existing researchers constructed the secure health framework with the application of a Transport Layer Security/Secure Sockets Layer, as it is a lightweight structure used to save cloud server information during the data transfer and does not necessitate any accompanying layer for confidentiality. This secure health architecture contains several security functions

such as reliability, confidentiality, and authorization, ensuring security services for broadcasted and stored information in the cloud database. Without consent, this construction does not permit users to retrieve the requested data, preventing malicious access. It also facilitates the critical manager's potential to recognize faults in the data provided. Despite its benefits, this framework has some things that could be improved; the principle issue is that it is platform-based and needs to be more flexible. The protection architecture must facilitate space for malleability and further enhancement in a cloud-based environment. This work projected a security system with various hierarchy levels to verify whether electronic healthcare service providers minimize the expense of data and permit information to be securely available online. Access control provision was done at the innermost middle level. In this way, rights were recorded and posed to various roles using the access framework of the attribute-based Encryption model. The chief difficulty with this method is its complexity in delivering the requested stored health data in the centralized cloud server when numerous requests are expected simultaneously.

Additionally, when individual requests are concurrent, they are implemented according to priority. The work considered the collaborative and shared nature of the electronic healthcare model to resolve the trouble of a centralized cloud server, which stores information related to healthcare services. The cloud server does not process the authentication and verification techniques; instead, they are the accountability of the cloud users, like patients and clinicians, to handle the verification procedure. Generally, they are provided access depending on their rights without revealing the users' features and personal identities.

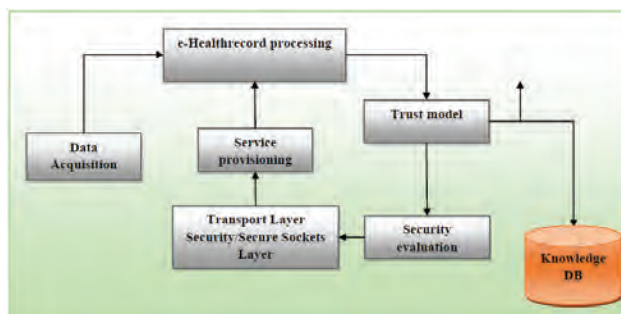


Fig. 2 Cloud-based model with security establishment

4. NUMERICAL RESULTS AND DISCUSSION

The experts in their proposed model develop IoT-based perceptive well-being applications by having an electronic health environment and respective protocols, zeroing in on interoperability, various criteria for innovation, and architecture prerequisites. Respective conventions, device scheduling, and network enhancements are utilized in the suitable guidelines and conventions. By analyzing several safety measures, this structural design is concluded as very safe because it can accomplish interchangeability among IoT devices, conventions, and ideas in electronic health structures every time in the online field. Researchers recommended Fog register in the scientific IoT ground to modernize the broadcasted delegate layer of data among the cloud and sensor hubs as a confident e-health method. They used the benefits of the omnipresence of existing patient care techniques to minimize the workload of organizations and remote populations of clinical amenities, resolving portability issues, energy usage, scalability, and consistency in this method. The effective deployment of electronic healthcare is an entranceway called UT-Gate that facilitates additional top-level highlights like IoT-based Early Warning Score (EWS) architecture with generally upgraded design awareness, execution, security, efficacy, usability, and interoperability. Experts proposed an environment for integrating IoT gadgets to provide access to user information through the network with the help of distributed computing. Improved training was provided to clinicians to look after their patients' situations efficiently by assisting in the attainment and incorporation of data required to screen health understanding. By employing distributed computing gadgets, data accumulation and handling, data stockpiling and investigation of features were constructed for electronic health architecture with a 4-venture engineering process. The performance metrics are discussed below:

1) Mean Absolute Percentage Error (MAPE)

$$MAPE = \frac{1}{N} \sum_{i=1}^n \frac{|y_i - y'_i|}{y_i} \quad (1)$$

Here, 'N' is the number of prediction results, and y_i and

y_i are predicted and actual values, respectively. This shows the degree to which the expected value deviates from real values.

2) Root Mean Squared Error (RMSE)

$$RMSE = \sqrt{\frac{1}{N} \sum_{k=1}^N \left(\frac{y_i - y'_i}{y_i} \right)^2} \quad (2)$$

It not only reflects the magnitude of relative error, but it also shows the stability towards prediction values.

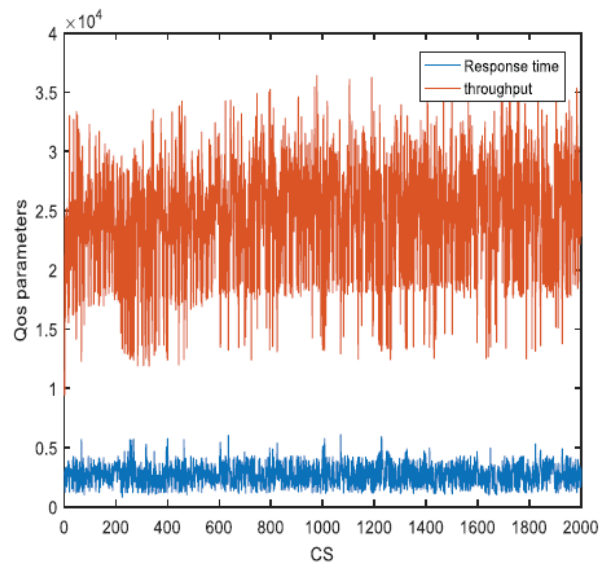


Fig. 3 Response time and throughput comparison

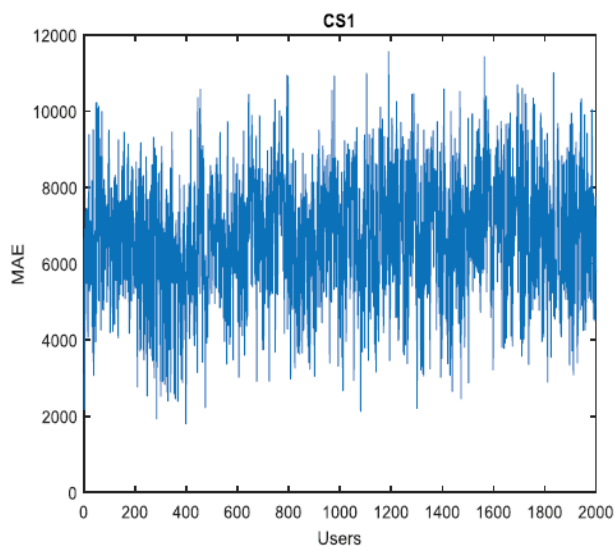


Fig. 4 MAE computation

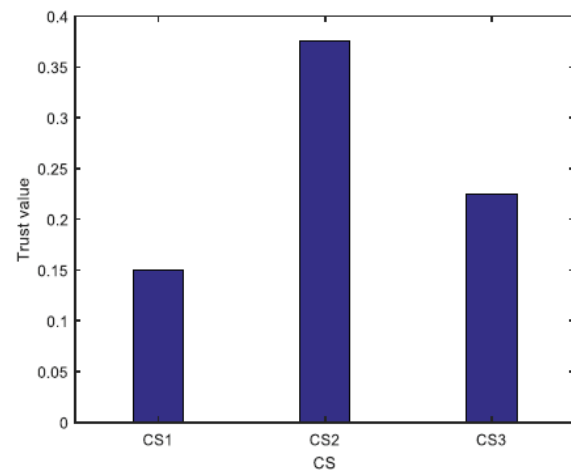


Fig. 5 Trust establishment among cloud servers

3) Throughput

Throughput is the actual rate of information transferred. It is depicted as the data quantity received or sent over unit time. They depicted functions where the method will be constructive, required integrated enhancements to make it functional, and uses and restrictions of chaperons. The experts recommended discovering IoT-related sensor networks with lightweight, isolated sensor hubs and IoT to broadcast and access data through distributed computing. They understand security and confidentiality conventions to attain the individual care service and ensure that the data is confidential and strictly related to the patient. The researchers examine the e-Health framework for the construction of the association of IoT with distributed computing to mark out some applicable difficulties, restrictions, and opportunities. They presented that authentication for IoT-based cloud e-health arena safety is imperative. They recommended a verification approach to access IoT-related cloud e-health structure with regular accommodation and implementation conventions. Specialists delineated the advantages of cloud-providing management and IoT cloud-based services, which can enhance new organizations by improving expandability and accessibility and minimizing the expense via the as-you-use pay method. The incorporation of three various security techniques, Role-Based Access Control (RBAC), Mandatory Access Control (MAC), and Discretionary Access control (DAC), can lead to a novel architecture that facilitates access rights

to be framed and executed by the healthcare service providers and users. This model can benefit us only when it works as a standalone security framework in the healthcare arena, and this is considered the most crucial drawback of this integrated model. This work introduced a protected user-centric e-health data approach to facilitate consistent access rights from the cloud server by employing the Proxy Encryption protocol model. Power Attribute-based Encryption is used in five essential phases to facilitate user-centered access. The presentation of this model proved to be outstanding during the performance measure process. The core drawback is flexibility, which means it cannot adopt other distributed systems. This schema also needs more flexibility and malleability. During evaluation, this technique considers only a restricted user count.

CONCLUSION

Patients, clinicians, and healthcare-related providers exploit intelligent healthcare services, greatly benefiting the IT field. Here, cloud servers are used to accumulate healthcare data, and a significant threat to this cloud server service is that the data are highly vulnerable to hacking. So, the chief requirement is to offer privacy and security to healthcare information in the cloud arena to protect it from malicious hackers. The accessible models can provide a specific level of security but are not considered a perfect approach. The success of the e-health records is obtained by maintaining the confidentiality and reliability of the patient's records. In this research, we aimed to provide the necessary security to the data in the cloud server stored by many users like health insurance providers, patients, doctors, and laboratory reporters. The assessment highlights extensive research of present e-health protecting cryptographic techniques and non-cryptographic mechanisms to care for the security of the cloud and to discover malicious activities in this rapidly changing modern environment. Main research fields with various aspects like enciphering models, security frameworks and access management mechanisms are provided by our research work. These modifications can enhance security, but there exist a few noteworthy research difficulties, and future enhancements are compulsory to take respective actions to ensure infallible confidentiality in intelligent healthcare services. As this

research recommends, the growth of a holistic security system can construct more protected and sustainable healthcare information.

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Predicting Functional Kidney Disease and Related Features using Adaptive Learning Model

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ABSTRACT

Functional damage of the kidneys or the renal disorder leads to severe chronic kidney infection throughout the patient's life. In the current research field, a tumour in the kidney is the most complex and deadliest significance considered for diagnosing and classifying the survival of the subjects. Through early prognosis and relevant therapy, it is probable to prevent or hold the replication of this chronic disorder into the advanced stage. This prior diagnosis helps to avoid the circumstances of renal transplantation, which is the only treatment to save the patient's life. The recent discovery of computerized devices to recognize subtypes of renal tumours has been a critical requirement. This research examines the capability of different DL techniques with Adaptive Gated Recurrent Unit (AGRU) for prior screening of kidney disorders accurately and proficiently. The categorization accuracy entirely relies on the data set used for the research. To improve the performance of the classification technique by minimizing the dimension of extracted features, we adopted an algorithm structured using a recurrent network. These sophisticated features assist in constructing a controlled tissue categorizer to distinguish between the infected and normal tissues. The demonstration with the Internet of Things (IoT) platform indicates that applying forecasting techniques with advanced ML models can facilitate a hopeful architecture for identifying intelligent solutions to ensure its predictive ability ahead of the environment of kidney disorder.

KEYWORDS: *Kidney disease, Renal network, Deep learning, Prediction, Accuracy.*

INTRODUCTION

The deadliest and most unfortunate infections, which are not likely to be screened through regular medical techniques, are termed kidney cancer. In the atmosphere of medical science, there is a lack of research based on renal adenoma, considered a high-level killer tumour [1]. This renal adenoma dominates other kinds of tumours in the clinical field and requires effective diagnostic techniques and healing methods. Still, individuals with renal tumours have a limited

curing chance, and life expectancy is evaluated to be less than one year. It is beneficial if the doctors utilize automated screening devices to help notice the disorder and protect the patient's life [2]. In numerous automatic clinical screening devices, classification techniques are frequently applied, and still, it is a tricky mission to recognize prior kidney disorders. The tool is employed to lessen the testing pressure [5], and Chronic Renal Disorder (CKD) affects the structure and working of the kidney. Severe issues are caused by more extended

disorders like complications, anaemia, heart or blood vessel problems, weak bones, increased PB, nerve damage, etc. [3]. The glomerular filtration rate (GFR) level controls the disorder at various levels. Chronic renal disorder can replicate drastically, which results in an intense threat of cardiovascular disease, and last-stage renal disorder can be eliminated by prior identification and through the therapy of patients who are at risk [4]. Recently, ML techniques have been applied to analyze the disorder in the earlier stage effectively. Kidney disorder screening is expected to use automated identification methods. It is a common health risk in developing countries as it cannot be identified at its prior level, and it is a significant problem [5]. Chronic kidney disease therapy focuses on reducing the kidney hazard by evaluating the fundamental cause of the disorder at its primary level—the growth of the chronic kidney disorder with several other medical attributes related to epidemiology. Generally, nephrologists take two assessments, such as urine and blood tests, to identify chronic kidney disorders [6]. Genetics, obesity, ageing, and high glucose levels are the factors that lead to chronic kidney disorders. The blood test reports are verified to check the kidney's functions and capability to filter to excrete creatinine, a regular waste released during tissue breakdown. At the same time, urine tests illustrate the protein deposits in the urine. Albumin (protein) is mainly a component in the blood that is generally not circulated into the urine during the kidney filtration process [7]. If any albumin content is present in the urine, it indicates that the kidney is not functioning correctly and can result in chronic kidney disorders. This research explains the embedded health scrutinizing wireless prototype structure employed in the Internet of Medical Things field. Several techniques are presented in this research for the prior detection of kidney disorders; these techniques are combined into a novel methodology to compensate for the lack of present health evaluation monitoring services [8]. The change in the regular physiological activity of the patient is used to track and assess the health situation. Thus, enquiring about the patient's physiological features is insufficient to recognize the occurrence of chronic disorders such as high glucose and kidney infections [9] – [10].

To sense and diagnose the chronic disorder of the kidney, this study suggested the Adaptive Gated Recurrent Unit

(AGRU). The enhanced method acquires the network features to assist vector machines in identifying kidney mitosis. A large-scale dataset trains the network to classify renal tumours by eliminating the computed tomography image features. Appropriate local and universal features of the AGRU technique are examined further to develop the detection speed and effectively screen the renal tumour by applying fully connected later present in the final layer. For the segmentation of renal tumors. Fully convolutional network and conditional random fields are trained using the image patches. At last, the image slices are directly calibrated by the system. Nearby image patches are associated with the complex network technique for training purposes. When the images are partitioned as 2D with the help of network modality, it is probable to eliminate the false positives by employing fully connected three-dimensional random fields.

The work is structured as: section 2 gives wider analysis of prevailing approaches. The methodology is drafted in section 3 and outcomes in section 4. The conclusion is provided in section 5.

RELATED WORKS

Neighbourhood Component Analysis (NCA) was presented by [11] to categorize subtypes in renal tumours using miRNA sample data. The classification process is done on the miRNA genome in kidney tumour subtypes, aiming to get discriminative features from the miRNA and LSTM, an RNN type. Neighbourhood Component Analysis chooses the dataset that contains the 35 most influenced miRNAs. The used subtypes of miRNAs permit Long short-term memory (LSTM) to cluster renal tumour miRNAs into five subtypes with 95% mean accuracy and 0.92 as its Matthew coefficient correlation coefficient under ten arbitrarily classified five times, which are highly related to the mean outcome of the entire miRNAs for rating procedure. The DNN technique was developed by Sheehan et al. to detect and classify new renal histology phenotypes [12]. Experts reveal that the ML approach and the deep neural networks have produced extensive performance in the execution processes of histologic images.

The features of the quantitative images are extracted and applied by the neural network to categorize the variations among the various genotypes. Admirable performance

was achieved by segmenting quantitative image attributes for non-glomerular and animal genotypes. These features are not recognized through the automated analysis on the IoMT. A Hybrid Neural Network (HNN) approach was introduced to acknowledge renal tumours [13]. Specialists recommended a hybrid model that ensembles auto-encoding systems and two-dimensional long-term memory. They analyzed the prediction issue as a function of binary categorization to extract the data entirely from e-Health records (EHR). The dataset is constructed based on several electronic health information. The dataset comprises 35,332 health reports from individuals with hypertension. The outcomes of the presented neural network technique can present 89.7% of accuracy. With the evaluation of multiple methods, the model was developed related to a synthetic neural network that facilitates the highest efficiency based on the constructed dataset. The author [14] presented the recurrent neural network (RNN) technique to predict acute kidney tumour growth. The input series will be identified by the RNN so that outputs of the earlier sequences are measured at a specific point in the series. Apart from that, RNN can predict the presence of acute kidney infection (AKI) using a series of clinical parameters. For every detailed security level of acute kidney injury, the proposed technique identified nearly 56% of acute kidney infection episodes with a time limit of 48 hours at the desired position with an accuracy of 33% [15]. This indicates acute kidney infection was analyzed in 1/3 of our patients, whereas the other two were wrongly predicted. About 57% of false positives are computed using further tests in patients infected with renal tumours.

METHODOLOGY

Smote

During data pre-processing, we employ a technique called SMOTE, which eliminates the rejected values before the normalization process, along with the traditional scalar method, to supervise the imbalanced features in the input source. The SMOTE approach is mainly implemented to develop a classifier that contains an imbalanced dataset and is also frequently visible with irregularly distributed output classes. Many editions of the approach were initiated so that the reliability and flexibility of the system could be enhanced for different

use cases. The SMOTE executes interpolation in the minority classes of the dataset to improve its amount, which includes the generalization of categorization.

Prediction

When something new is in the environment, humans pay more attention to that specific portion; based on this inspiration, the attention mechanism in the DL approach was developed. This system is widely applied in various applications in the natural language processing environment. In some research, experts used the attention system in association with recurrent system to identify sequence periodically subjective by many critical factors in parallel.

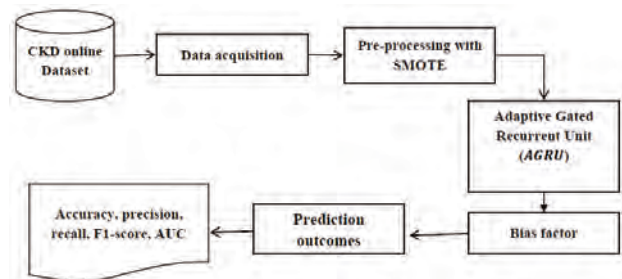


Fig. 1 Flow diagram of the anticipated model

All components over the input sequence are not uniformly necessary to predict at every step when presenting energy expenses. To execute the forecasting process effectively, the attention mechanism concentrates only on the significant data instead of focusing on all elements uniformly. Three stages in the attention system compute the attention value applied to study how to produce different weights of the input sequence at varied intervals. For example, the approach has been defined as:

- 1) Compute the α_{tr} relevance with $r = 1, 2, 3, \dots, r$ for every prior input/output at the given time t , $e_{tr} = \text{attend}(x_{tr})$ is the attention score.
- 2) The softmax function is applied to convert the relevance to possibility; α_{tr} represents the attention element weight in the input series for the provided instant.

$$\alpha_{tr} = \exp \frac{(e_{tr})}{\sum_{r=1}^r \exp(e_r)} \quad (1)$$

- 3) The likelihoods received in the 2nd step are

multiplied by the fundamental interpretation of the relevant input module to identify the constituent's influence on the estimated value.

Adaptive GRU

Without losing its generosity, the gating method of the long short-term memory is recreated by the Gated Recurrent Unit network. Every GRU gate contains a reset gate (j_t) and an update gate (b_t). A reset gate such as LSTM is utilized to balance the earlier data to be maintained, and how much new data is to be added depends on the recorded timing sequence. The update gate rapidly memorizes random data, regulating how much historical data is forgotten. The restrictions of the GRU cell evaluated to LSTM cell are given in Fig 2. The GRU formation technique is less complex than the LSTM creation procedure. GRU is derived from long, short-term memory to handle the issues. The following steps are included in the fundamental GRU system: 1) The j_t represents the reset gate, and the v_t represents the update gate developed by the latest input x_t and incomprehensive state produced by the earlier h_{t-1} cell at the present state in time t . The results of both the reset and update gate are:

$$\mu_t = \alpha_{tr} x_{tr} \quad (2)$$

$$j_t = \sigma(w^j [h_{t-1}, x_t] + b^j) \quad (3)$$

$$v_t = \sigma \quad (4)$$

The possible weight calculation matrices refers bias vectors and σ refers sigmoid function. One method to classify the patient's disguised situation at time t is as.

$$\lambda_t = \tanh(w^h [(h_{t-1} * j_t), x_t] + b^h) \quad (5)$$

The equation tangent function is given as $\tanh$, hidden layer coefficient matrices with suitable weight are presented as w^h , the related bias vector is shown as b^h , and the symbol indicates the matrix dot product among the matrices. 3) The linear association of the present hidden state of the candidate h_t and the previously hidden state h_t is used to access the present hidden state output (h_t) by having the sum of the weighted measurement equivalent to unity:

$$h_t = (1-v) * \lambda_t + v_t * h_{t-1} \quad (6)$$

Since the nature of machine learning approaches are dynamic, the parameters used in this process must be

modified to achieve enhanced results. By selecting the most favourable weight values, the effectiveness of the attention GRU system can be improved; otherwise, it is a time-consuming process because the information and network features are manually optimized. The topology of the GRU network is given as a fully connected layer, an input layer, an output layer, and two hidden GRU layers. In addition, while training the model, the biases and weights of the GRU system are optimized through the approach described in the succeeding section. Batch length, hidden layer count, and step time are the hyper-parameters included in the GRU network. The average absolute flaw percent determines the fitness value.

$$fit_i = \frac{1}{N} \sum_{i=1}^n \left| \frac{E_i - e_i}{e_i} \right| \quad (7)$$

Here, the population size is represented as n , the sample output value is given as E_i , and the original output value is defined as e_i .

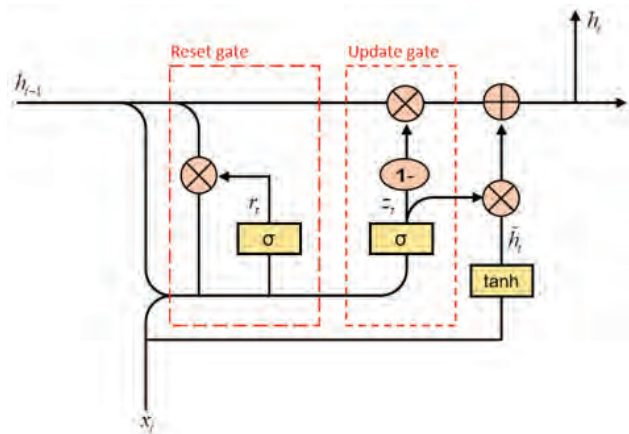


Fig. 2 Adaptive GRU network model

NUMERICAL RESULTS AND DISCUSSION

This research explains the prototyping of the associated e-healthcare technique based on the IoT platform. The flow diagram for CKD based on the IoT is illustrated in Fig 1. IoT installation enhances clinical regulation from face-to-face consultation between the doctor and the patient to e-health models. It is possible to track and monitor the patient's physical state with IoT to screen for irregularities by the clinicians.

Precision: This tracks the model's accuracy by verifying the exact positive outcomes of the forecasted. The positive fractions accurately predicted to the sum of the forecasted things is:

$$\text{precision} = \text{TP}/(\text{TP}+\text{FP}) \quad (8)$$

Recall: The sum of true positive (TP) values traced and marked as positive is identified.

$$\text{recall} = \text{TP}/(\text{TP}+\text{FN}) \quad (9)$$

F1-score: It is the function related to both recall and precision. Stability, recall, and accuracy are needed.

$$\text{F1-score} = 2\text{TP}/(2\text{TP}+\text{FP}+\text{FN}) \quad (10)$$

Fig 2 depicts the projected model's F1 score. This model can attain enhanced precision and recall, similar to existing models like RNN, CNN, DNN, ResNet, and FNN. Table 1 illustrates the presented model's F1 score.

Table 1 Performance evaluation

Models	Accuracy	Precision	Recall	F-measure	ROC
RNN	98.4	98.4	98.4	98.4	99
CNN	98.5	98.4	98.4	98.4	99.5
DNN	94.1	94	94	94	94
ResNet	97.4	97.4	97.4	97.4	98.2
FNN	96.8	96.8	96.8	96.8	99
BayesNet	98.4	98.4	98.4	98.4	98.4
Proposed	97.8	97.8	97.8	97.8	99

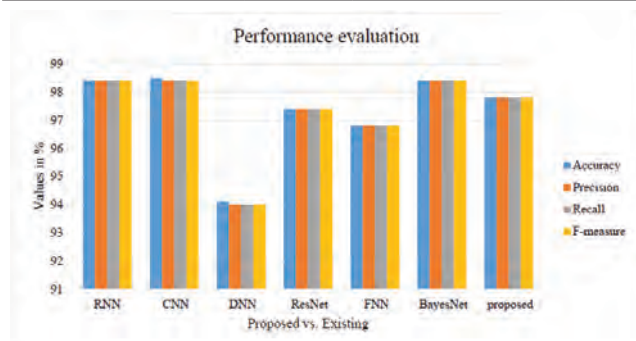


Fig. 3 Performance metrics comparison

Renal tumour diet modification and Walser schema facilitate improved outcomes with increased precision and reduced biases. The outcomes for the automated classification, including the screening level, are verified. Fig 3 depicts the performance of kidney ratings. The accurate detection and classification were performed in 4/5th of the kidneys where Dice is more significant than

0.90. When the Dice value is less than 0.65, it leads to algorithm failure. It takes only 10 seconds to complete the implementation procedure. It is a geometric evaluation of the resemblance between 2 samples. The issue of deprivation is resolved by deep residual learning that occurs as deep systems exposure, which improves the precision-based complexity reduction. The residual method arranges the layers to bind into the map as an alternative to the prearranged context framework. The experimental outcomes enhance the optimization of the residual network and accomplish precision by increasing the depth.

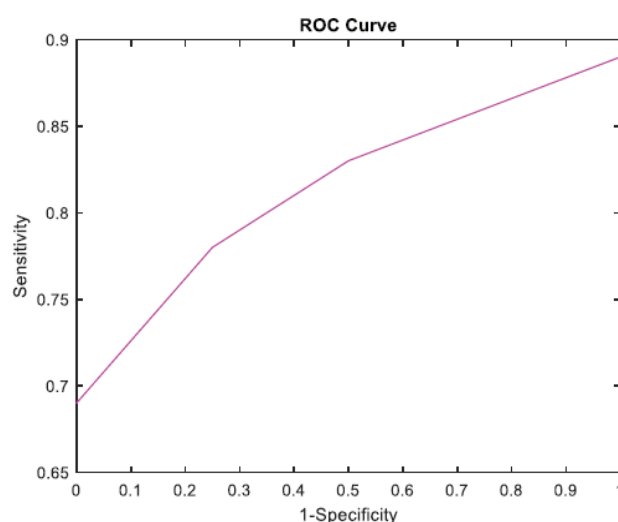


Fig. 4 ROC computation

CONCLUSION

In this research, we presented the Adaptive Gated Recurrent Unit (AGRU) to predict and diagnose CKD in its initial stage. Typical injury subtypes are identified in the CT images using a DL network in renal tumours. The gathered features are evaluated, and the lost values are restored to estimated average value. Various features connected with renal infection are identified from noiseless information and those features are fed as input into the classifier to detect deviations. After computing the bias and weight, the network trains the features. The features are verified to recognize the abnormalities. The learning mechanism intends to train the features twice to eliminate kidney disorders efficiently. The regression and sharing of the features are learned. This technique depends on the deeper network model, and radiologists suggested ROIs show potential outcomes in the renal

cell subtypes classification. The anticipated model is developed and radiologists' ROIs have shown hopeful results in categorizing renal cell subtypes.

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Skin Cancer Prediction Using Integrated Dense Normalized Convolution Network with Pre-Trained Network Layers

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ABSTRACT

Melanoma or skin cancer is one of the hazardous diseases. The diagnosis and detection of skin lesions in color skin imaging are complicated by the high degree of similarity between different lesions, such as nevus and Melanoma. An automated, reliable, reliable lesion classification system is necessary for the prior detection of skin lesions to reduce time in prediction, human lives and effort. This study suggests an automated approach for classifying skin lesions. This approach combines a deep learning (DL) network that has already been trained with deep learning. Atypical nevus, common nevus and Melanoma are the three types of lesions that pre-trained ResNet50 and Xception network with Dense Normalized Convolutional Network (DNCN) classifies using data augmentation and fine-tuning. The final layer is replaced with a softmax. The suggested model is tested and trained on the ph2 dataset. Here, 98%, 98.3%, 98.5% and 97%, respectively are the results of these metrics are used to assess the efficacy of the suggested strategy. The established quantitative metrics of sensitivity, accuracy, precision, and specificity are also used. When the suggested method's classification rate was compared to the performance of the current methods, the new method's performance was superior.

KEYWORDS: Skin cancer, Deep learning, Pre-trained network, Prediction, Accuracy.

INTRODUCTION

Among the most common and dangerous diseases worldwide is skin cancer. There are two types of skin cancer: non-melanoma and Melanoma. The cure rate could reach 90% if these lesions are found early [1]. Due to the great degree of similarities among many skin lesion forms, visual inspection can be challenging and may result in inaccurate investigation. Thus, an automated system is necessary for classification [2]. Artificial intelligence and image processing techniques were applied in this classification system. The prior CAD methods for image prediction and classification

had two main issues. The tough challenge is the imaging process. While biopsy and microscopy are used to gain images of other medical structures, such as histology, dermoscopy is a specialized instrument used to capture images of the skin [3]. The previous approaches necessitated extensive segmentation, feature extraction, and preprocessing to identify the skin images.

Researchers worldwide have recently successfully applied DL to visual tasks [4] and object recognition. A hybrid system was proposed by the author for the classification of Melanoma. The combined use of DL, support vector machine (SVM) and sparse coding

produced a classification accuracy of 93% in this system. The author developed a method for categorizing skin lesions [5]. To classify the lesion as Melanoma, abnormal, or normal, they employed learning approaches like ANN that yielded the highest accuracy of 92%. The author in [6] suggested a melanoma detection system that employed joint reverse classification (JRC). Even when the lesions were labeled as non-melanoma or Melanoma, the accuracy remained at 92%. The author in [7] anticipated a skin lesion classification for irregular color distribution and KL divergence method for structural similarity measure and color histogram. This approach produced an 83% classification rate. To classify Melanoma, A machine-learning model was created by [8] based on distinguishing characteristics of skin lesions, such as various color and texture variables. The categorization success rate of their model was 96%. The author in [9] use a contrast-constrained adaptive histogram equalization methodology to enhance images in their melanoma classification system. Next, the filtered greyscale image is segmented using Otsu's normalized approach. With DL, 9% of the classifications were accurate [10]. This work identifies three kinds of skin cancer are nevus, common nevus, and Melanoma from color images using a deep network. The proposed model intends to resolve the issues given below:

- 1) Here, a novel deep normalized convolutional network model (DNCN) is anticipated to categorize the skin cancer images as atypical nevus, Melanoma and common nevus.
- 2) The proposed method pose significant advantages over prevailing methods for skin cancer prediction.
- 3) The anticipated method does not require any pre-processing as the pre-trained VGG16 and ResNet50 models intends to eradicate the noise over the images.

The work is drafted as follows: section 2 provides a broader analysis of existing approaches. Section 3 outlines the methodology, and section 4 presents the numerical results. Section 5 provides a summary.

RELATED WORKS

The deep network was constructed using several neural network layers. Pooling and convolutional layers are separated within these layers. The purpose of these

layers was to haul out features from the input images. The final stage layer, the fully linked layer, is in charge of class score computation and class prediction [11]. The network can be trained for the first time using newly labeled data that is different from the prior data. Due to noise, aberrations, and an absence of labeled data, the network application in the categorization of skin lesions was limited. Lesions of different types may have apparent similarities, yet the same feature may vary greatly in dermoscopic images [12]. The authors presented their suggested approach for the effective classification of skin lesions as a result of all these difficulties. A network has been applied to several tasks to enhance performance, including action recognition, natural language processing, and visual tasks. There are various architectures that can be used in diverse scenarios. The suggested skin cancer classification model uses the architecture AlexNet. The next subsection provides a brief summary of these net.

ImageNet uses AlexNet, which was developed by [13] for visual recognition. AlexNet is composed of 3 fully connected layers and five convolutional layers, totaling eight compromise layers. The width (W) and height (H) of the input layer cannot be larger than the expected 224x224 dimensions, with a depth (D) of 3. The color spaces of red, green, and blue are related to the input image depth. The input image filtering was the first convolutional layer. Here, 4-pixel stride and an 11x11 filter (F) are used with 96 kernels (K) in the first layer. The convolutional layers output size is calculated as the stride (S) length separating adjacent neurons and receptive field centers. It is used to get the convolutional output size. The second convolutional layer will receive an input pixels. When two graphics processing units (GPUs) are used, each GPU will have workload. Typically, every feature map requires the application of the dimensional reduction method. The pooling layer in AlexNet is used to lower the feature map's dimension after the convolutional layer [14]. You can use Average, Max, Sum, and so forth for pooling. The 256 filters connected to this pooling layer have a stride of two pixels and a measurement of pixels. Since there are two GPUs, as we previously determined, each GPU can handle an average load. From the second layer's output, 384 kernel connections constitute the third layer's input; each kernel in this layer has a diameter

of $3 \times 3 \times 192$ for two GPUs. 384 and 256 kernels are in the fourth and fifth layers, respectively. Each kernel in the fourth layer will be $3 \times 3 \times 192$ in size, and in the fifth layer, the kernel size will be $3 \times 3 \times 128$. Normalization and a pooling layer are absent from the third and fourth levels. However, they are included in the max pooling layer of the fifth layer. In the end, there are two fully linked layers. The fourth, fifth, and third convolutional layers supply the input to these newly created layers. There are 4096 neurons in each completely linked layer. However, fails to give promising outcomes [15].

METHODOLOGY

The methodology is initiated by looking at deep normalized convolutional network model (DNCN) model for DL. Because convolution processes perform well on shape extraction, this kind of model is frequently employed in image classification. There are a total of 11 layers in the customized model. An overview of the layer attributes for the modified CNN may be found in Table 1. Fig 1 conceptually depicts the DNCN layout and shows an example of how it examines a skin lesion image.

We also assess the effectiveness of deep normalized convolutional network because it could be computationally costly to fully train a new deep learning model. We look into three distinct pre-trained models: ResNet50 and VGG16. The pre-trained network considers channels as distinct entities that learn independently of one another, in contrast to Inception, which permits correlation across channels (e.g., color and spatial shifts). The original purpose of VGG16, another CNN model, was to examine the relationship between network depth and the use of lesser convolution filters. With the residual version, the network's architecture is based on VGG16. With over a million images, the ImageNet database served as the training set for all three models. Recently, there has been a greater focus on pre-trained models for cancer prediction. It may be possible for these models to shorten training times. However, in the end, their effectiveness depends on how well the classification task at hand and the kind of images used to fine-tune the hyper-parameter match. We divided the categorization procedure into two stages to evaluate this. The VGG16 and ResNet50 base models are first used to train a neural network. The outer layers weight

of the embedding NN are changed; but the base layers stay unchanged. The second stage, which involves retraining multiple base layers to boost accuracy, involves adjusting the retrained base layer weight and the outer layers (embedding neural network).

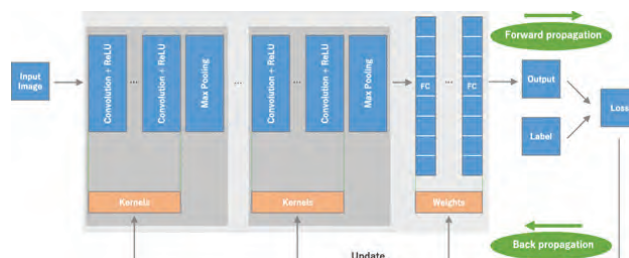


Fig. 1 Network architecture

We divided the data for each system into two groups: a testing dataset (20%) and a training dataset (80%). For the DL models, we additionally use a validation dataset. Twenty percent of the data are included in this validation dataset, which is extracted from the training set. Since we assign values of 0 and 1, respectively, to two separate classes, benign and malignant, the dataset can be regarded as discrete. The dataset is shuffled, and the results are 10-fold cross-validated to protect against bias or misrepresentation. This is how feature engineering is done. Pixel values serve as the basis for the classification models. Pixel values in images are vectorized and rescaled between 0 and 1. Images have 224×224 pixels. Furthermore, it is important to replicate the various circumstances (light, orientation, and magnification) under which dermoscopic images are acquired. As data augmentation methods, we employed random flips, random rotations, and random zooms for DL models.

Table 1 Network specifications

Layers	Description
2D_conv_1	Size = 3 and filter = 8
Max_pool_1	
2D_conv_2	
Max_pool_2	Size = 3 and filter = 16
Batch Norm	
2D_conv_3	
Max_pool_3	Size = 3 and filter = 32
2D_conv_4	
Max_pool_4	

FC	
DenseNet	128
DenseNet	Classes =2

NUMERICAL RESULTS AND DISCUSSION

An NVIDIA GeForce 920m graphics processing unit, 8 GB RAM and a core i5 processor were installed on an IBM PC used for the investigation. The suggested DNCN approach is written in MATLAB 2017 and the GPU executable is created. We can successfully reduce the error rate by training an enormous number of images on the GPU. The pre-trained DNCN models adjust the prediction layer based on the required task. Two different kinds of experiments were conducted. The initial series of studies was meant to assess the suggested method using unprocessed images from the original database. A second set of tests was developed to compute the model by image augmentation over the exact dataset. To get accurate findings, every experiment has an identical starting batch size, training period count, and learning rate. The training epochs, batch size, and starting learning rate are 32, 0.001, and 10, respectively. Of the dataset, twenty percent is employed for testing, and eighty percent is employed for training. MATLAB is used to randomly split the dataset into testing and training groups. The previously trained network cannot process a color image greater than $227 \times 227 \times 3$. To tackle this issue, we divided the ROI to minimize dimensions and remove needless areas from the input images. Next, since each image was created using the R, G, and B color spaces, it was assessed to fulfill its height, width, and depth did not exceed the pixel value and was three pixels deep. Four numerical metrics were used to assess the effectiveness of the suggested model: accuracy, sensitivity, specificity, and precision. We employ the following forms to compute these measurements:

$$Acc = \frac{TP + TN}{TP + FP + TN + FN} \quad (1)$$

$$TPR = \frac{TP}{TP + FN} \quad (2)$$

$$TNR = \frac{TN}{FP + TN} \quad (3)$$

$$PPV = \frac{TP}{TP + FP} \quad (4)$$

FP, TP, TN and FN are denoted by the symbols. Positive prediction value (PPV) is indicated in (4), true negative rate is shown in Eq. (3) and true positive rate is shown in Eq. (2). Another qualitative metric is the receiver operating characteristic (ROC). The two researchers share the dataset. Without any enhancement, the original set of data images will be employed in the first experiment. The second experiment takes advantage of augmented visuals. A fixed-step 50 is used to rotate the color images at angles ranging from 00 to 2700. Table 2 displays the computed performance measures.

Table 2 Metrics comparison

Images	Acc	TPR	TNR	Precision
Original image	80	72	83	75
Pre-processed image	98	98.4	98.5	97

Table 3 Comparative study

Methods	TPR	TNR	PPV	ACC
Xception	67	89	69	83
VGG16	87	93	84	92
AlexNet	90	96	92	92.5
DenseNet	97	84	85	96
ResNet50	96	95	97	97
DNCN	98	98.9	98.5	98.5

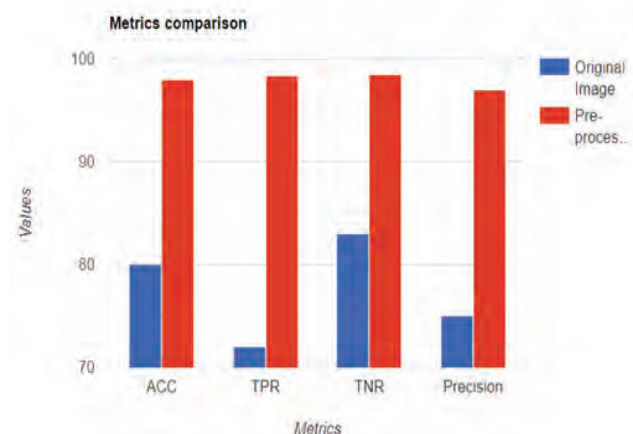


Fig. 2 Metrics comparison

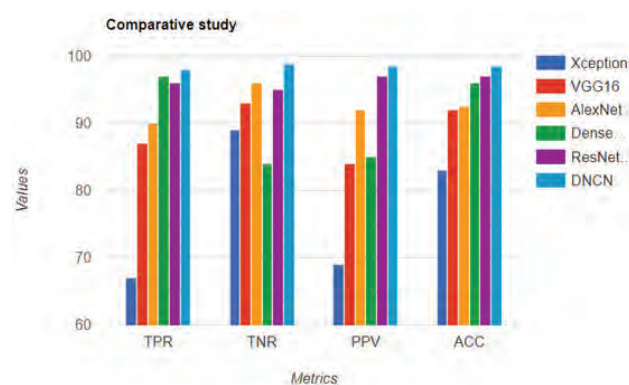


Fig. 3 Comparative study

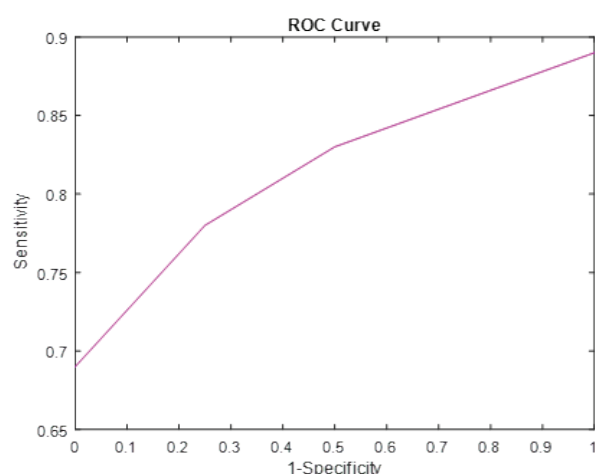


Fig. 4 ROC computation

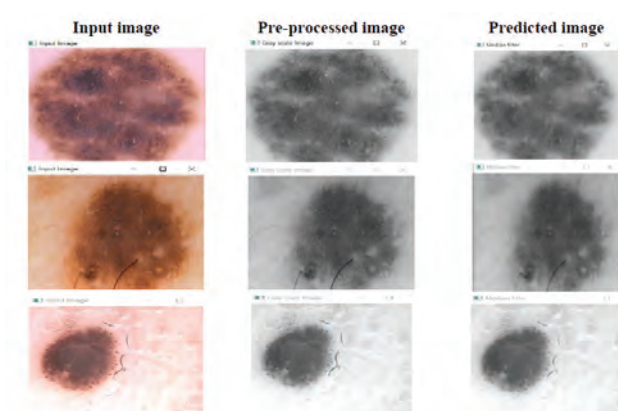


Fig. 4 Prediction outcomes

To compare the proposed method's performance with the prevailing methodologies, the same set of data on skin lesions is employed. As was covered in the preceding part, several current techniques divide lesions into two classes, calculate the accuracy for each

class, and then rank the class with the highest accuracy. According to the performance average, the anticipated method separates lesions into successive categories: Melanoma, atypical nevus and common nevus. Table 2 displays the comparison process results, showing that the suggested approach has the highest categorization rate. Fig 2 displays and visualizes comparing the obtained categorization rates. Fig 3 shows the ROC curves of the suggested model. The suggested DNCN-based classification algorithm outperforms the other current approaches by all measures.

CONCLUSION

A deep neural network (DNCN) with good performance cannot be built without many labeled images. A pre-trained VGG16 and ResNet50 is used with learning and image augmentation to navigate this major obstacle. The suggested Dense Normalized Convolutional Network (DNCN) approach can classify three distinct lesions by substituting only three classes for the final layer. Apart from enhancing the quality of the set of data images, the DNCN model's weights have been modified by pre-trained network learning. Four performance metrics were computed to evaluate the suggested strategy against the current approaches. According to the findings, the suggested approach worked better than the existing methods. Sensitivity, accuracy, precision, and specificity rates achieved are 98%, 98.3%, 98.5% and 97%, respectively.

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Sign Language Prediction for Real-Time Applications Using Deep Learning Approaches

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ABSTRACT

Machine translation (MT), computer vision, and linguistics combine to explore the multidisciplinary field of automatic translation from signed to languages. Even if the bulk of computer scientists who work in this subject do so alone, the field is becoming increasingly popular; in fact, the last five years have seen the publication of most scientific articles on sign language (SL) translation. This article extensively reviews the literature on SL translation across domains. They present a high-level overview of MT and SL linguistics to demonstrate the conditions for automatic SL translation. They then carefully review the most current studies from the literature. Lastly, they highlight critical research difficulties that need to be addressed. This work intends to model a novel hybrid model known as MobileNet and Xception model. According to the findings, significant progress has been achieved in spoken language machine translation research. Nevertheless, existing methods occasionally need more linguistic motivation or are not modified to account for the unique qualities of second languages. Researchers examine issues about SL data representation, dataset gathering, and SL translation model evaluation. It supports multidisciplinary study and the foundation of linguistic analysis of SLs in subsequent research. To further produce successful SL translating models, hearing and deaf users of SL applications must be engaged in the prediction, data collecting, and assessment phases of use case development.

KEYWORDS: Sign language, Prediction, Deep learning, Translation, Computer vision

INTRODUCTION

The rapid advancement of deep learning appears to have made possible many fresh uses for the synthesis, translation, and identification of sign language, all of which fall under the general category of “sign language processing. Including Finger spelling Recognition [1] and Sign Classification [2], Sign Language Recognition (SLR) is understood as information extraction from sign language. Translating this extracted information into another language, either spoken or signed, is known as

sign language translation, or SLT [3]. It is also feasible to go the other way, from text to sign language. Building sign language from a virtual avatar’s representation of meaning is the aim of Sign Language Synthesis (SLS). It focuses on spoken language translation from the signed language in this post. Specifically, they work on converting movies with spoken language in sign language to text or spoken language in written form. It will not address SLT models that require 3D cameras, wearable wristbands, or gloves as input; instead, it will only address models that support video data as input.

Sign language communities (SLCs) are considered intrusive and do not accept systems that use wearables such as wristbands, intelligent gloves, or others [4].

Moreover, they cannot record non-manual acts or other types of information contained in signatures. When compared to wearable systems, video-based approaches also have advantages. For instance, they can be trained using pre-existing data and linked into the program for conference calls or used to caption videos of vloggers signing automatically [5]. Scientific studies that have already been published compare SLR and gesture recognition, and some even suggest using a fingerprint acknowledgement system as an SLT solver. These categories are faulty and unnecessarily oversimplified. They could result in misinterpreting the technical difficulties that need to be overcome. SLT is at the nexus of linguistics, machine translation, and computer vision. To adequately address SLT, experts from all relevant fields must collaborate. Concurrent with this piece, an additional survey on SLT was composed and released [6]. It situates SLR and SLT within the broader context of sign language processing and offers a narrative historical review of the two fields [7] – [8]. The “to-sign” orientation of SLT, which we ignore, is also covered. With a background in sign language linguistics, we offer a thorough and systematic review of the most recent research on SLT. They focus primarily on computer science and provide a more general overview of the field than their more in-depth work. Based on panel discussion outcomes, the study in [9] provides a concise yet insightful summary of the SLR, SLS, and SLT domains. This article is also connected to their work [10]. Among the issues they note are the need for more data and the participation of SLCs, two issues that are consistent with our findings.

- 1) The proposed model introduces a novel hybrid model known as MobileNet and Xception that merges the significance of both models for the prediction of sign language;
- 2) The model shows a transparent perspective towards the decision-making process for helping the clinical application.

The work is organized as follows: section 2 explains various prevailing approaches. Section 3 drafts the methodology, with results in section 4. Section 5 explains the conclusion.

RELATED WORKS

It is a widespread misperception that there is one sign language that applies to everyone. Sign languages naturally change with time and space, much like spoken languages do. While many nations have sign languages, regional variations and local dialects are common [11]. It is also not possible to translate a sign language by only picking out since signs in sign languages do not correspond precisely to words in any spoken language; one can replace individual signs with their equivalent words in a spoken language. There is no connection between sign and spoken languages; they have separate vocabularies and grammar. There can be significant differences between the regional signed languages applied in two areas where the same language is spoken [12]. For example, Dutch is the language most people use in Belgium, Netherlands, and Flanders.

On the other hand, in the 1990s, separate from standard Belgian Sign Language is primarily used, VGT and LSFBis far more similar to LSFB historically and linguistically. Likewise, even though both nations use English as their official language, ASL and BSL. Visual in nature, sign languages utilize much space surrounding the signer. Signs are made up of more than just hand motions. In actuality, a sign is made up of many more parts. Signs are made up of hand shape, movement, and articulation point criteria, according to [13]. Afterwards, Battison included orientation for the fingers and the palm.

Additionally, there are no manual elements like mouth patterns. These can be separated into two categories: mouth motions, such as flaunting one’s lips, and mouthing, in which the pattern alludes to a spoken word. The lexicons and grammars of sign language rely heavily on non-manual elements [14]. For instance, they can distinguish minimal pairings, which are signs that share all but one articulation parameter. Mouth patterns, for example, can differentiate between two signs if the hand’s point of articulation, movement, form, and orientation are the same. As the last example showed, non-manual activities are significant, not just at grammatical and lexical levels. A good illustration of this is how brows are moved: raising or furrowing them can suggest a question is being asked and its nature (open or closed). The area surrounding the signer can

also be utilized to convey other information, such as the location or current topic of conversation. A signer can indicate a former occurrence by pointing behind their back, and a future event can be shown by pointing in front of them. It is also possible to create a fictitious chronology where time flows from left to right ahead of the signer. Referents can also be positioned using space [15]. One may be talking about a discussion with their father and mother, for instance. Each referent in the signing area is given a position (locus), pointing, gesturing, or gazing at these places to indicate further references to these people. For instance, the “to give” symbol can be moved from the point connected to the one associated with signifying “mom gives something to dad.” For SLT models, it is crucial to model space, identify locations in space, and retain these places.

METHODOLOGY

Using a Windows Nokia Lumia 1520 smartphone, this work aims to recognize 16 static ASL alphabets in real time. On top of the sign library, the algorithm is constructed. Every image is sampled with an RGB resolution of 320×240 pixels. To accomplish automatic hand gesture detection, the suggested framework first samples the RGB values of the signer’s pixels for calibration. This framework focuses on a smartphone platform, where the complexity is reduced by utilizing many known circumstances for sign language input. First, to allow the entire hand to fit within the image frame, the signer’s hand motions are always positioned in the centre of the frame. After that, there is a limited range for the change in distance between the camera and the hand movements. Normalizing the size of a hand gesture is no longer necessary when suitable scale-invariant procedures are applied. The seeded region growth method is appropriate for use in the prediction stage since we applied these conditions, which allow us to calculate the sure-background and sure-foreground pixels. Hand gesture edges are extracted using sophisticated edge detection to increase accuracy and employed as a limiting barrier for the seeded region expansion.

The features and characteristics are eliminated from the edge-detected image, and k-means clustering is used to group them into 16 sign language classes. Using the BoF model from the cluster centroid, one

generates a histogram of visual vocabulary. There are 1600 examples used as training images overall, 100 for each sign language. As test photos, an additional 800 photographs of sign language are gathered. Organizing the test pictures for sign language involves training a multi-class hybrid model. Fig 1 provides a sign language recognition flowchart. When the system is implemented on a smartphone, the text-to-speech library displays the result of the discovered sign language in text and audible voice.

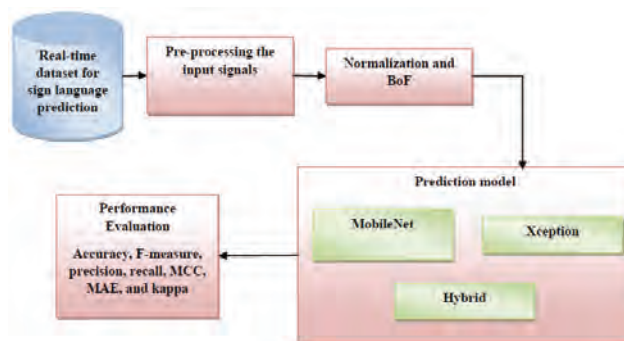


Fig. 1 Block diagram

Prediction model

The proposed model in this work improves sign language detection and classification by combining the best features of the MobileNet architectures. The core component of MobileNet is depth-wise separable convolution, which comprises two phases: depth-wise convolution and point convolution. This method facilitates effective operation, maintains the network’s representative capacity, and minimizes computing complexity. The MobileNet architecture consists of 28 levels. These layers integrate necessary layers like batch normalization, average pooling, and softmax activation functions with 1×1 point-wise and depth-wise separable convolutions. The 1×1 convolutional, batch normalization, depth-wise convolutional and ReLu layers form the depth-wise separable layer. Often called Extreme Inception, the Inception design served as the model for the Xception model, a deep CNN architecture that employs fresh approaches with depth-wise separable convolutions. The basis for feature extraction is provided by the 36 convolutional layers that comprise the Xception model. Except for the first and last modules, these levels comprise 14 modules with linear residual connections. Defining and changing a

sequence of depth-wise convolution layers with residual connections. The Xception model consists of 126 layers, both trainable and non-trainable. The particular application, changes, and count of classes in the classification task can all affect how many trainable and non-trainable parameters are included in the Xception model. Three million parameters are non-trainable, and approximately 22 million are trainable. These layers, which encompass the entire design, comprise the input, middle, and exit flows and additional layers, such as the output layer and the first convolutions.

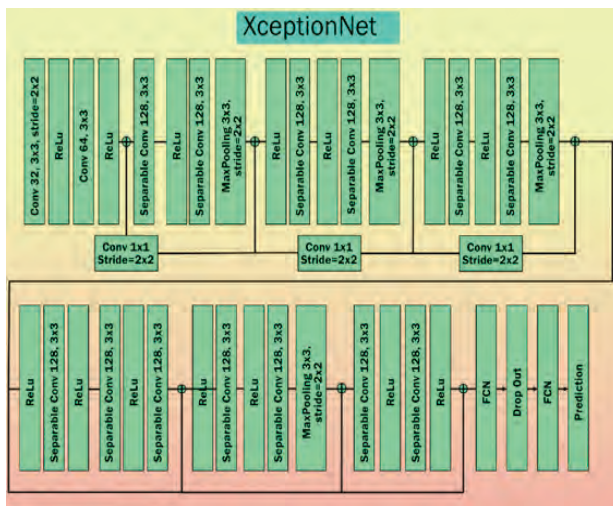


Fig. 2 Network architecture

Hybrid model

As seen in Fig 2, the hybrid sign language detection and categorization model is derived by combining the MobileNet and Xception architectures. The following two components comprise the hybrid model: Extracting meaningful information from unprocessed data is known as feature extraction. The task at hand is finding a collection of characteristics that uniquely and precisely characterize a character's shape. In our work, researchers use the Xception and MobileNet models to extract the image attributes. Next, we input the two features into the dense layer by concatenating them. One kind of supervised machine learning method that forecasts a category label is classification. Using similar features in photos from different classes, images are recognized and labelled this way. This research is about utilizing attributes drawn from the Xception and MobileNet models. These characteristics subsequently

give way to a dense layer using ReLU activation. After that, a flattened layer receives the output from the thick layer to translate the input into a vector form. To facilitate multi-class classification, the softmax activation function is selected for the fully connected layer that uses the resultant vector from the flattened layer.

NUMERICAL RESULTS

With varying illumination conditions and a reasonably complicated background, the suggested framework can distinguish between hand motions. Fig 3 shows the normalization and BoF identification results for an image with a shifting backdrop and lighting circumstances.



Fig. 3 Robita dataset samples

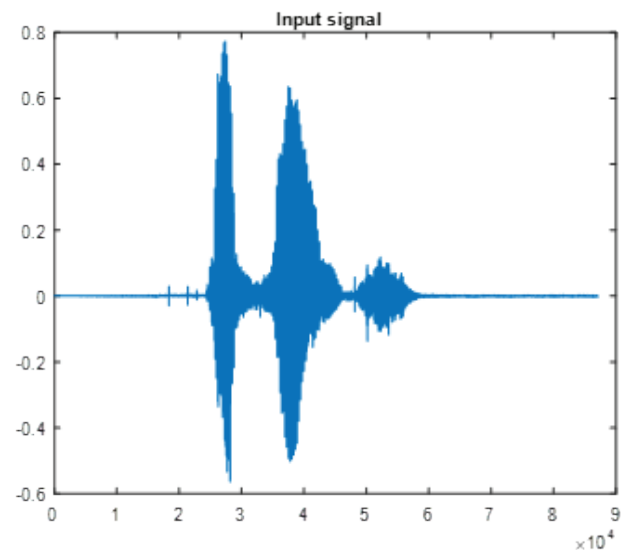


Fig. 4 Input

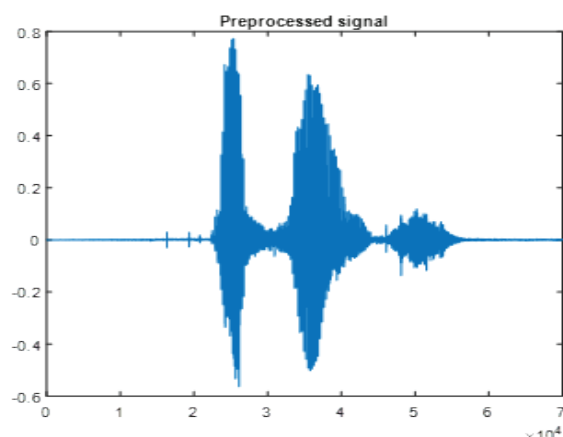


Fig 5 Pre-processed sample

Table 1 Metrics comparison

Methods	Accuracy	Precision	Recall	F-measure	MCC	MAE	Kappa
CNN	54	35	54	38	0.32	1.52	58.65
DNN	33	11	33	16	0.33	0.66	33.33
Xception	80	73	82	78	1.23	1.5	68.56
MobileNet	81	49	83	54	0.52	0.36	45.31
Hybrid	95	92	91	93	0.45	0.19	25.6

For each of the 16 movements that make up the sign language are the effectiveness of the sign language recognition framework is assessed. To train the database, 1600 picture samples are collected, including 100 photos for each alphabet letter in ASL. Eight hundred test photos are used for the offline accuracy evaluation process. Every image is gathered from a single signer, and each sign has a small amount of scale and rotation variation. They ran an experiment to compare the suggested framework performance. The entire framework recognition rate as determined by the hybrid and conventional methods, is displayed in Fig 7.



Fig. 6 Prediction accuracy

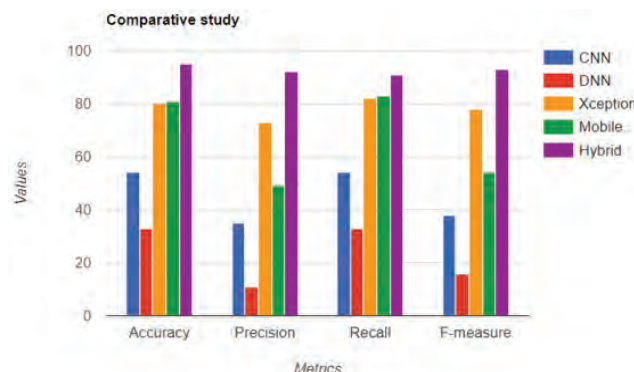


Fig. 7 Performance evaluation

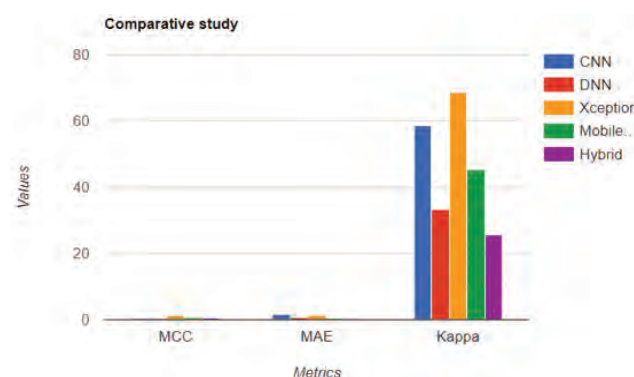


Fig. 8 MCC, MAE and Kappa comparison

The identification rate of 16 gestures with our suggested framework is displayed in Table 1 below. The proposed model yielded an average accuracy of 92%, while standard MobileNet yielded an accuracy of 91%. Intel Core i5 processor running at 2.30GHz with 8 GB of RAM trains the database. The proposed model pose averaged six minutes forty seconds to teach a database of 1600 images, compared to just 4 minutes 28 seconds for a hybrid. The 2.2GHz processor and 2GB RAM of the Nokia Lumia 1520 are used for online sign language recognition. Using the recommended structure, a test sign language input takes an average of 0.62 seconds. Our experiment revealed that each sign language's accuracy mainly depends on how similar a gesture looks to several sign languages kept in the database. Visually unique sign languages, like the alphabet 'C' and 'O,' can be recognized more precisely. On the other hand, visually identical signs, like the alphabet 'N' and 'S,' are more likely to be misinterpreted. False prediction is identifying movements incorrectly classified as other motions and calculating the proportion of each gesture.

CONCLUSION

With an average accuracy of 95%, our suggested framework can identify 16 classes of the ASL alphabet. As demonstrated by our experiment, the hybrid model outperforms standard approaches regarding accuracy and processing efficiency. The test photos were taken with background settings and lighting that were usually similar. If the background and lighting are altered, the results can decrease slightly. Based on our examination of the data, researchers discovered that highly similar-looking sign language alphabets are more likely to be incorrectly identified, which lowers their accuracy. Conversely, aesthetically distinctive motions used in sign language typically yield excellent accuracy. Overall, the hybrid methodology presented in this study may be used to create a portable sign language translator, which could help bridge the communication gap in society for those vocally impaired. Since this is the first time SLR on a mobile device is demonstrated, the range is constraint to simple sign alphabets. Expanding the application to a more extensive vocabulary could be one of our framework's future developments. More sophisticated algorithms may eventually replace the ones in use to increase the system's accuracy and processing speed.

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Modelling A Multi-Variate Boosting Approach For Analyzing Car Sharing And Renting Purpose

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ABSTRACT

The online vehicle rental company lists different vehicles and their features. The technology enables users to rent a car online and pay with a credit card. Additionally, this system has a feature that allows users to request a car for rent from the admin. Visitors must fill out a personal registration form when using the system. After the registration, the user may access the system by logging in with his username and password. The user can view every car feature and browse through different car listings. Using the multi-variate boosting model, the user can also check the car's features. The product can be chosen by the user and added to the shopping cart. Users may use their cards to make payments by selecting the card payment option. The proposed prediction model gives satisfying results in terms of sharing and renting.

KEYWORDS: *Car sharing, Renting, Machine learning, Booking, Registration.*

INTRODUCTION

The sharing economy has drawn much interest in the past ten years because it offers the potential to be a scalable, eco-friendly company concept. According to [1], the secret to sharing is to increase product utilization by substituting temporary on-demand access for permanent individual ownership. A significant component of the sharing economy is sharing. Using car-sharing as a prominent example, underused assets typically have benefits when shared, according to [2], instead of owned and utilized ones. It has been described as a system allowing users of locally accessible autos at any moment and for any duration [3]. With fewer automobiles on the road, fewer emissions from smaller, cleaner vehicles, less traffic and parking congestion, and increased social cohesiveness among sharers, car-

sharing can thus satisfy personal mobility requirements positively and sustainably [4].

This study intends to evaluate and contrast several car-sharing business concepts. We investigate the reasons behind the coexistence of various business models and their operational effectiveness. To achieve this, we built an extensive database containing all German car-sharing firms [5]. These companies ranged from small car clubs operating in tiny communities to major automakers with fleets numbering thousands. There are several types of car-sharing models that we differentiate between, including cooperative, roundtrip, one-way, and business-to-consumer (B2C) models [6]. Researchers can considerably add to the corpus of knowledge by comparing the absolute fleet size with relative fleet size—that is, cars per person in the running city—which

helps one to understand the efficacy of sharing economy services. We examine the compatibility of various fleet sizes with multiple business models. Different company models' local market presence can be compared based on the respective fleet size. Explaining how car-sharing business models coexist is a second addition to the present literature [7]. We examine how businesses enter the car-sharing market, considering the benefits of being the first entrant. This allows us to explain the lack of a dominant design and shed light on path dependencies. Knowing route dependence and first-mover advantages helps one to understand how business models in the sharing economy and other spheres evolve.

Numerous distinct business models, such as car sharing, can be discovered in a developing sector. According to [8], "fundamental truths" regarding customers, cost models, and rivals must still be investigated in the early phases of a new sector. A generic model may be adopted as the industry standard in the car-sharing sector. Many companies could run using a single "sharing" business model. Moreover, it is essential to grasp the unique traits of every company model since organizations might exploit these variations to their advantage while competing with others, tackling a new target market, or working in different surroundings. The proposed model intends to analyze car sharing and renting in multi-variate short-term features and enhance the prediction accuracy. The learning model gives promising solutions in a more complex environment with a diverse feature set.

The work is drafted as follows: section 2 shows the current study related to the proposed model. Section 3 discusses the proposed boosting model for car renting and sharing. Section 4 evaluates the experimental framework, and section 5 concludes the work.

RELATED WORKS

Participants in a car-sharing program use a locally available car for the desired amount of time at any given time. Primarily due to its potential for the environment, car-sharing has drawn a tremendous deal of scholarly interest. Much research has demonstrated the benefits of car-sharing for the environment and transportation. In a German context, one car-sharing vehicle can replace up to twenty individual vehicles; the author in [11] also discovered that customers of this service cut their car

ownership by 62%. After enrolling in car-sharing, car ownership decreases from 1.12 to 0.72 cars per family, according to a Nijland survey in the Netherlands on car-sharing customers. Car miles driven were also reduced by 15-20%. Car-sharing has beneficial effects on energy use and greenhouse gas emissions during its whole lifecycle, according to calculations done by [12]. According to the findings, participating in car-sharing reduces emissions and energy use for transportation by 51%. It is yet unknown how these changes will affect other aspects of society, such as jobs and the overall state of the economy. As more technological advancements occur, especially with the introduction of self-driving automobiles, these characteristics will likely alter significantly [13].

These early companies were set up in a business-to-consumer (B2C) model, where, whether for profit or not, the business had a fleet of vehicles accessible to its customers. Their aim to serve a small population in one town means that many of these cooperatives remain modest. Most organizations started as green-conscious local communities looking for more sustainable ways to address mobility demands [14]. At first, these companies' basic business plans were similar. They relied on roundtrip (RT) rental cars, which must be returned to the original location after the trip. Several grassroots operators saw rapid expansion, partly because of technological advancements and the professionalization of services. Specifically, online apps enhanced the efficiency and usability of booking processes, and smart cards and smart locks improved car access. These expanding companies are situated in medium-sized to big cities, and they frequently converted from cooperatives to for-profit businesses to pursue faster expansion and increased specialization. On the other hand, various community-based organizations remained modest and carried on as neighbourhood cooperatives, primarily in tiny towns and villages. Large firms from adjacent industries entered the car-sharing market alongside the early grassroots groups [15]. The national railway operator arrived, and Shell, the oil company, joined it. Unlike two cooperatives, whose members depend less on car ownership, these operators usually target larger cities. The car-sharing practice is a subset of a more significant trend known as "shared mobility." Ridesharing, in which customers

share a vehicle driven in a similar direction, is another rapidly expanding service that fits the umbrella of shared mobility [15]. In addition, there has been a significant increase in the popularity of ride-hailing, in which users request a journey from a specified spot driven by an on-demand taxi company. Despite being connected to car-sharing, these developments exhibit distinct dynamics and are outside the purview of the current investigation.

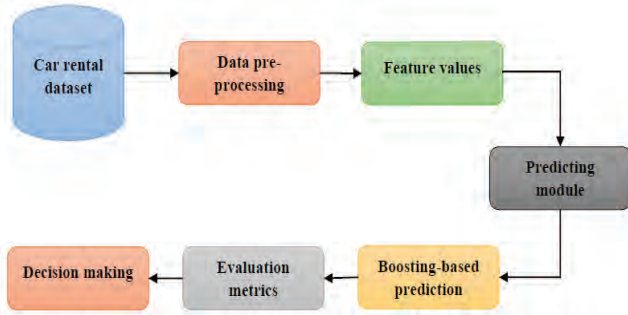


Fig. 1 Proposed framework

METHODOLOGY

The multi-variate regression problem related to car renting and sharing is then formulated. It is based on the values of the features in the F_{rental}^x , $F_{sharing}^x$, and F_{time}^x categories to predict the time spent driving. Here, T is the historical period taken under consideration for training; t_1 ...and t_{k-1} are the historical time points in T ; t_k is the current sample time. We shall indicate the utilization level at time t_j as usage (t_j) [$1 \leq j < k$]. One-hour time slots will be provided as the prediction horizon. The future use of automobiles depends on several factors. F_{rental}^x indicates car usage levels; F_{time}^x marks temporal information at time T_x ; $F_{sharing}^x$ uses the multi-variate regressor R to show local weather conditions at time T_x .

$$Rental(t_{k+1}) = R(F_{rental}^x, F_{sharing}^x, F_{time}^x, 1 \leq x \leq k) \quad (1)$$

Another study goal is to find the variables contributing to vehicle usage prediction. Three features are under consideration: environmental factors, temporal information, and historical usage. Researchers investigated numerous deep learning and machine learning algorithms, either pooling the several feature categories or leveraging each individually to identify features that increase the models' predictive accuracy.

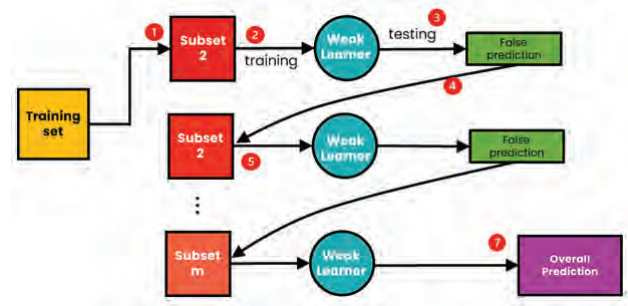


Fig. 2 Overall prediction process

Prediction with boosting approach

Comprising a tree learning method and a fast linear model solver, the XGBoost package provides a scalable and practical application. XGBoost fits the new model to the updated residuals of the old forecast, reducing loss and including the most recent estimates. It offers improved performance by using a more consistent approach for malizing to manage overfit. Supervised learning issues, in which we forecast a target variable (y_i) using the training data (x_i), are the domain of XGBoost. Comprising the training loss and regularizing term, the goal function must be defined after the target variable, y , has been selected. This will allow us to assess the degree of model fit for the training set.

$$\text{obj}(\theta) = L(\theta) + \Omega(\theta) \quad (2)$$

Here, L is the training loss function Ω is the regularizing term, and θ indicates the parameters we must learn from the data. The mean-square mirror, provided by, is a popular option for L .

$$L(\theta) = \sum_i (y_i - \bar{y}_i)^2 \quad (3)$$

Additionally, the regularization term limits the model's complexity, preventing overfitting.

NUMERICAL RESULTS

Using a pre-processed car-sharing operator and city weather data set, the experiments aimed to identify variables that help forecast automobile use and compared them to other models where the efficiency of deep learning, especially the boosting model, is high. Using a Windows 10 running system and MATLAB 2020a programming environment, Researchers have used the advised models on a PC running an Intel (R) Core i7 at

3.00 GHz and 8 GB RAM. Along with meteorological conditions, the hourly temperature readings consider humidity, wind speed, pressure, rainfall, and time. It computed every weather condition's normalized frequency distribution to have a broad knowledge of the ones usually connected with the car-sharing state. The metric that indicates how closely the forecast resembles the historical data is called the evaluation metric. These come in handy when contrasting prediction approaches using the same facts.

Mean absolute error (MAE): It is widely used because it is simple to compute and comprehend. It is calculated as the average of the absolute anticipated error values.

$$MAE = \text{mean}(\text{absolute}(\text{expected}_{\text{value}} - \text{predicted}_{\text{value}})) \quad (4)$$

Mean Square Error (MSE): MSE typically gives significant errors more weight. It is computed by averaging the values of the squared expected errors.

$$MSE = \text{mean}(\text{expected}_{\text{value}} - \text{predicted}_{\text{value}})^2 \quad (5)$$

Root Square Mean Error (RMSE): Prediction squares allow one to represent the mean-squared error already described. The mean-squared error score's square root could help translate it back into the original prediction units. RMSE penalizes huge prediction errors more relative to MAE, so it is chosen as an evaluation metric.

$$RMSE = \sqrt{MSE} \quad (6)$$

Thanks to its scale independence and interpretability, mean absolute percentage error (MAPE) is among the most widely used measures for forecast accuracy. It is calculated by dividing the absolute inaccuracy for each time by the visible data for that age and then averaging those set percentages. MAP indicates the degree of prediction error about the reference value. For the actual value, n is the count of forecast points;

$$MAPE = \frac{100}{n} \sum_{t=1}^n \left| \frac{A_t - F_t}{A_t} \right| \quad (7)$$

In RMSE, the target and forecasted values' RMSE after log transformation is the log transformation that eliminates the size of the mistake, and RMSLE only considers the expected and actual values' relative inaccuracy. The RMSLE formula is shown as follows:

$$RMSLE = \sqrt{\frac{1}{n} \sum_{i=1}^n (\log(p_i + 1) - \log(a_i + 1))^2} \quad (8)$$

Where p_i is the target prediction, the target is i , $\log(x)$ is the natural logarithm of x , and $\log_e(x)$ is the total count of data set observations. Studies used many parking stations from different classes to determine which features made the predictions more accurate and to adjust the demand predictions. Our time series was tested a few times before using the various models.

Table 1 Performance comparison

Methods	MAE	MSE	RMSE	MAPE	RMSLE
SVM	0.072	0.00976	0.09869	0.30399	0.07190
RF	1.06	1.20553	1.4850	0.9860	1.1529
k-NN	1.52	1.8695	1.6940	1.7978	1.3580
CNN	1.19	2.7745	1.7745	1.91975	1.4508
XGBoost	0.065	0.00970	0.0985	0.305	0.0715

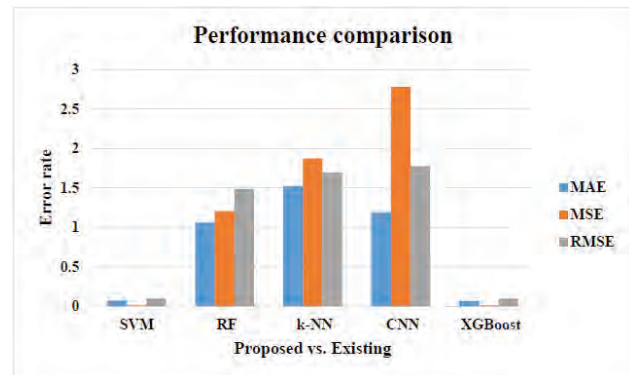


Fig. 3 Performance comparison

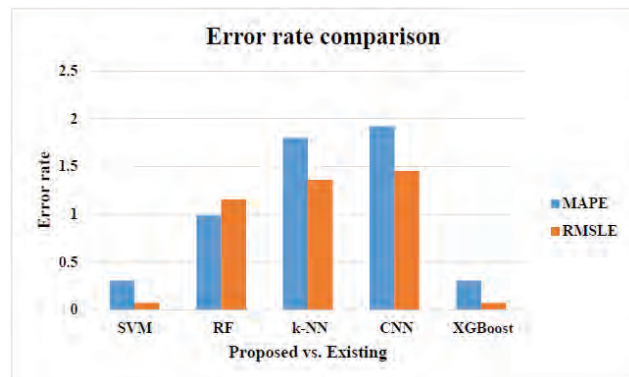


Fig. 4 Error rate comparison

A method that examines the connections between the many causative time series variables. After analyzing the data in Table 1, I discovered that every p-value provided was below the significance level (0.05).

For instance, the causality test for temperature_x causing number_rented_cars shows the p-value (0.05) significant threshold with a result of 0.0003. According to the findings, every variable is a strong contender in forecasting the quantity of hired cars. XGBoost was the most effective machine learning model, with SVM, RF, k-NN and CNN closely behind (See Fig 3 and Fig 4). This is evident from comparing assessment criteria and outcomes obtained with the models. Among the several predictive benefits of the XGBoost model were comprehensive feature extraction, an appropriate solid effect, and excellent prediction accuracy. The second SVM prediction series lacked regular and random trends. Due to the large number of inputs, k-NN fared the worst among the machine learning models, and as a result, it could have performed better. In contrast, random walk patterns might be seen in the XGBoost and prediction series.

CONCLUSION

Only non-financial metrics could be used to gauge success, and additional information about the car-sharing companies' performance would benefit future studies. The quantity of cars and their utilization are different and may vary depending on the business strategy. For example, P2P car usage is far less common than other business models. Furthermore, researchers observe that the database only contains companies with an online presence, which may result in the rejection of smaller, locally oriented car-sharing programs without a website. With its lengthy cooperative background, the car-sharing sector is particularly unique. It was challenging to generalize specific findings to other nations. This research study attempts to anticipate a novel boosting model for car usage and explore the elements contributing to increased prediction accuracy by applying machine learning on multi-variate time series. Using environmental variables and temporal information elements applied to the number of car-sharing transactions, the boosting model generates the best prediction accuracy based on experimental data. Evaluating different machine learning using various performance metrics shows that the proposed boosting model produces fewer errors than the single-used models. The boosting model aims to properly combine the advantages of two deep learning methods. Apart

from the efficacy of the proposed boosting model in sustaining events over long periods, the technique intends to extract crucial information and grasp the internal representation of time series data.

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Modelling A Pre-Trained Network Model for Analyzing the Forest Fire Features Using Learning Approaches

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ABSTRACT

For a very long time, forests have been made up of various animal and plant species that coexist to create essential ecosystems. Wildfires are a persistent hazard to these ecosystems and can start spontaneously, unintentionally by humans, or as a result of lightning strikes. Human-started fires are more costly and deadly since they are usually found in rural regions. In addition to causing damage to houses and other infrastructure, wildfires can kill people and animals. They have the potential to increase and become quite harmful. It is crucial to detect wildfires early to save lives, property, and other assets. Improved imaging technologies could be very helpful in detecting wildfires early on. Deep learning (DL) is being used to automatically identify forest fires using a dataset of photos from satellites, drones, and airplanes. Using transfer learning approaches, our team builds a DL model specifically for wildfire detection in this work, using the latest DL computer vision architectures, such as VGG16 and ResNet50. Our proposed technique has a promising detection rate of over 98% across many parameters, which makes it suitable for real-world forest fire detection scenarios.

KEYWORDS: Forest fire, Detection, Pre-trained, Deep learning, Accuracy.

INTRODUCTION

One of the planet's most precious natural resources is wood. They supply sustenance for a wide variety of flora and fauna, control the climate, and provide a host of other social and economic benefits. Nonetheless, one of the biggest threats to forests is wildfires, which can cause enormous damage and destruction. Unintentionally, like from a campfire spark, a wildfire might start; purposefully, from someone looking to harm. Wildfires have the potential to spread swiftly and destroy everything in their path. Furthermore, by eliminating soil, destroying trees and other plants, and releasing harmful pollutants into the environment, they

have the potential to have a catastrophic impact on the ecosystem. Over the past few years, wildfires have worsened. Wildfires in the Mediterranean region tore through Algeria, Tunisia, Morocco, Italy, and Greece around the middle of July 2021. Hundreds of acres of land burnt, allegedly as a result of arson, resulting in dozens of deaths and numerous injuries. The fires negatively impacted local economies due to extensive agricultural devastation, destruction of businesses and residences, and other factors. Because many tourists decided not to visit the impacted areas, the tourism industry also suffered. The fires destroyed everything in their path for weeks despite the volunteers' and firefighters' best efforts.

To reduce the likelihood of wildfires, we can take several measures, such as employing fire-resistant materials and maintaining trees properly when constructing homes and other buildings. Additionally, addressing the underlying causes of these fires is crucial. The process of converting digital pictures into useful information is known as computer vision (CV). Applications of CV include motion tracking, scene description, and object recognition. High-level and low-level are the two categories of computer vision algorithms. High-level algorithms operate on more abstract elements such as corners and edges, while low-level algorithms deal with individual pixels. Simpler algorithms can be faster and more accurate, but they also tend to be more complex and require more computing power. Higher-level algorithms might have greater accuracy, but they are also simpler and faster. Nevertheless, deep learning has shown significant potential in this field and has generated excellent results in object recognition and scene interpretation.

Computer vision powered by deep learning is capable of reading text and recognizing faces and objects in images. Moreover, photos can be automatically classified and categorized by it. An example of a deep learning network is a convolutional neural network (CNN), which is made up of numerous hierarchically layered layers of neurons. By progressively taking more information out of the input data, the goal of a deep learning network is to acquire data representations. To solve computer vision difficulties, due to its ability to extract characteristics from the given input, CNNs are particularly beneficial. The feature extraction method involves locating crucial elements in the data and conveying them in a form that the network can understand. Traditional machine learning methods, on the other hand, demand that the programmer define the qualities that the algorithm should use. Preliminary wildfire detection is required to protect people, property, and assets. Early wildfire detection can be aided by imaging technologies. Wildfire heat signatures can be identified by satellites, aircraft, and high-altitude drones by top-spotting the fire area. The most popular and highly efficient pre-trained computer vision architectures available are employed in this study to apply deep learning to produce the most accurate forest fire detection model possible. The text's remaining sections are organized as follows: Although

the techniques used are highlighted in the second part, the third segment discusses relevant works. The next section outlines our recommended course of action. Finally, the final section summarizes and talks about the results of our study.

RELATED WORKS

Several research projects have been started to create models for systems that detect smoke and fire. As artificial intelligence has progressed, much research has been done on deep learning and machine learning models for smoke and fire detection in photographs. Researchers have primarily studied CNN-based smoke and fire detection models in this work. A survey that includes summaries of the most recent datasets and cutting-edge computer vision algorithms examined CNNs for smoke and fire detection. The authors described the difficulties and possible fixes to further CNN's advancement in this area. The author created a quick fraud detection system by utilizing CNN and transfer learning. This model claimed that the time required for training and classification was lowered by using transfer learning in comparison to previous models in the literature. It made use of a CNN architecture that allowed for fast data processing for real-time uses. The v3-base dataset of recorded and internet videos was carefully chosen to enhance the MobileNetV2 and InceptionV3 models. After training on a limited dataset, transfer-learned models outperform fully trained ones, according to the researchers.

A Fast Regional Convolutional Neural Network was used to create an alternate technique (Fast R-CNN). The potential shots were located among the sample photos using a selective search technique. The findings demonstrated that Fast R-CNN smoke detection had a greater detection rate and generated fewer false alarms. Advanced CNN models for object identification serve as the foundation for new fire detection methods such as YOLOv3, R-FCN, and Faster-RCNN, as shown by. In terms of object detection, CNN-based algorithms outperformed and were more accurate than other algorithms, according to an analysis of proposed and existing frequency detection techniques. Furthermore, the YOLOv3-derived model attained a much higher mean accuracy of 83.7% when compared to the other suggested techniques.

One study presented a technique to locate and identify the fire point in an image by employing YOLOv3 and a depth-wise separable CNN. Initially, a depth-wise separable CNN was used to classify the images, which significantly reduces detection time without sacrificing accuracy. YOLOv3 is utilized to derive the fire's location from the images that are categorized as fire to reduce the impact on detection accuracy. This method significantly reduced the target regression identification time for images without fire. When tested against a publicly accessible network database, they achieved about 98% detection precision. The author employed feature maps composed of densely packed convolutional layers to build a multi-scale prediction system. The final prediction could incorporate feature maps at various scales through the use of a feature-squeeze block. The spatial and channel dimensions of the feature maps were successfully compressed by the feature-squeeze block. In experiments, the proposed approach outperformed existing CNN-based techniques. These studies highlight the ongoing advancements and potential of CNN-based models in improving smoke and fire detection systems, addressing current challenges, and proposing innovative solutions.

METHODOLOGY

Dataset

The data for this study were collected using Copernicus Sentinel-2, MODIS, VIIRS, Landsat-8, and other geostationary weather satellites (Kaulage, 2022). Because these satellites have high temporal precision and can detect changes in faraway places, they are used for free detection all over the world. Additionally, the dataset includes photos sourced from Google and Kaggle, specifically from the following URLs: Kaggle Fire Dataset, AI for Mankind Wildfire Smoke Dataset, and Kaggle Fire and Smoke Dataset. The dataset comprises 4800 images, including satellite images capturing woodland conflagrations. The labels Fire, No Fire, Smoke, and Fire from Smoke have been manually applied to the photos. To boost the number of photos, a variety of image augmentation techniques were used, including translating, moving, flipping, modifying, resizing, obfuscating, and cropping. Three categories were applied to the dataset: testing, validation, and training. Of the dataset, 80% was used for training,

while the remaining 20% was divided equally between testing and validation. This distribution ensured that the classifiers were adequately trained and evaluated. These efforts enhance the robustness of the dataset and contribute to the development of more accurate and efficient smoke and fire detection systems.

Prediction

One or more fully connected layers (FC) are usually coupled to a modern CNN, with the classification output positioned above the input following the convolutional layers. To achieve smaller feature maps and better translational invariance, max-pooling layers are usually combined with convolutional layers. Two well-known CNN topologies are compared in this study: the residual network and the VGG network. The network layers below are naturally divided into "blocks" where the feature map size remains constant throughout the block but is lowered at the start or finish (usually by a factor of 2). For instance, multiple 3x3 convolutional layers are layered at the same depth to form a "VGG block," and then a 2x2 max pooling layer doubles the size of the feature map. Unless specified differently, 2x2 max pooling and 3x3 convolution are the two common filter sizes that could be applied in this investigation. A VGG block can thus be represented as $N \times K$, where N is the number of convolutional layers and K is their depth. The first convolutional layer reduces the size of the feature map at the start of a "Resnet block" by substituting stride=2 for 2x2 max pooling. The next step is to stack many convolutional layers. With filter widths of 1x1, 3x3, and 1x1, we apply the "bottleneck design" to three convolutional layer repeating units. Creating a shortcut between each unit's two ends is a crucial component of the Resnet block. This makes it possible to quickly skip past features and focuses each unit on obtaining the "residual" data.

Each convolutional layer in the Resnet uses batch normalization or BN; it has a regularization effect and is known to fasten convergence. The configuration [L-M-N]AResnet block can be characterized by $\times K$, L , M , and N stand for the three convolutional layers in a unit, while K represents the number of units. Patch classifiers, such as the VGG16 and Resnet50, are employed. Five VGG blocks and two FC layers made up the initial VGG16 design. The global average

pooling layer computes the average activation of each feature map, taking on the function of the two FC layers to guarantee that the output of the final VGG block is consistent with Resnet50. For example, following the global average pooling layer, the output of the preceding VGG block, which measured $7 \times 7 \times 512$ (height $\times$ breadth $\times$ channel), becomes 512. An FC layer is then used to connect the categorization's output to this output. Once the heatmap has been made more visible, a straightforward way to turn it from a patch classifier into a full image classifier is to link it to the classification output of the image using FC layers. By tracing the output of the patch classifier using a max-pooling layer on the heatmap, the prototype's translational invariance can be strengthened. Creating a shortcut from the heatmap to the production can facilitate further training. Directly from the output of the patch classifier, the heatmap was created, which makes use of the softmax activation:

$$f(z)_j = \frac{e^{z_j}}{\sum_{i=1}^c e^{z_i}} \text{ for } j = 1, \dots, c \quad (1)$$

Nevertheless, the softmax activation attenuates gradients for large inputs when applied in an intermediary layer, potentially impeding gradient flow. Therefore, using the rectified linear units (ReLU) is one option:

$$f(z)_j = \max(0, z_j) \text{ for } j = 1, \dots, c \quad (2)$$

Unless otherwise specified, the activation function in the discussion that follows is always ReLU. Convolutional layers are recommended as the top layers of an image classifier when addressing the heatmap as a whole since they preserve spatial information. The patch classifier layers (ResNet or VGG) can have two blocks layered with convolutional layers on top, followed by the image's classification output and a global average pooling layer. To classify an image, this architecture constructs an "all convolutional" network. The feature map's depth between the patch classifier and the upper layers is suddenly reduced by the heatmap, which may cause information loss during the whole picture classification process. Researchers also evaluated the results of removing the heatmap from the total image classifier, to build higher layers that optimize the features derived from the patch classifier.

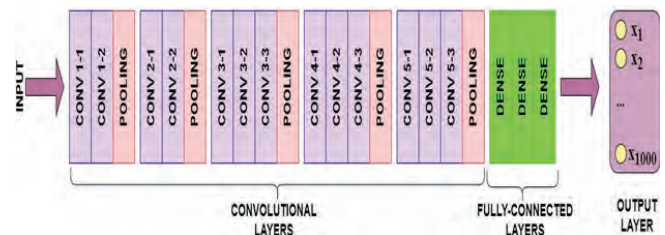


Fig. 1a VGG16 model

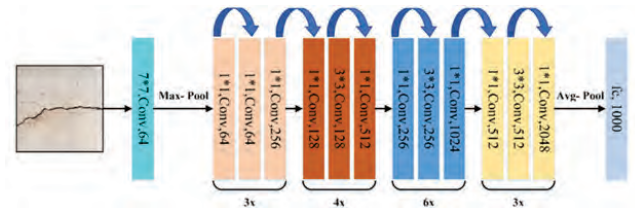


Fig. 1b ResNet model

NUMERICAL RESULTS AND DISCUSSION

Feature extraction, fine-tuning, and forgetting-free learning tests were used by researchers to assess the efficacy of pre-trained models. Because they are deeper, the recommended models were trained using GPU-enabled kernels on Kaggle. Model training was done using the frameworks TensorFlow and Keras. The hyper-parameters listed in Table 1 were used to train the models. Table 1 shows the optimal hyper-parameter settings that resulted in the best training outcomes. The models were trained for up to 100 epochs, but training was stopped early if there was no improvement in validation loss or accuracy. This early stopping mechanism ensured that the models did not overfit and only trained for the necessary number of epochs to achieve optimal performance.

As mentioned before, two different sets of tests were carried out by the researchers. All we had to do to conduct these experiments was to replace the classifier that these models were using with our own. Two completely linked layers and a softmax layer were added to VGG16. There is now one fully connected layer and one softmax layer in VGG16 and ResNet50. The top 5, 8, and 7 layers of ResNet50 and VGG16, respectively, were retrained by the researchers following model modifications. To evaluate the models' performance, researchers compared them to test data. The results of the testing and validation processes for each of the

suggested models are summarized in Table 1. Because each image in the dataset had to fall into one of the four categories, It utilized each model's recall, accuracy, precision, and F1 score to compare its performance with the four classes. TN, TP, FP, and TP were determined using Equation (3). Then, using the formulas from Eqs. (3) to Eq. (6), the F1-score, accuracy, precision, and recall are determined:

$$tp_i = c_{ii} \quad (3)$$

$$fp_i = \sum_{l=1}^n c_{il} - tp_i \quad (4)$$

$$fn_i = \sum_{l=1}^n c_{il} - tp_i \quad (5)$$

$$tn_i = \sum_{k=1}^n \sum_{l=1}^n c_{lk} - tp_i - fp_i - fn_i \quad (6)$$

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (7)$$

$$Recall = \frac{TP}{TP + FN} \quad (8)$$

$$precision = \frac{TP}{TP + FP} \quad (9)$$

$$F1 - score = 2 * \frac{precision * recall}{precision + recall} \quad (10)$$

The researchers employed confusion matrices to produce True Positive (TP), False Positive (FP), False Negative (FN), and True Negative (TN) values after running each model through Eqs. (3) to (10). The degree of agreement between the actual values and the anticipated results is graphically represented by a confusion matrix. The confusion matrix's diagonal elements reflect correct classifications, whereas the off-diagonal entries represent wrong classifications. The X-axis displays the expected classes, while the Y-axis displays the actual classes. For example, VGG16 accurately recognized three photographs belonging to the Smoke class, six images belonging to the Fire class, and so on. The computed results for each class for each suggested model are shown in Table 2. F1-score, recall, accuracy, and precision are among the results. These

metrics derive from the TP, FP, FN, and TN values. Additionally, a performance comparison between the suggested models and existing deep-learning models was made. It is crucial to remember that the models and datasets utilized in this study differ from those in other studies.

Table 1 Performance analysis with VGG16

Image types	Accuracy	Precision	Recall	F1-score
Fire	93	86	96	97
Smoke	94	84	91	91
Smoke fire	93	85	86	90
No fire	98	89	85	92

Table 2 Performance analysis with ResNet50

Image types	Accuracy	Precision	Recall	F1-score
Fire	97	96	95	97
Smoke	98	97	98	97
Smoke fire	98	96	96	95
No fire	97	95	95	96

Our project uses both conventional and contemporary CNN models to categorize photos of forest fires into four groups. This section presents the experiment's outcomes and summarizes our investigation's conclusions. This study has used several criteria to evaluate the efficacy of transfer learning techniques. The first metric assesses how well the suggested models can categorize datasets related to forest fires using just transferred data (feature extractor). On the other hand, the second measure evaluates whether classification accuracy may be increased by fine-tuning some of the upper layers of the pre-trained models. Because the created models use the weights of pre-trained models to extract features, their accuracy might be higher. However, fine-tuning involves retraining several top layers' weights, enhancing the models' ability to capture the dataset's characteristics. Transfer learning proves effective when leveraging a network's visual data expertise for new or related tasks, thereby increasing model accuracy while reducing training time.

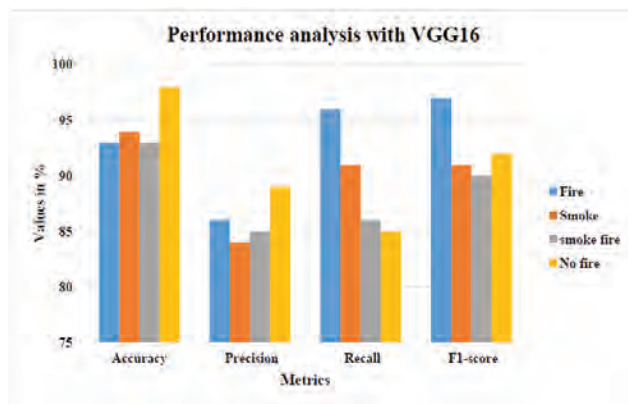


Fig. 2 Performance analysis with VGG16

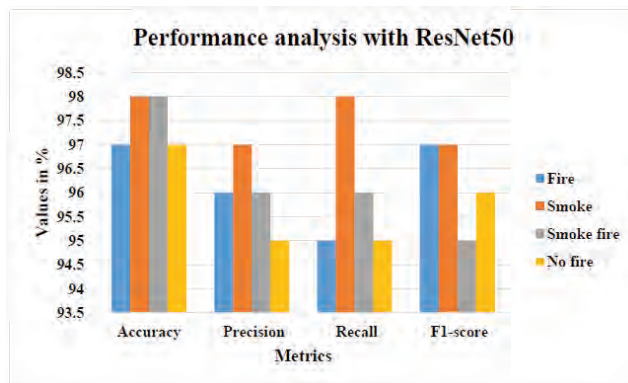


Fig. 3 Performance analysis with ResNet50

Because our results outperformed those of other models in the literature, they can conclude that transfer learning models are more effective at classifying difficulties. Of all the models that were suggested, the VGG16 model performed the best. One possible explanation could be the use of depth-wise separable convolution by ResNet50, which allows for faster and more accurate learning.

CONCLUSION

This study focused on training models for smoke and forest fire detection, emphasizing feature enhancement and extraction. According to our findings, the ResNet50-based model outperformed all others, achieving an accuracy of 98%. Researchers kept the original dataset's features intact by using VGG16, then discovered that fine-tuning for the new task produced better results than straightforward feature extraction. Early identification of fires is crucial for preventing widespread damage, as highlighted in recent studies. Building on our findings,

future research aims to leverage state-of-the-art CNN models to swiftly detect rare events with minimal false positives. Additionally, exploring pre-trained models and multitask learning will be priorities in expanding this research.

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Electricity Measurement Based of Water Material from the Home Environment

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ABSTRACT

In a frigid climate, most of the year's outdoor temperature is usually below zero. By freezing water in a limited area, it is feasible to use the low temperature as a free energy source. It is commonly known that enormous pressures can be produced by analyzing a contained amount of water. A hydraulic motor could harness this force and produce mechanical energy. This study aims to familiarize readers with producing electricity by freezing water. This study also describes and shows how various circumstances affect the quantity of energy the water may produce. This was accomplished by building a computer model that explains the idea and verifying it with experimental data from a tiny go-kart that had previously been produced. Results from experiments and simulations indicated that freezing water has the potential to make a significant quantity of energy. The results of the simulations demonstrated how much the design and starting conditions affect the amount of energy. A system with a superior design can produce more power.

KEYWORDS: *Electricity, Water, Cost, Home environment, Demand.*

INTRODUCTION

It is common knowledge that when water freezes, it expands rather than contracts due to hydrogen bonding, which is incredibly rare. When water is frozen in a sturdy, confined container, one can use its low compressibility and expand upon freezing to achieve high pressure. It is theoretically possible to attain a maximum pressure of 220 MPa at a temperature of -22 °C [1]. During the winter, big stones were split using the high pressure created by drilling a hole and filling it with water. The rock collapses when the water grows inside the hole as it freezes. Alternatively, a hydraulic motor can be directly operated by high pressure, producing mechanical energy. However, the

literature review affirms that this phenomenon still needs to be unexamined in energy production [2]. To our knowledge, the conversation has yet to occur in the scientific literature on exploiting the high pressure from freezing water to generate mechanical energy. The study examined the viability of freezing water in generating energy. A tiny go-kart constructed represents the device the authors used to simulate the frosty rider. A hydraulic motor that runs the vehicle is powered by pressure. The extremely high pressure, which powers a hydraulic engine, is produced by freezing 0.027 m³ of water in a small space. When the driver is added, the entire rider weighs about 200 kg. The hydraulic system transfers the energy produced during freezing. In this

manner, the frosty rider covers a maximum driving distance of around 400 meters at a top speed of about 70 km/h [3].

On the other hand, the model generated might not accurately represent the chilly rider because of the potentially imprecise nature of the employed technique. This is demonstrated by the notable departure of the theoretical conclusion from the experimental data, predicated on their suggested model [4]. The current endeavour involved the creation of a theoretical model to replicate the cycle of thermodynamics that produces mechanical power when water freezes in a limited volume. The Frosty Rider's operational experimental data was compared with the conceptual model to confirm its validity. The model was then applied to examine how various parameters affected the amount of energy that frozen water could produce. The melting point typically shifts toward higher temperatures as pressure increases; however, the opposite is true in water [5] – [6]. To be more precise, the melting temperature decreases as pressure rises. An experimental demonstration of the relationship between pressure and the temperature at which ice melts is shown. In these experiments, the ice's temperature remained constant while pressure increased. The pressure at which abrupt melting occurred was identified as the melting pressure. However, a recent study characterized the link between pressure and melting temperature in a novel approach [7] – [8]. A freezer maintained at a steady temperature was used to hold a water container. The pressure inside the container rises when the water freezes because of the expansion. As long as the water is freezing, the pressure will continue to rise [9]. It was previously said that the melting pressure point is the point at which pressure increases stop. The results of these measurements show repeated for the freezer at various temperatures [10]. As demonstrated, a temperature of $-22\text{ }^{\circ}\text{C}$ can lead to a maximum pressure of 220 MPa. It is outside the purview of this investigation to generate a novel kind of ice at below $-22\text{ }^{\circ}\text{C}$ temperatures. The link between pressure and melting temperature can be roughly approximated as follows: In this case, the pressure is $P(\text{MPa})$, and the melting temperature (T) is expressed in degrees Celsius. The work is organized as follows: section 2 is existing works. The methodology is drafted in section 3. The numerical values are given in section 4, and the summary in section 5.

RELATED WORKS

Artificial muscle based on dielectric elastomer technology is a state-of-the-art sophisticated material science with unique qualities and characteristics not found in other materials. Dielectric elastomers' fundamental building block is a simple design consisting of two flexible electrodes sandwiched between thin polymer films or elastomers. Actuators powered by electricity can be derived from dielectric elastomers. The elastomer expands plane-wise and contracts thickness-wise when electrostatic forces between the electrodes cause a voltage differential to be applied between them [11]. Our team has demonstrated that the electro-active strain response to an applied voltage is unaffected by externally applied pressures of up to 100 MPa, confirming that the dielectric elastomer type of electro-active polymer can maintain good operational characteristics even in an ultrahigh-pressure environment [12]. When dielectric elastomer actuators are used in the opposite mode, which generates electrical energy by exploiting the elastomer's deformation brought on by external mechanical action, it has garnered more attention recently.

Liquids typically expand upon melting and constrict upon freezing, unlike water. The reason for this contraction is that the molecules in the liquid need more room to move about because they are held in place within the solid. A volume increase of roughly 9% occurs when water freezes at $0\text{ }^{\circ}\text{C}$ (at 1 atm pressure). The reason for the expansion upon freezing is that water crystallizes into an open hexagonal shape. There is more space in this hexagonal lattice than in the liquid state. Then, as the temperature drops, the ice gets smaller. On the other hand, the shrinkage from -1 to $-22\text{ }^{\circ}\text{C}$ is less than 0.4% [13]. Otherwise, the ice's contraction is negligible and will not be considered in this investigation. It is important to note that the volume increases significantly upon freezing if more pressure is applied to lower the melting point [14]. In particular, the water's expansion volume is 16.8% at $-20\text{ }^{\circ}\text{C}$ and 200 MPa of pressure and 9% at $0\text{ }^{\circ}\text{C}$ and 1 atm of pressure are caused by freezing [15].

METHODOLOGY

Energy converter

A radically fluctuating source of energy is the wave.

As wind blows across the ocean, waves are produced at the surface. They have a long range once they are created. They are called “swells” when they reach a remote region from the production area. Waves exhibit significant fluctuations in intensity between their peaks and averages, but they also follow seasonal trends. Antenna, phase, and directionality are used to categorize the behaviour of ocean waves. The most common devices include point absorbers, wave surge devices, oscillating water columns, and attenuators. The first three technology categories usually comprise one or more bodies that generate energy using rotational motion or relative translation motion driven by waves that pass between the body and a frame of reference (like the seabed). Unlike these systems, oscillating water columns consist of an air column trapped above a water column. The air is forced through a turbine by the water column’s rise and fall due to incident waves. Most gadgets operate on a wave-to-wire system, meaning electricity is first generated inside each gadget, then gathered within an array and sent via an export cable to the shore. Water is pumped to onshore power generation equipment by additional hydraulic apparatus designed for near-shore circumstances.

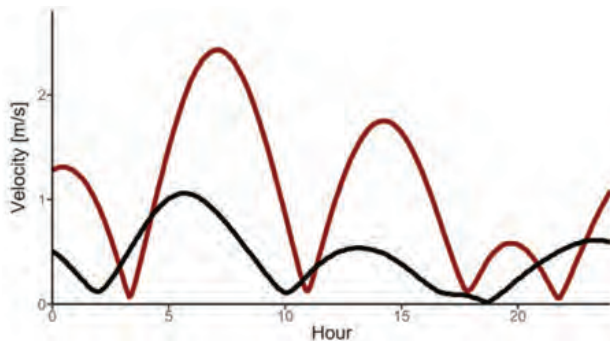


Fig. 1 Velocity [m/s] measurement for energy production

Converter deployment

Like tidal current devices, energy costs still need to be commercially developed, but numerous converters were tested and deployed globally, many of which have been linked to local grids. Some existing utilities established a 300 kW water column oscillation system fitted into the harbour breakwater. Furthermore, this system was the first multi-turbine system to undergo global testing. According to a power purchase contract, the Department of Defence entered into an agreement

that included a desalination plant to create fresh water for energy generation. Grid-connected converter deployments have also occurred. Compared to current-generation technologies, the expenditures associated with deploying wave and tidal devices are anticipated to be relatively substantial. Most deployments have been small-scale initiatives or pilot programs to assess their ability to produce power, their interactions with the maritime environment, their technology in the sea and their ability to work with power networks. Project-specific device development is a customized procedure that raises building costs and delays without standardizing production procedures, coordinating supply chains or having applications that may be applied to the maritime industry for scale and availability economies.

The working environment brings particular risks due to new and inevitable expenses. Regulatory needs and environmental problems will arise from the deployment and aquatic life interactions. With exposed mechanisms and varying degrees of submersion, wave energy devices are purposefully agile. Innovative coatings, corrosive-resistant materials or protective casings will be necessary for specialized tidal and wave electronics protection. Unique supply chains, specialized equipment and vessels, and constrained operating windows can all restrict deployment on the ocean. Strong, multidirectional forces must be accommodated into the design of gadgets by technology developers. Research and development initiatives worldwide have encouraged calculated investments to reduce these expenses. The natural fluctuation in wave strength requires that it is possible to construct wave energy conversion devices with a power output capacity substantially higher than their average power output.

Electricity cost

The levelized cost of electricity is the most often used statistic to compare the costs and benefits of different energy-producing technologies. As an illustration, the widely used Lazard estimates compare technologies based on their lifecycle costs and benefits. By considering actual generation, levelized electricity cost provides a more comprehensive picture of energy representing installation price for each rated power unit. Using the Life Cycle Economics of Engineering (LCOE) metric,

a relationship may be established between the energy output of a project throughout its whole lifespan and the present value of its lifetime expenses. It is expressed as a unit of money per unit of energy or dollars per kilowatt hour. The calculation looks like the figure considers that project prices change over time and that the location of renewable energy projects affects the energy and strength of the resource. The denominator of the LCOE equation is affected by variations in energy output; the lower the cost of electricity becomes, the greater the yearly energy production capacity of the facility. When governments consider incentives for new technologies, LCOE is generally the preferred metric. It is a primary screening tool to determine which cutting-edge innovations are getting close to commercial viability and if investing outside of the year might be contemplated.

$$\text{Levelized electricity cost} = \frac{\text{generation cost}}{\text{total energy generated}} \quad (1)$$

NUMERICAL RESULTS AND DISCUSSION

To determine the extractable energy resulting from Eq. (1), the freezing point of water in a limited space must be determined. The experimental information obtained from running water was compared with the theoretical model to confirm its validity. Table 1 lists the water specifications. The volume of water in the chosen containers was determined by considering the vessels' strength to ensure that the pressure did not exceed the maximum pressure allowed for the components with a sufficient safety margin. It indicates that 34.9 kJ is the extractable mechanical energy. The predicted weight and top speed of 200 kg and 70 km/h correspond to a kinetic energy of 37.8 kJ. Thus, there is an 8% divergence from the experiment's kinetic energy. The following can be used to explain the discrepancy between the kinetic energy derived from the preliminary findings and the extractable energy derived.

Table 1 Water specification

Weight	200kg
Volume of water	270
Volumetric coefficient	10%
Pressure	10MPa

Pressure during freezing	25Mpa
Index factor	1.5
speed	70 km/h
Temperature	-10
Room temperature	21° C

The empirical measurement overestimated the driver and the weight of the water, but the experimental study overestimated the speed. Stated differently, to achieve a reasonable correspondence between the simulation and the actual data, the speed or weight should be modified to 69 km/h or 185 kg, respectively. The experimental and water measurements were acquired at the lowest feasible cost, which is essential to note. This indicates that the experimental outcomes could be significantly ambiguous.

On the other hand, the water's volumetric expansion coefficient, a smaller approximation of the actual expansion coefficient, is $\varepsilon = 9\%$. It is common knowledge that if the melting point is dropped due to increased pressure (e.g., at -20°C $\varepsilon=16.8\%$), the volume of freezing will grow more. Otherwise, the expansion coefficient must be changed to $\varepsilon=9.8\%$ to match the testing and simulation results for the claimed weight and speed, which are 70 km/h and 200 kg, respectively.

Therefore, the proposed conceptual model can be used to simulate the creation of mechanical energy by freezing water. The established model also proves that one litre of water can produce a maximum energy output of up to 22.1 kJ. This solution can be obtained by substituting 1l, 219 MPa, and 220 MPa for the volume and P1 and P2, respectively. The latter shows the 220 MPa maximum pressure can be achieved. At the end of the expansion pressure, the pressure was supposed to be less than the initial pressure (i.e., P4) to power the theoretical model of the chilly rider.

Table 2 Sensitivity analysis

Factors	Range
Freezing Temperature	-13.5 – 8.5
Normal temperature	15.5 – 25.3
Volumetric coefficient	1.1 – 2
Pressure	7.5 – 12.6

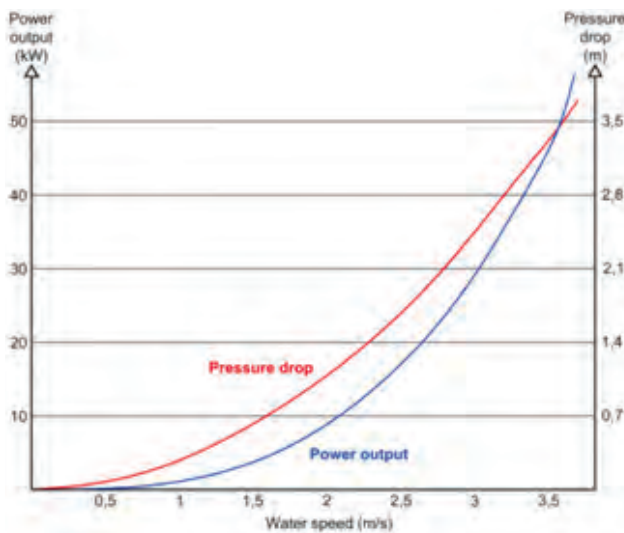


Fig. 2 Power output

To examine the impact of various operating parameters on the extractable energy, calculations were made for specific values of the initial pressure, the water's coefficient of volumetric expansion, the freezing and ambient temperatures, and the gas's adiabatic index. To do this, it was hypothesized that the parameters would vary from 25% higher to 25% lower than the nominal values listed. Table 2 lists the identified components and their corresponding ranges, which deviate 25% from the projected values shown in Table 2 by 25%. Modifications to the extractable energy resulting from differences in the elements considered were used to calculate the influence of the parameters. Different elements have distinct effects on the extractable energy. However, the water's volumetric expansion coefficient and starting pressure are critical factors. These two variables are significant because they affect the gas pressure after completely freezing. This indicates that the energy generated increases when a substance with a higher volumetric expansion coefficient is substituted for water. For example, paraffin wax has a more significant volumetric expansion coefficient than water; melting it can provide energy in hot temperatures. Strengthening the system enables us to raise the starting pressure, which raises the energy produced. Put another way, there may be various methods for increasing the energy produced by phase shift. Roughly 1.4 kW was the average power since the extracted energy was

consumed for roughly ~25 seconds, or the length of the ride. However, improving the hydraulic system (better motor, wider pipe, increased flow capacity, etc.) to shorten the extraction time significantly increases generation power. The model shows the mechanical energy generated from the examined water parameters according to the extraction time.

CONCLUSION

A concept for producing electricity by water is presented in the current study. This goal led to the creation of a theoretical model. The conceptual model was verified through experimental data gathered from a previously manufactured. The findings demonstrate that water in a finite volume can transform low-quality thermal energy into high-quality energy in cold climates. The constructed model revealed that one litre of water could produce roughly 20 kJ. Though this idea can only generate a modest amount of energy, additional uses for such a device come to mind. Nevertheless, the design and starting conditions significantly impact this energy level. A system with improved design has the potential to produce more energy. Water is utilized in the current investigation to create high pressure because of the frizzling. However, high pressure can also be made with any other material, even with a more significant volumetric expansion coefficient. As stated differently, distinct methods may exist for augmenting the energy generated by phase transition.

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Measuring the Performance of Upgraded Embedded-System-Based Electric Bicycles

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ABSTRACT

Re-manufacturing is an end-of-life strategy that lowers waste production and the use of natural resources by permitting a new product and component life cycle. Reusing, cleaning, sorting, reworking, and reassembling the discarded items returns them to their original forms. Disassembly is essential because it sets the parameters for each subsequent stage in the production chain and dramatically impacts how profitable a remanufacturing process may be. This study evaluates whether disassembling and re-manufacturing electric bicycle motors is appropriate. To analyze the disassemblability of the electric bicycle motors, a quantitative evaluation called the ease of disassembly Metric was tailored to their specific requirements. Lastly, the method's use was assessed after disassembling five electric bicycle motors from reliable producers. Based on the findings, it can be concluded that the bicycle motors are appropriate for re-manufacturing after being disassembled with minimal damage.

KEYWORDS: *Electric bicycle, Embedded system, Performance, Remanufacturing process, Transportation.*

INTRODUCTION

E-mobility, or using electric cars for passenger and cargo transportation, is expected to rise significantly over the next few years. This category comprises electric automobiles and other modes of transportation like electric bicycles [1]. Over the past few years, electric bicycles have become incredibly popular. One indicator of the market expansion is the annual sales volume of electric bicycles in Germany, which has climbed by almost 800% over the past ten years [2]. Germany sold about two million electric bicycles, accounting for 43% of the entire sales of bicycles in the industry. The market for electric bicycles is predicted to increase to account for more than 50% of all bicycle sales by 2025. The popularity and quantity of electric bicycles

have increased, so it is essential to consider the natural resources and prospective treatments after the usage phase. Even with this, the author in [3] demonstrates that there are no comprehensive circular ideas for raw materials and components of electric bicycles. As high-value components, remanufacturing is increasingly concentrating on the accumulator and engine of an electric bicycle.

Since remanufacturing is an essential part of economy, i.e. End-of-Life (EoL) option. It permits a novel product and component life cycle, which minimizes waste and reduces the consumption of natural resources [4]. With the preservation or restoration of the product's shape and related attributes, remanufacturing completes product cycles and allows products to be

reused after their use has reached its end. This easily distinguishes remanufacturing and material recycling. Replacing faulty items with new ones with the same guarantee is known as remanufacturing [5]; this industrial procedure allows for a fresh product life cycle while bringing the remanufactured product up to par. Comparing remanufacturing to fresh production, studies reveal that the resource requirement may be as low as 10%. To prepare a product for a final product test, the remanufacturing process comprises product disassembly, cleaning, examining, classifying, repairing, or replenishing items that have been rejected [6]. Qualitative assessments incorporate the first five stages of the remanufacturing procedure. Certain restrictions specific to a product may affect the number and order of production steps.

Non-destructive, semi-destructive, and destructive disassembly are the three general disassembly techniques. Higher flexibility is made possible by destructive disassembly (metal cutters, crowbars, etc.), which also prohibits component reuse. Consequently, material recycling is best suited for destructive disassembly. In this case, “disassembly” refers to “the procedure wherein a piece of equipment is disassembled so that it can be put back together and used,” as remanufacturing prefers non-destructive disassembly. Destructive techniques are permitted in remanufacturing, loosening fasteners, or letting inexpensive parts access expensive ones. Therefore, assuming the damage does not impede reprocessing or reassembly, semi-destructive procedures are allowed [6]. Hence, compared to other EoL processes, remanufacturing process requirements are stricter. The product’s disassemblability and the related effort significantly impact the technical viability of remanufacturing as well as the financial effectiveness of the implementation [7] – [8]. This work intends to deal with the research gap on the disassembly of electric bicycle motors since literature still needs to address this topic [9] – [10]. Thus, assessing the disassembly ability is crucial in examining the cost-technical study of the re-manufacturing procedure and the technical remanufacturing of electric bicycle motors feasibility. Consequently, this work’s objective is to methodically ascertain how complex the electric bike motors’ product structure is when disassembling and, ultimately, ascertain if it is possible to remanufacture

electric bicycle motors by analyzing how simple it is to disassemble their parts.

The work is organized as follows: section 2 analyses various existing approaches. Section 3 elaborates on the methodology. Section 4 gives the numerical outcomes. Section 5 discusses the summary.

RELATED WORKS

Life cycle engineering is where “the degree of easy disassembly” for disassemblability first emerged to lessen environmental impact. It’s fascinating to measure how simple something is to disassemble; thus, several scholars have proposed techniques to assess disassemblability. Both absolute and relative metrics are employed in the methodologies that are being described [11]. Absolute measurements are used to compare design variants for the same product, such as entropy, disassembly energy, and time or cost estimates. These techniques are employed to determine how much design has improved. On the other hand, relative measures, like disassembly design effectiveness, contrast the current design with an idealized hypothetical design. Time is seen as a legitimate and relatively easy indication in the context of absolute measurements, but other indicators like energy, entropy, and so forth are more intricate. Two methods for determining how long it will take to disassemble a product are direct measurement and calculations based on product features. Ideally, a standardized method that considers process and product attributes (such as connector type and quantity) should be used to calculate disassembly time. A technique for estimating disassembly time was created using a standard connections database. Measurements of particular disassembly phases form the basis of the approach [12]. Other goods with comparable disassembly operations can also use the time-measuring method.

An approach for evaluating disassemblability quantitatively was developed by [13] and is suitable for medium-sized items. The assessment plan consists of five criteria paired with a numerical score determined by difficulty. A trained worker completes a basic disassembly process, forming the assessment plan’s basis. The author created the Ease of Disassembly Metric (eIDM) as defined. This technique provides an index of disassembly to determine how long it will take to disassemble. The time estimate is derived from

MOST [14]. The disassembly jobs are divided into six groups according to the type of task, employing measurable product features as the basis for reference values for the MOST-based disconnect time rather than classifying them according to difficulty degrees. The approach present in their work was first created as a tool for disassembly-based design improvement [15]. They developed five criteria influencing the degree of intricacy and, consequently, the disassembly time. The disassembly step's essential motion times, also called the Maynard Operation Sequence Technique (MOST), are used to estimate the time required.

METHODOLOGY

The initial stage is to create concepts for novel and business strategies for electric bicycles. The emphasis is on business strategies permit bikes to be remanufactured as their valuable lives end. Moreover, product-service systems are given the same attention as pure sales models. Product service system-enabled business model to develop new avenues for competitive advantage and added value while promoting greenness. Any "marketable product set and services fulfilling the user's requirements" is the product-service system definition. Three primary types of product-service systems may be identified.

Product-oriented services: Although more services are provided, the sale of goods remains at the core of the company concept.

Use-oriented services: Although the business strategy does not prioritize product sales, the product is essential to the operation. It is made available in many formats, remains the provider's property, and is occasionally shared by several users.

Result-oriented services: The company plan is based on a goal agreed upon by the client and the provider. There is no set product here.

Ideation is crucial in developing new business models since it creates potential business models and expands the solution space. Ideation is coming up with as many fresh business model concepts as feasible; their evaluation comes next. The work consortium employed creativity approaches like brainstorming in a workshop to develop early ideas for potential business model advancements. Innovative business model methods can be approached

through the first ideas generated by applying creativity techniques. Nevertheless, transforming a first idea into a new company model presents a more significant difficulty. One possible explanation for this could be because the customer's value proposition is excessively ambiguous or that it is difficult for all people involved to engage in the abstract mental process that business models require to encourage the use of business models in thought processes rather than technologies, goods, and procedures, to help with the brainstorming phase, business model patterns were utilized. One can modify the 55 business models listed in the Business Model Navigator database to create a customized business model.

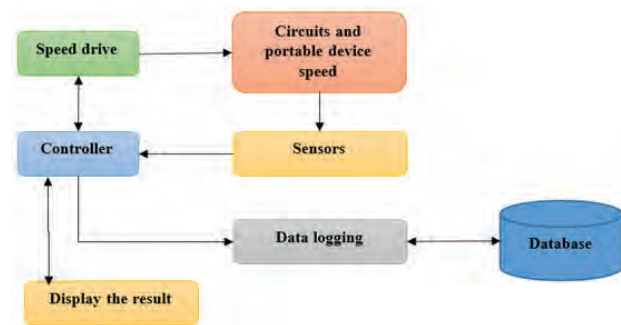


Fig. 1 Architecture of the proposed system

The concepts are then reviewed in the next step, which is developing circular business concepts based on electric bicycle remanufacturing. The goal of idea evaluation is to increase the probability that a novel concept or business model innovation will be commercially successful while reducing the possibility of failing. Not all ideas may be implemented due to resource limits, so the assessment selects the ideas that show the most promise from the many available options. Each business model innovation's marketability and economic feasibility are assessed and graded concerning opportunities and hazards. The goal is to find company model concepts with excellent market potential or minimal resource use, and the assessment was conducted through a two-phase filtration procedure. A preliminary decision was made in the first step of selection since evaluating every option would require an unreasonable amount of work, such as the necessary information collecting. For this reason, the project consortium used a scoring system to base the top preference for business models founded on readily verifiable requirements. Positive selection

was used in the second step to create a ranking and choose the finest concepts for a thorough examination. To increase the product's lifespan and ascertain the assessment technique, focus on two circular business models: To evaluate if business models are acceptable for re-manufacturing models like sales, access, and performance models are explored. With additive manufacturing and remanufacturing, business models changes linear product life cycle to closed one. Also, employing quantitative techniques like profitability computation, business models evaluation determined their applicability to the circular economy, its rationale, and any difficulties that arose in their creation or execution. Four workable business models for combining additive manufacturing with electric bicycle remanufacturing were discovered during the review process.

Table 1 Business model-based description

Block	Details
Cost structure	Total cost needed to execute the business
Key partners	Network partners offer resources for performing certain activities
Activities	Companies provide certain building blocks to analyze the business model
Resources	Companies provide specific resources to analyze the business model
Revenue	Companies generate from every user segment to offer value propositions
Relationship	The companies maintain relationships and preserve specific customer segments.
Channels	Company interface with users can communicate and deliver value
Proposition	Services and products to generate specific value for the segment
User segments	Some organization targets to serve and reach the company

NUMERICAL RESULTS AND DISCUSSION

The absence of specifications for particular parts of electric bicycles (such as the motor, accumulator, and controller) and the speed at which innovation occurs make it challenging to apply circular business concepts

utilizing additive remanufacturing. According to [13], electric bicycle buyers also favour sustainable business models that involve remanufactured parts, repairability, and extending the usable life of the bicycles. Sustainably designed business models were found and examined to assist electric bicycle firms in converting the closed product cycles from the linear product life cycles of their constituent parts. These results led to the definition of two business models, one for sales and the other for services, that work particularly well when combined with additive manufacturing for remanufacturing electric bicycles. The four circular business models previously addressed centre on shifts from merely selling electric bicycles to considering the entire life cycle of an electric bicycle. Value is created in the whole value chain by a circular business model. In this structure, remanufacturing is a viable option for solving issues and developing a sustainable electric bicycle market. Remanufacturing allows for the closure of product cycles and keeping or restoring a product's design and related qualities, allowing it to be reused after its useful life has ended.

Additionally, as the end user is crucial to the value cycle, this leads to a tighter relationship with the consumer. An increase in the number of faulty components can be anticipated due to the recent sharp rise in the sales of electric bicycles and the temporal delay at which associated flaws manifest. Because of their high value, frequent failures, and significance to overall functionality, the motor and accumulator are the most significant opportunities for remanufacturing in an electric bicycle. The need for closer collaboration throughout the various value chain participants is also evident regarding circular business models. It is unlikely for one manufacturer to complete a product cycle in the electric bicycle market. It is also necessary for businesses to share information about things like core availability, hazardous materials, and repair choices to make remanufacturing affordable. Circular business concepts are proposed based on the business models shown in the Business Model. But even so, a straightforward implementation of a circular business model can only be achieved with a comprehensive and well-organized idea based on corporate needs. The practical viability of organizational and technological operations must be assessed to gauge the success of such a company plan.

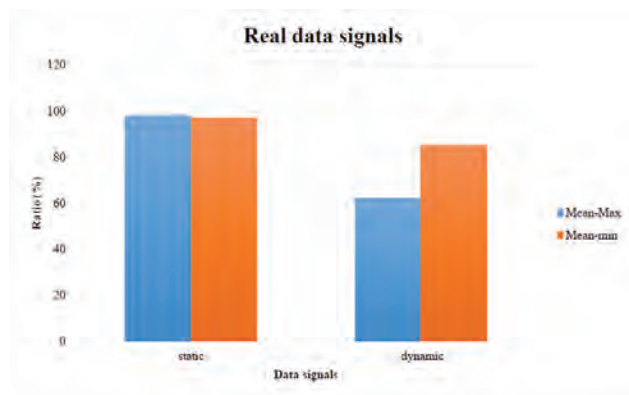


Fig 2 Real data signal analysis of bicycle

Table Electric bicycle motor-based computation

Electric bicycle motor	Changes in tool	Identification	Manipulation	Position	Disconnection	Removal	Motor model
Comfort drive	35	15	55	220	236	25	590
BBSS01B	36	0	28	300	250	65	680
Bosch	30	0	40	185	295	30	580
Borse	23	0	41	156	190	20	420
E6110	30	0	45	190	290	25	575

The embedded system-based model intends to conduct additional research to ascertain the advantages of circular business models. Through the creation of simulation models, an investigation is conducted from an economic, social, and environmental perspective on how Circular business models may prove advantageous for the electric bicycle industry in the long run. Therefore, it is crucial to determine how to use additively remanufactured electric bicycles and circular business models to reduce greenhouse gas emissions based on the following metrics in Fig 3.

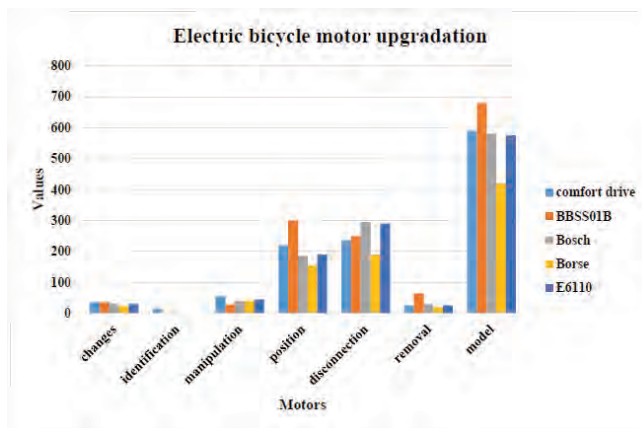


Fig. 3 Various bicycle electric motors

CONCLUSION

From a business model standpoint, this study looks at new concepts for additive remanufacturing of electric bicycles. The objective is to evaluate the additive upgradation as a solution to address the circularity issue. These models integrate additive manufacturing and remanufacturing. These models drew from market and literature analysis, three user surveys, workshops on electric bicycles, and consultations with industry experts. By demonstrating the possibilities of several circular business models that combine additive manufacturing with remanufacturing, this paper adds to the body of literature on circular business models. This business models can assist managers develop prominent business plans for environmentally friendly electric bicycles. Implementing business models for electric bicycle was emphasized, focusing on general principles. These guidelines covered various topics, including value propositions, critical partners, and essential activities. As far as the authors know, no previous study has looked into potential commercial strategies for remanufactured electric bicycles produced with additive manufacturing.

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Threshold-Based Distance Management using Cluster Head and Sensor Node Analysis on WSN

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ABSTRACT

For wireless sensing networks (WSN) with energy constraints, the equilibrium energy consumption is critical to preventing premature network collapse. Some cluster heads may find the current methods too simplistic or require intricate calculations for accurate clustering. Researchers suggested Threshold-based distance management (TDM) in CH and SN in this research to solve these issues. In the case of energy non-harvesting, it could optimize WSN life; in the case of energy harvesting, it could enhance energy use efficiency without requiring more computations. The clustering, inter-cluster routing and cluster head election operations have all been completed. The first two techniques are distributed cluster head election using innovative node division procedures for the intersection region and dynamic cluster radius. The benefits of reducing hot zone issues and distributing the workload among cluster heads are thus realized by lightweight distributed clustering. Finally, researchers optimized the TDM method by examining cooperation and rivalry amongst cluster heads. Clustering is a significant improvement in transmission efficiency among the CH. In addition, this study investigates the reasoning behind the algorithm's capacity to achieve balanced energy usage, reduced calculations, and increased energy efficiency compared to the prevailing approaches. The simulation findings determining that the proposed TDM outperforms the delay-constrained technique regarding network energy consumption and total surviving nodes in energy harvesting scenarios.

KEYWORDS: *Wireless sensor network, Energy, Threshold, Cluster head, Sensor nodes.*

INTRODUCTION

With wireless communication, many low-cost microsensor nodes throughout the monitoring region make up the WSN, a self-organizing network system. The WSN's shared goal is to sense, gather, and process data from sensing objects inside the monitoring region to transmit to the watcher. The primary disadvantage of WSN is its energy limitation of the nodes and the severe lack of resources like computational power and storage capacity. Large-scale

data collecting can quickly lead to excessive node energy usage if hardware resources are constrained. In the WSN, network congestion will encourage poor data transmission if the rate of node energy decays, and there are too many tired nodes [1]. Consequently, the main goal of WSN research has always been to create a network protocol that uses less energy, balances node energy consumption, and maximizes network lifespan. In situations where power is limited, multi-hop transmission is preferable due to the high cost of long-

distance transmission. Planar and hierarchical routing protocols are the categories into which WSN routing protocols can be subdivided based on topological structures [2] – [3].

Frequently, WSNs are run as hierarchical networks. Clustered routing systems can oversee a greater region while maintaining a high level of service. They have been widely deployed because of their superior energy-saving, scalability, and fault tolerance [4]. It is necessary to explore the balanced energy clustering routing protocol to guarantee that nodes can send their data to the Sink node and to prevent an early network collapse brought on by the overuse of specific nodes [5]. An energy-harvesting sensor network is created when augmenting the network's nodes' collective energy is possible. Optimizing the energy efficiency of the network, reducing the rate of cluster updates, and streamlining the cost of route maintenance [6]. Optimizing the energy usage of the sensor nodes is also essential [7]. The main topic of this study is energy-balanced routing strategies for clustering. The problems brought up by a thorough examination of the DCEM method, energy-efficient cluster-based multi-hop routing meant by this with delay constraints [8] served as the impetus for this study. This paper presents a novel complete strategy that considers the design phases of the inter-cluster routing algorithm, clustering, and cluster head election. Compared to the present techniques, it has extended network life or increased energy efficiency without requiring additional computations [9] – [10]. This paper applies a TDM approach to address the energy-based clustering problem. The following are this study's main contributions:

1. A comprehensive routing strategy for energy balance using TDM is suggested. This strategy can boost energy utilization in energy-collection situations or optimize WSN life in non-energy-collecting scenarios without requiring more computation.
2. A distributed TDM approach is suggested by introducing dynamic clustering to traverse regions.
3. TDM that is optimized between clusters is suggested. This significantly increases the transmission efficiency between cluster heads by considering both the cooperative competition relationship and the notion of relay cooperation.
4. This research examines the rationale for the algorithm's ability to achieve more energy efficiency, more minor calculations, and balanced energy usage in comparison to popular algorithms currently in use.
5. The simulation results are compared to the CEM and BCR algorithms, which use less energy, have more nodes that survive, and use less network energy while operating more effectively.

The work is organized as follows: section 2 is related works. Section 3 provides the methodology explaining TDM. Section 4 gives the numerical results, with a summary in section 5.

RELATED WORKS

The following categories are primarily included in the uniform clustering method's cluster head election procedure in WSNs. A random cluster head selection process is used by both low-energy adaptive clustering hierarchy SN protocol [11]. The node produces random number among 0 and 1. It can become the CH when its value surpasses a particular threshold. The threshold is determined based on the network's current running round number and cluster head election probability. Its drawbacks are its inability to ensure that the nodes chosen are appropriate and the cluster head selection process being entirely random. Instead of being determined randomly, the Sink node has complete control over the LEACH-C algorithm's cluster head selection. Utilizing the simulated annealing process, the Sink node gathers all global nodes' position and energy data, computes the average energy within the network and groups, and chooses cluster leaders. Only small-scale systems can benefit from it, which is a drawback [12]. Massive energy usage and possibly network congestion will result from widespread network flooding. The three factors determining which cluster head to select in the hybrid energy-efficient distributed clustering scheme are the residual energy, node density, and closeness to neighbouring nodes. Many iterations are needed to locate the cluster head, and each cyclic cycle uses much energy. An efficient multi-hop routing strategy for clustering based on time constraints is the algorithm known as the delay-constrained energy multi-hop, which was introduced. Considering each node's relative energy and distance data, a distributed method

chooses the cluster head. Compared to other algorithms, it has benefits in energy usage and the nodes quality that survive. Based on PSO, the energy-efficient CH selection process chooses the CH that surpasses residual energy average, which employs all nodes' position and energy information [13].

During the algorithm's clustering phase, nodes select which cluster to intersection by evaluating the reachable energy of minimum reachability power in the message sent by CH. When a node eventually joins the correct cluster after being monitored continuously by many cluster heads, this resolves the issue. "Isolated nodes" identify themselves as cluster heads but fail to get the message with the cluster header. Two drawbacks are the emergence of isolated nodes and the disregard for the distance among the CH node and neighbouring node. Furthermore, the stability of the network will be impacted by significant clusters since they might easily lead to some nodes dying too soon. Conventional algorithms are inferior to the CEM method regarding how much energy is used and how many nodes are still alive. The dominating node serves as the cluster head in the CEM clustering technique [14]. This has the disadvantage that the area is entirely occupied by the dominating node in a given location as long as it is within its communication range. Cluster replacement will be necessary often as the dominating node will break fast. Information about the cluster will be lost if there is a slight difference between the update and failure times. When using the PSO-ECHS clustering method, the cluster with the highest cluster head weight is selected by the non-CH node which computes the CH weighted function based on the cluster head's energy, distance, and node degree [15].

METHODOLOGY

An energy model is utilized in the WSN to reduce inefficient energy transfer and enhance energy usage. The suggested approach eliminates uncertainty in the selection process using a cutting-edge CH selection mechanism. Cluster heads are chosen to minimize the distance among BS and optimize the residual energy (r_e) of the sensor node (s_n). The updated Threshold ($T(H)$) incorporates a distance ratio and balanced energy to mitigate low node energy issues and lessen energy depletion in cluster heads. While waiting to finish data

transmission activities within their clusters, this method boosts cluster heads' remaining energy (r_e). Thus, the protocol improves overall system performance by drastically reducing energy consumption in the WSN.

The following factors have been taken into account when creating the suggested protocol:

Sensor node (s_n) distribution throughout the Region of Interest (ROI) is uneven.

There is no option for battery recharge; sensor nodes function deterministically, and the base station (b_s) maintains a steady power supply.

The Received Signal Strength Indicator (RSSI) is essential to ascertain the precise separation between two nodes.

Energy Model

Eq. (1) can be used to calculate the necessary broadcast energy (T_E) needed to send c bits across a distance of d .

$$T_E = \begin{cases} c * E_{elec} + c * E_{fs} * d^2 & \text{if } d < d_0 \\ c * E_{elec} + c * E_{amp} * d^4 & \text{else} \end{cases} \quad (1)$$

The variables have the following definitions in this context. Electrical energy $\rightarrow E_{elec}$ necessary to convert a bit of data into a signal, $E_{fs} \rightarrow$ Power needed for transmission in free space, $E_{amp} \rightarrow$ Power needs for models with multiple paths.

$$d_0 = \frac{v_{fs}}{E_{amp}} \quad (2)$$

Eq. (3) provides the following expression for the energy required to receive c bits:

$$E_{Rx} = c * E_{elec} \quad (3)$$

The cluster member (cluster_{member}) requires the following amount of energy for the c bits to cooperate:

$$\text{cluster}_{\text{member}} = c * E_{elec} + c * E_{fs} * d_{CH} \quad (4)$$

The energy needed by the cluster head (C_H) is calculated using the distance to the C_H as a factor:

$$C_H = c * m (E_{elec} + E_{fs} * d_B + E_{DA}) \quad (5)$$

In this case, m represents the number of cluster members, E_{DA} stands for accumulation energy, and d_B represents the base station's distance.

CH selection

The criteria for choosing C_H include decreasing the distance from the Base Station (BS) and optimizing the nodes' residual energy (RE). Two categories are created out of the nodes: two types of nodes: primary and sophisticated.

$$N_p = \frac{P}{1 + NN_a} \quad (6)$$

$$A_p = \frac{P}{1 + NN_a} (1 + N_n) \quad (7)$$

The threshold calculation is expressed as follows: N_a is the percentage of advanced nodes, N_n is the amount of energy more significant than N_n , A_p is the selection probability of an advanced node as a C_H , and NP is the election likelihood of a typical node as a C_H .

$$T(H) = \frac{P}{1 - P * (r \bmod \bar{l})} ; \text{if } n \in G \quad (8)$$

$$E = (\text{recurrent} - (E_a + E_t + E_r)) \quad (9)$$

$$D = \frac{D_{BS}}{D_L} \quad (10)$$

The updated $T(H)$ is determined by modifying Eq. (8) in the particular context, where $T(H)$ is the Threshold Rate, r is the current count of rounds, and P is the expected percentage of an S_N to be a C_H . The following formula is used to calculate the biased energy (E) and distance ratio (D):

$$T(H) = \frac{N_{PX}}{1 - \Delta V_F * \left(r \bmod \frac{1}{N_F} \right)} (a * E + b * D) \quad \text{if } n \in G \quad (11)$$

$$T(H) = \frac{A_{PX}}{1 - A * (r A_F)} (a * E + b * D) \quad \text{if } n \in G \quad (12)$$

D_{BS} is the distance to the base station; D_L is the longest distance from B_S , and E_a , E_t , E_r , and R_E are the current residual, aggregation, transmission, and reception energies. The low energy problem is avoided, and the CH survival rate is raised using the new $T(H)$. It is possible to expand the distribution of standard and advanced nodes concurrently. The updated $T(H)$ for the advanced and standard nodes can be found in Eq. (12). It helps to enhance the WSN energy usage. Compared to short-distance S_N , long-distance S_N often consumes

more energy. The WSN's residual energy (R_E) of nodes is boosted, resulting in a better distribution of S_N by employing the updated $T(H)$ for both advanced and ordinary nodes. Within the network, there are advanced nodes and regular nodes. Adopting a new threshold value makes the C_H selection process less arbitrary. A data fusion rate combined with a trust function is used to acquire reliable data. Energy models are also utilized to prevent unnecessary energy transfer inside the network.

NUMERICAL RESULTS AND DISCUSSION

Fig 1 depicts the overall network node distribution simulation scenario. Here, 95 nodes were evenly and randomly dispersed throughout the $100m \times 100m$ space. The sink node positioned at $(100,50)m$ is believed have infinite energy source. Every node creates packets regularly, which are then sent to sink nodes. There are $l = 1$ bits in the packet. For computing energy consumption, $\epsilon_{amp} = 0.0013 \frac{pJ}{\text{bit} \cong m^4}$, $\epsilon_{fs} = 10 \frac{pJ}{\text{bit} \cong m^2}$, $d_0 = 60 m$, $E_{fuse} = 5 \frac{nJ}{\text{bit}}$, and $E_{elec} = 50 nJ/\text{bit}$ are examples of frequently used variables. The radius of a cluster for the proposed algorithm is 35 meters. The optimal researched values for the other algorithm parameters might be used for α head, α_3 , and d_{hop} . To see the total performance in this case, the parameters are $0.2, 0.2, 87m$. The heated zone's cut-off point for assistance is three. The set of control parameters includes $\lambda = 1, \alpha_1 = \beta_1 = \alpha_2 = \beta_2 = 0.5$. The control parameters for the algorithm are $\alpha = \beta = 0.5$.

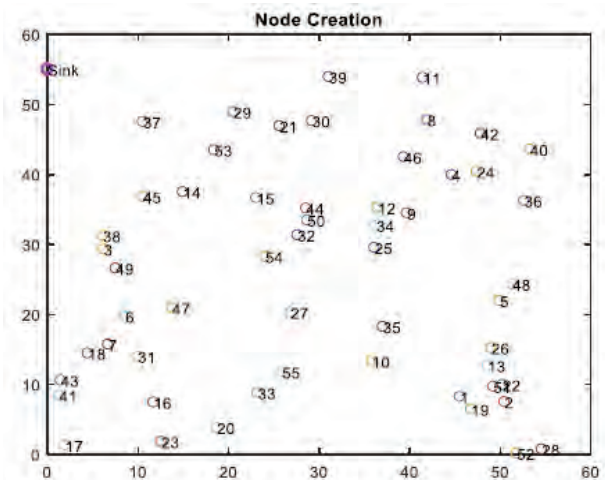


Fig. 1 Node creation

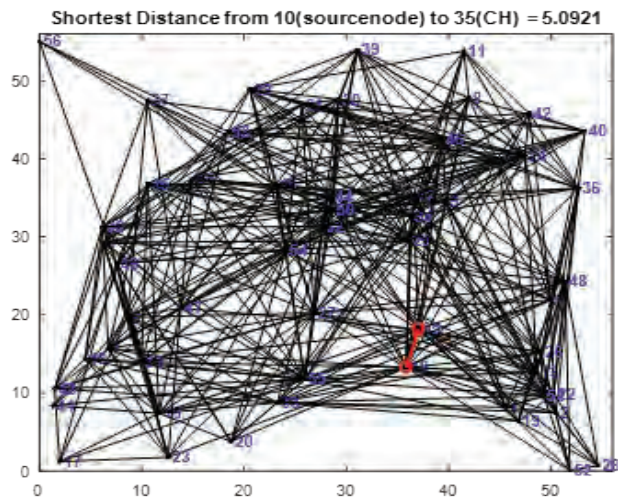


Fig. 2 Connection establishment

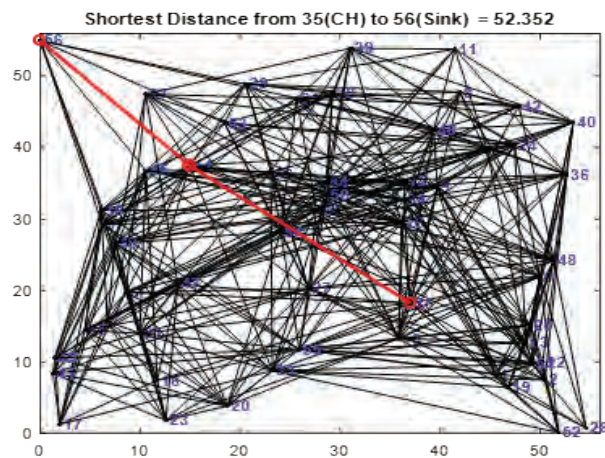


Fig. 3 Connectivity with 35 CH

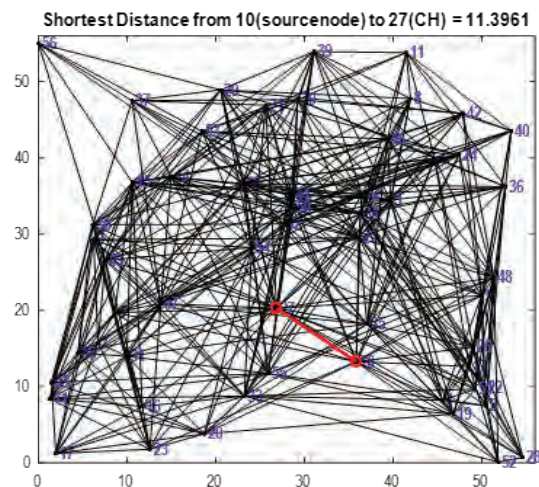


Fig. 4 Connectivity with 27 CH

Table 1 Average energy used/message forwarding

Approach	500	600	700	800	900	1000	1100	1200
EDB	15	15.1	15.7	15.2	15.2	15.3	15.8	15.4
CEM	14.5	14.1	13.6	13.1	12.6	12.3	11.9	11.7
BCR	14.9	14.5	14.6	14.6	14.3	13.8	13.4	12.9
Proposed	13.2	13.3	13.5	13.8	13.9	14.2	14.3	14.5
% energy saved	0.70	2.96	6.25	12.32	20.22	27.91	36.19	42.48

The combined energy consumption of the proposed and existing approaches is depicted in Fig 5. C_H are nodes with more incredible energy by the algorithm during the clustering phase, which creates a dynamic search radius based on the nodes' distance and energy from the sink node. However, it does not identify a node with an advantage when choosing cluster leaders or attempting to seize control of every node in the communication region. It also provides a fair division mechanism and permits dividing the clusters' cross areas. As a result, the cluster head is not overworked, the hot zone issue is resolved, and excessive cluster head consumption is prevented. First, the cluster head nodes' participation in the inter-cluster routing procedure advantageous inequality relations are used to choose potential following hop nodes. When selecting the following hop nodes, more balanced usage is made possible by considering the coordination relationship and cooperation order amongst the cluster head nodes. The proposed algorithm's life cycle is substantially shorter than the network's. Furthermore, every network operation round executed by the proposed algorithm results in a lower total network energy consumption than that of the existing method. By doing this, the network's lifetime is prolonged.

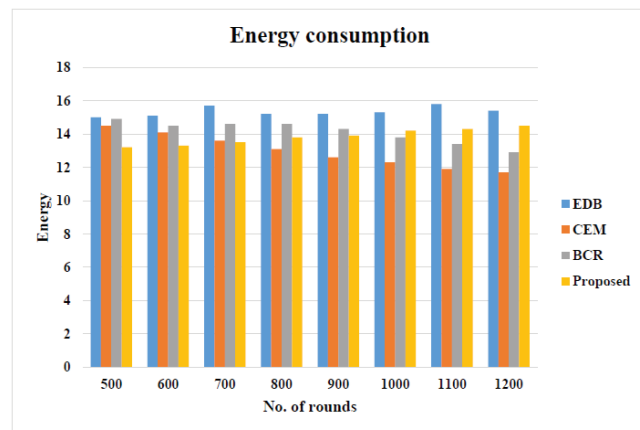


Fig. 5 Energy consumption-based comparison

The number of nodes that are still operational for the proposed TDM and existing algorithms is shown in Fig 5. Table 1 compares the round numbers for the proposed and existing algorithms. BCR represents the network's energy-based algorithm's dead round count, whereas CEM represents the CEM method-based dead round count. This shows how quickly EBCR's performance elevates compared to CEM. For clustering, cluster head selection and cluster routing, the approach is unquestionably optimized to split the network load evenly between nodes and lower the number of failure nodes in a particular cycle. In round 90, round 493 saw the failure of the first and 50th death nodes. There are 982 rounds in the overall amount of running rounds. Compared to the CEM method, performance has dramatically improved in the relevant elements by 87.5%, 5.8%, and 22%, respectively. There is a noticeable increase in the network life cycle. Energy efficiency and total energy consumption should be considered for WSNs with energy harvesting capabilities. The efficiency of energy use is displayed in Eq. (13):

$$Efficiency(k) = \frac{E_{consume}(k) + E_{left}(k)}{E_{harvest}(k) + E_{initial}} \quad (13)$$

The entire energy consumed by data transmission by time slot k is denoted by $E_{consume}(k)$, and the whole residual energy in the temporal network is denoted by $E_{left}(k)$. In contrast, the complete absorption energy by time slot k is represented by $E_{harvest}(k)$. There are significant differences in the energy harvesting rate between these circumstances, suggesting that there are variations in the overall amount of energy that may be utilized. In addition, because of the restricted energy capacity and energy use, excess energy waste is also present. For these reasons, there are more practical ways to gauge how well a method works than calculating the overall energy usage. When measuring a procedure's effectiveness, energy use efficiency has more value.

CONCLUSION

This paper investigates the TDM approach that combines cluster radius, intersection region and CH election are presented. In the energy harvesting scenario, excellent network energy efficiency is achieved, while in the energy non-harvesting situation, a longer network survival life

is achieved. The simulation results demonstrate that the proposed model performs better when balanced energy consumption. Additionally, it significantly speeds up cluster update times, lowers the likelihood of cluster head failure, and lowers cluster maintenance expenses. The approach outperforms the distributed clustered algorithm in terms of balanced energy consumption. In comparison to existing methods, it also requires less calculation. Overall, energy-balanced utilization and avoiding tedious computations are two areas where the proposed approach outperforms the current approach. It will be talking about the method's parameter selection later on.

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Modelling A Braking System for Analyzing Torque and Associated Fluid Components

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ABSTRACT

There are numerous problems with the current braking systems, including poor time-delay reaction, noise from mechanical components, wear and tear from contact and friction, poor performance, and large size. This study outlines the conception and advancement of a vehicle electromagnetic brake system that seeks to supersede the complex braking systems currently in use with a comparatively straightforward electromagnetic system. A magnet is fastened to the vehicle's tyre rim, and an electromagnet is positioned to the tyre's rim parallel in the suggested system, replacing the mechanical components of the braking systems with electronic components. Managing the electromagnet's supply allows the driver to regulate the vehicle's motion. The electromagnet seeks to latch with the tyre rim magnet once powered on and begins to function like a magnet. The braking process then takes place as the tyre stops rotating. An antilock braking system's operation is comparable. Some automobile systems are the best candidates for the planned task. Future work will create and analyze a real-time system, as only a similar prototype was experimented with and studied.

KEYWORDS: Brake, Magnetic, Electromagnetic system, Magnet, Noise.

INTRODUCTION

Among the most significant components of an automotive system is the braking system. Braking systems come in a variety of forms. Conventional braking systems comprise mechanical devices such as servo, hydraulic, pumping, and frictional brakes. These systems have a lot of issues, such as enormous size, restricted performance, wear and tear from contact and friction, and inadequate time-delay reaction because of mechanical parts. Examples of contemporary braking systems are electromechanical brakes, which consist of hybrid and eddy current brakes [1]. These brakes employ electronic circuits to control the braking function and electrical components, such as motors and

generators, to produce braking action. When compared to mechanical braking systems, they offer superior control. Furthermore, due to experiencing significant power loss and performance problems, these systems also experience deterioration, much as traditional mechanical brakes, despite having superior control and time response. For example, the limiting torque of the magnetorheological brake affects how it is used [2]. Other brake classes are also offered explicitly for parking and emergency braking. Standard braking and speed control applications cannot be used with these brakes while being more dependable and efficient than the typical mechanical and electromechanical braking system [3].

Thus, a more sophisticated and potent braking system is required as vehicle performance and speed rise to guarantee improved performance, safety, and dependability. This study suggests the application of an ignition coil and electromagnets to create an electromagnetic contactless braking system. The suggested brake system eliminates all of the issues above because its electronic operation offers superior performance, time response, and power loss. In addition to the brake application, the traction mechanism uses the following scheme. The following system is extremely lightweight and durable; additionally, as it is contactless, there is no deterioration [4]. The magnets on the tyre rim and the electromagnets positioned parallel to them make up the braking system configuration. When powered on, the tyre's rim magnets lock with electromagnet, triggering anti-lock braking. Because the entire system is electrical and hence more controllable, traction is accurately achieved by regulating the electromagnet supply and measuring the difference in tyre speeds on the two sides of the car [5]. The suggested brake system is also appropriate for parking and emergencies due to its independent tyre control capability. Compared to current braking systems, the contactless electromagnetic braking system minimizes the system's size, weight, and noise while offering improved reliability, performance, control, and reaction speed. This research project aims to improve the braking mechanism of an automobile. Enhance the braking system's functionality by adding the ability to execute traction and emergency braking in addition to regular braking.

The work is drafted as follows: section 2 provides existing approaches. Section 3 drafts the methodology, and section 4 provides the numerical outcomes. Section 5 gives the summary.

RELATED WORKS

The area of electromagnetic braking systems is currently the focus of numerous research efforts. In addition to the suggested tasks, the literature lists several initiatives presently being looked upon. Boosting the magnetic field and using a magnetorheological brake can enhance torque [6]. Thus, it was also possible for the brake to achieve a high braking torque when considering the influence of the braking system and input power for increased torque. Motorcycle multi-pole magnetorheological

brake: structural study and validation [7]. It contrasts the inner and outer rotor structures and confirms that the application is feasible. In addition to meeting the size restrictions, the following braking method offers the required braking torque. A comparison study between hydraulic and electromagnetic antilock braking systems will make it feasible to effectively and dependably control a contactless braking system for automotive applications using an eddy current [8]. The approximate theoretical model used for brake torque analysis is updated throughout experimentation to obtain a trustworthy result. It has been noted that the following model works well for minimizing stopping distance while maintaining the necessary slip ratio given the particular driving circumstances [9] – [10]. The eddy current braking system's modelling and control by applying currently available mathematical techniques and controlling the AC and DC magnetic field frequency to increase the braking torque production capacity of a time-varying magnetic field in conjunction with an eddy current brake [11]. Genetic algorithms are utilized to improve the frequency management. They are investigating the impact of air gaps and tracking materials on the magnetic flux density indesigning a magnetic braking system and a magnetic brake utilizing the image approach founded on Maxwell's equations and the magnetic drag and lift forces [12] – [15].

METHODOLOGY

A mathematical representation of the MR fluid's transition is shown using the fundamental magnetic induction equations from the Newtonian fluid to a semi-solid. Based on magnetic dipole-dipole interactions among nearby particles of chain structure, the behaviour is described in most MR fluid models. A majority magnetorheological effect model is obtained by averaging these inter-particle interactions throughout the sample. The dipole model of particle energy interaction that occurs when two magnetic dipoles are uncovered towards a magnetic field in the magnetic resonance fluid (MR) is shown in Fig 1. A chain has two particles. A chain's distance from its neighbour is determined by $h=r_0/d$, where r_0 is the particle's centre-to-centre distance. Given these particles' equal intensity m interactions, the result is:

$$E_{xy} = \frac{|m|^2 (1 - 3 \cos^2 \theta)}{4\pi\mu_1\mu_0|r|^3} \quad (1)$$

$$E_{xy} = \frac{|m|^2 \left(1 - 3 \frac{r_0^2}{r_0^2 + x^2}\right)}{4\pi\mu_1\mu_0(r_0^2 + x^2)^{\frac{3}{2}}} \quad (2)$$

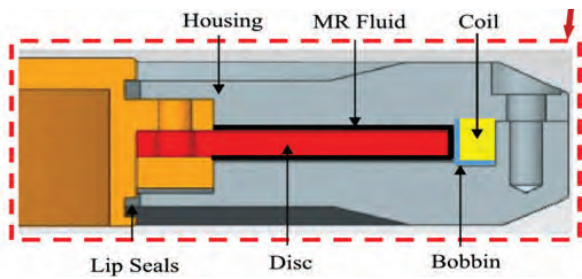


Fig. 1 Systematic configuration of MR brake

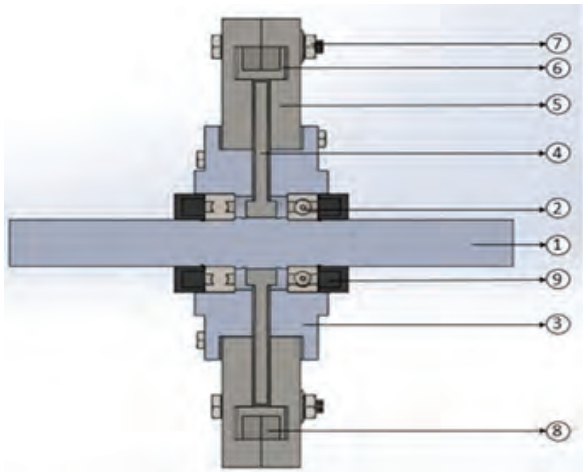


Fig. 2 Fluid braking system

The overall energy density is calculated by multiplying the scalar shear strain, represented as x/r , where the volume is divided by total particles. One can acquire the complete energy density as:

$$U = \frac{3\phi(E^2 - 2)|m|^2}{2\pi^2\mu_1\mu_0 d^3 r_0^3 (1 + \varepsilon^2)^{5/2}} \quad (3)$$

The dipole magnetic particle volume/unit is calculated by differentiating the energy concerning strain and utilizing average polarization density as dipole magnetic particle volume.

$$\sigma = \frac{\phi \varepsilon (4 - \varepsilon^2) J_p^2}{8\mu_1\mu_0 h^3 (1 + \varepsilon^2)^{7/2}} \quad (4)$$

The maximal shear stress also called yield stress is attained for the highest amount of strain to identify stress about the strain and correspond to zero yield stress.

$$\sigma_y = \frac{\phi J_p^2}{\mu_1\mu_0 h^3} \quad (5)$$

The following formulae represent the relationships between field strength, magnetic flux, intrinsic induction, and saturation polarization density, presuming that saturation uniformly occurs and the applied field direction.

$$\phi_p = B_s A_s \quad (6)$$

$$\frac{R_p}{R_m} = k \frac{\theta}{(1 + \alpha)} \quad (7)$$

$$\mu_0 H = \frac{B - \phi \cdot J_s}{1 + \frac{3}{2} \phi \alpha^2} \quad (8)$$

$$J_p = \frac{\alpha^3 B + J_s}{1 + \frac{3}{2} \phi \alpha^3} \quad (9)$$

Eq. () must be solved concurrently to find the solution for shear stress. MATLAB 2020a coding was used to do this. We used the Gauss-Jacobi procedure, which involved assuming a variable's value, verifying the governing formula with a 2% maximum error and solving the remaining variables related to this variable. If it fell outside this range, the process was repeated with the variable value modified until the issue was fixed. This was an iterative process. The connection between intrinsic inductions and field strength is displayed in Fig 2. It illustrates how the induction values vary with field strength for volume ratios. The graph shows that the induction in the fluid increases with an increasing volume ratio. This is because a higher particle count causes a higher magnetic effect, which causes a higher induction. The correlation between field strength and shear stress is depicted in Fig 2. As expected, it was found that induction increased at first when the iron particles became saturated and eventually achieved a saturation value. The saturation induction rose with increasing volume ratios, resulting in the yield stress rising with concentration. Thus, intrinsic induction is likely to be critically dependent on the result of the volume ratio. The experimental behaviour study is verified using various mixtures.

NUMERICAL RESULTS AND DISCUSSION

With two 12V-DC motors operating at 300 rpm and two 12V-2.5N electromagnets, the experimental setup composed of motor drivers, two opamps-based differential amplifiers and Arduino board. Using the two-tire model as a two-sided analogy, operating in real-time, it is constructed here with Arduino as the controlling element, motors as the tyres, and electromagnets as the car brakes. Electromagnets are coupled with the Arduino via the motor driver. To simulate artificial real-time traction, the two motors are operated with the same current but at different voltages.

Table 1 Fluid components

Braking components	Sample -1	Sample -2	Sample -3
Oil	19.5	17.5	19.5
Powder	6.3	9.5	17.3
Grease	2.5	4.1	6.5
X-100	0.5	0.56	0.6

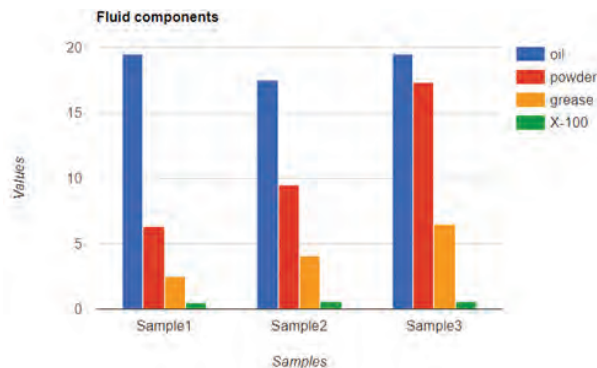


Fig. 3 Fluid components

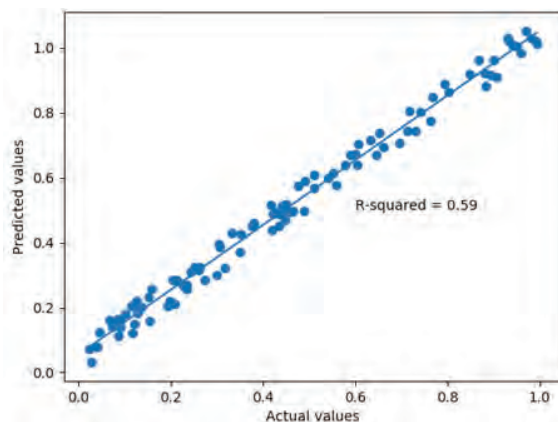


Fig. 4 R-square plot

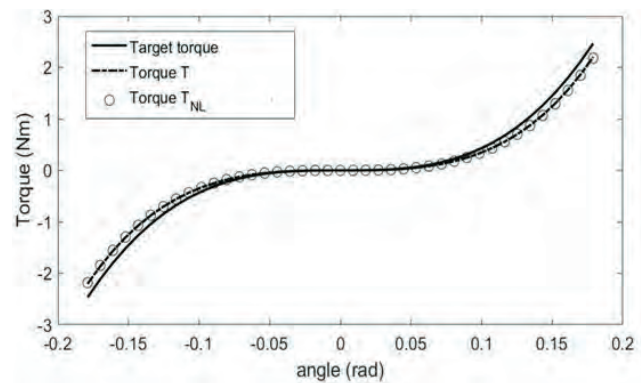


Fig. 5 Torque vs. angle

The potential difference is a gauge for the speed difference between the two motors due to their differing operating speeds. The differential amplifiers are wired so that one of their input connections counterbalances the other differential amplifier's input connections. The traction variable's value is set to either 1 or 0 by the Arduino, thanks to programming that utilizes these two differential amplifiers' input values. If the differential amplifier values are different, the importance of the traction is set to 1 and 0; otherwise, inputs from both amplifiers are the same. When applying brakes, a brake variable takes precedence over traction. When one is set as the brake value, the brakes apply; otherwise, it is set to 0. This means that Arduino is designed to apply traction when the braking variable is zero if such an occurrence occurs automatically. To illustrate the operation of the suggested work concerning the real-time framework, an analysis of the prototype model was done using MATLAB.

CONCLUSION

According to this study, the current mechanical and electromechanical braking systems can be replaced with an electromagnetic brake design. It provides various advantages over the brake systems that are already in use, including improved performance, safety, and dependability because all of the mechanical parts have been entirely replaced with electronic components. It is a fully electronic, contactless brake that is lightweight, durable, and simply implementable for software control. It also has no wear and tear. The design process involved creating an analytical model of the suggested system to calculate the necessary power dissipation, electric potential, and magnetic field strength. A

simulation model was created to show how the suggested model functions. Utilizing an experimental setup with DC motors serving as the tyres, an Arduino acting as the control unit, and electromagnets providing the brakes, the system's dependability and performance are evaluated. The experimental findings demonstrated that braking torque increases as potential increases, and traction is maintained under the given circumstances. However, speed reduction may be obtained when the electromagnet is fully capable. As a result, future designs will need to modify the magnetic circuit to account for material and temperature attributes. Create an electromagnet using the necessary criteria as well.

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Modelling A Novel Bubble-based Whale Optimizer for Analyzing Energy Efficiency in Sensor Networks

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ABSTRACT

Energy harvesting approaches enable theoretically infinite lifespans for WSN nodes by implementing subsystems that continually supply energy and store it for future use. The energy harvesting systems can harness many possible energy sources, including mechanical, solar, wind, and temperature fluctuations. Sensor nodes with limited energy are compact devices. Thus, a few procedures are needed to lower energy usage and increase network lifetime. The process of clustering is used in WSNs to improve energy efficiency. Sensor nodes are grouped to form clusters during the clustering process. The ideal number of clusters to construct and the procedure for choosing cluster heads are two elements that affect how well the clustering process performs. This paper provides a clustering mechanism for energy efficiency based on a bubble whale optimizer (BWO). The suggested study uses the whale and grey wolf meta-heuristic algorithms to boost the clustering process' efficacy. The proposed BWO technique offers much better exploitation and exploration capabilities during algorithm evaluation than the traditional, distinct, current metaheuristic algorithms. Results from this BWO method are optimal.

KEYWORDS: Energy, Wireless sensor, Network, Cluster, Bubble.

INTRODUCTION

EH-WSNs, or wireless sensor networks that harvest energy have been the subject of extensive research in recent times [1]. Moreover, sensor nodes (SNs) in EH-WSNs can gather energy from the surrounding environment. EH-WSNs are vital to many applications [2]. SNs that harvest energy can enhance their lifetime and sensing range compared to traditional SNs that rely on battery power. To obtain a steady power supply from environmental sources, SNs might benefit from energy harvesting techniques. The amount of energy gathered and the resources for energy availability are two further issues that this plan brings up. Energy management concerns and energy harvesting

techniques are two difficulties that must be addressed for WSN deployments to be successful [3]. Natural energy is transformed into electrical energy in energy harvesting systems. Reducing energy use is the energy management mechanism. Optimizing the residual network energy is the ultimate goal. Sensor nodes should be able to gather more energy than their energy consumption rate. However, this need is rarely met. The duty cycle (DC) approach should be applied to do this [4]. The convergence rate of wireless communication systems improves with increased network connectivity, which extends the node's sensing range. Nevertheless, this shortens the lifespan of EH-WSNs by increasing energy consumption [5]. For WSNs to be deployed

successfully, lowering energy consumption and thus increasing network lifetime is essential. Numerous schemes have been developed to accomplish the goal above, including duty cycle, cooperative transmission, and multi-hop schemes [6]. Radiation risk in wireless sensor networks (WSNs) is the primary barrier to wireless charging. The battery may also run out when using a wireless charger. Low risk is associated with the energy-collecting process. It is possible to efficiently energize the SNs by harvesting environmental energy [7]. A power management strategy is required to control the energy of sensors effectively. Maximizing the duty cycle of the sensors is the outcome of this mechanism. The clustering-based strategy sends data from SNs to the closest CH that is selected. CHs do compression and data aggregation. As CHs are given more duties, the analysis and transmission of data from each cluster will require higher energy consumption [8], which will cause the network to degrade prematurely and irregularly. There are various methods to measure and optimize the energy wasted and the lifetime longevity of the network. Many existing approaches concentrate on enhancing one aspect while potentially increasing energy use in another. Furthermore, using current methodologies, the quantitative assessment of the network's overall energy usage needs to be considered. This study offers the new bubble whale optimizer (BWO) based energy-efficient clustering for further development.

These are a few of the article's noteworthy takeaways and insights. Researchers propose a bubble whale optimizer (BWO) to dynamically select the CHs and find the optimal number of clusters to construct. According to the novel research, the clusters with energy CHs are dynamically assigned by the proposed BWO optimization method. Combining existing optimization approaches, such as the optimization methods for whales and grey wolves, yields the bubble whale optimizer (BWO). In addition, parameters related to energy efficiency are used in selecting relay nodes (RNs), which are subsequently prioritized. Compared to the suggested BWO methodology, several current techniques are evaluated based on performance-measuring attributes utilizing existing approaches. These qualities are energy consumption, remaining energy in nodes and number of clusters. Based on a comparative study, the average percentage gains of the

suggested system are higher than those of the current approaches.

The work is organized as follows: section 2 gives a broader analysis of existing approaches. Section 3 drafts the methodology. Section 4 provides the outcomes, and section 5 concludes.

RELATED WORKS

The notion of SIF (swarm intelligence-based forwarding) was introduced by [11]. Using an effective clustering technique, SIF selects the pertinent CHs after creating clusters. This procedure produces both an exact and balanced amount of clusters. This routing strategy has many potential uses and aims to prolong the network's life. Next, an effective routing strategy is suggested. This solution uses a topology control mechanism and an efficient clustering method. Finding the ideal number of clusters is done using the clustering approach. Sensor nodes (SNs) also select the most effective path based on the best forwarding communication region within the topology management mechanism. Increasing network longevity and lowering energy usage are the main goals of this protocol. A unique routing and clustering approach for EH-WSNs is also recommended by [12]. By employing the multi-layer architecture, this technique seeks to reduce energy usage. This plan lowers the communication overhead by narrowing the communication range. Additionally, a multi-hop routing technique is proposed in this study that considers the two elements of the relay nurses' overall energy and distance.

Effective SN energy management is a significant concern in WSNs. As a result, careful consideration is needed. Multi-hop routing is utilized in long-distance data transfer. The multi-hop routing scheme's ability to identify effective routes is limited. An energy-efficient plan based on the Dijkstra algorithm is put out by [13]. Relays are made up of nodes with higher energy. The Dijkstra algorithm seeks to find the least expensive path effectively. The author put up a productive geographic routing plan. The suggested plan provides improved route recovery from a routing hole problem. It dynamically uses the three parameters—location data, residual energy calculation, and overall energy consumption—to determine the best action. Data is routed using only local location information in earlier-

developed geographic routing algorithms. As a result, traditional geographic routing techniques have the routing hole issue. As a result, the delivery ratio is lower and delivery delays are more significant in the existing methods [14]. Additionally, to lengthen the network lifetime, A multi-hop graph-based method for efficient routing algorithms in WSNs is presented by [15]. This technique consists of two stages: the clustering and routing phases. The process of creating clusters and selecting additional CHs is known as the clustering phase. The routing phase's primary goal is to build the multi-hop paths between CHs and the sink dynamically.

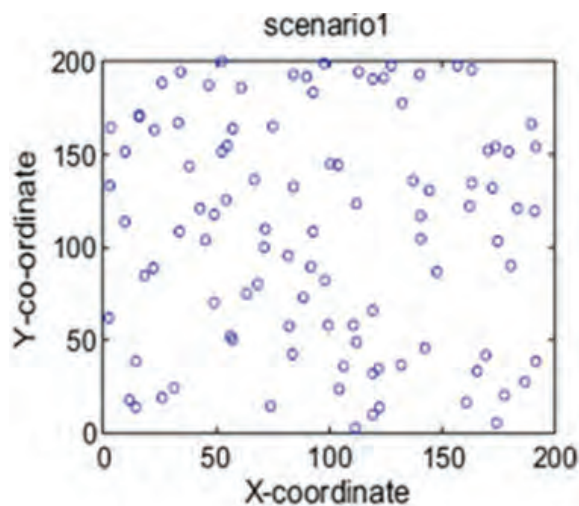


Fig. 1 Network model

METHODOLOGY

The Meta-Heuristic Algorithm Family includes the natural characteristics of bubble whale optimizer (BWO). The design and development of BWO take advantage of the natural traits of humpback whales (HW). A humpback whale creates a wheel-shaped bubble, following its prey through the water. According to pilot research, humpback whales used bubble netting techniques to attract food below the surface. However, they swiftly burst their bubbles into spheres to rise to the top. The premise of prey encircling is that a reasonable solution can only be reached if the prey-based current objective responds well enough. When HW notices the prey's location, it will circle it. Upon defining the hunting agent, the remaining members will align their locations with the leading hunting agent. The encircling mechanism is incorporated into WOP to encircle the

victim by applying Eq. (1) and (2).

$$Q = \|P \cdot y^*(u) - Y(u)\| \quad (1)$$

$$y(u+1) = Y^*(u) - FQ \quad (2)$$

When the coefficient vectors are represented by F and P, the current iteration count is indicated by u, Y shows the optimal solution location found in the iterations completed and the position is represented by Y(u). (·) signifies the multiplication of constituents, and ||·|| denotes the absolute integer value. To better aid in surrounding the prey, Eq. (2) is designed to update the searching agent's location within the currently selected optimal solution. Y^{*} must be updated after every iteration and only if a superior solution is discovered. Using Eq. (1), the coefficients of the F and P vectors are calculated:

$$F = (2 \cdot b \cdot rv) - b \quad (3)$$

$$P = 2 \cdot rv \quad (4)$$

In this case, y represents a random vector falling in [0,1], and c is the encircling component linearly reduced from 3 to 0 throughout the total rounds. Two distinct approaches are modelled to express how whales behave in a bubble-net attack mathematically: (i) encircling using the shrinking method and (ii) updating location using the logarithmic spiral method. The encircling method is achieved by applying Eq. (3) to minimize the value of vector b linearly from 3 to 0. It is observed that decreasing the significance of vector b will lead to the vector F's value. Another way to put it is this: vector F is a random value between -b and +b; in every iteration, b is minimized from 3 to 0. After the searching agent moves from its unique site to its current prominent position, a random value between -1 and +1 will be set for vector F. The whale first begins looking for its prey and measures the distance between its current and prey's locations. Eq. (5) and Eq. (6) provide each whale's mathematical expressions, which must update its current location by the spiral flight route approach.

$$Q' = \|Y^*(u) - Y(u)\| \quad (5)$$

$$Y^*(u+1) = Q' \cdot \exp^{c \cdot m} \sin\left(\frac{2 \cdot m}{\pi}\right) + Y^*u \quad (6)$$

Where m is an arbitrary value in the interval [-1,1], c denotes a constant value that characterizes the

logarithmic spiral form, and $(\cdot)$ stands for constituent-based multiplication. Additionally, Q' reflects the distance between the position of the prey and the best solution site that has yet to be identified. It should be mentioned that while HW travels in a circle toward its prey, it also moves in a logarithmic spiral model. Eq.(7) expresses the updated position of the whale, which is assumed to be determined by either Eq. (2) or Eq. (6) for ease of explanation.

$$Y^*(u+1) = \begin{cases} Y^*(u+1) & \text{if } z > 1/2 \\ Q' \cdot \exp^{c \cdot m} \left(\frac{2 \cdot m}{\pi} \right) + Y^* u & \text{if } z < 1/2 \end{cases} \quad (7)$$

Where the random number between 0 and 1 is denoted by z . Furthermore, the whale includes random prey-seeking behaviour, and its mathematical model is examined. When whales intend to follow other people's answers, they will all hunt prey randomly. At this point, the whale focuses on the search space and tempts the search agent to explore a better answer in the far future. To investigate a deep scan for prey to be more than one or less than -1 , the vector F is employed. Unlike the exploitation era, a search agent's location would change during the discovery time rather than using the most outstanding agent yet discovered; it is based on a randomly chosen search agent. To find global solutions and avoid local optimal solutions, WOPR uses the vector F , which has a value greater than 1, where the same may be described mathematically in Eqs. (8) and (9).

$$Q = \|P \cdot Y_{rv} - Y\| \quad (8)$$

$$Y(u+1) = Y_{rv} - F \cdot Q \quad (9)$$

Where, Y_{rv} is chosen from the random location vector that is currently identified. To avoid local minima, whales use levy flight to diversify the search agents and explore better search spaces. This suggests striking a better balance between investigating and exploiting. To put it briefly, following updating, the whale uses a levy flying approach to synchronize its location, as expressed by Eq. (10).

$$Y^*(u+1) = \begin{cases} Y^*(u+1) & \text{if } z > 1/2 \\ Q' \cdot \exp^{c \cdot m} \left(\frac{2 \cdot m}{\pi} \right) + Y^* u & \text{if } z < 1/2 \end{cases} \quad (10)$$

Where N is the array circled times operator, δ represents

a randomly picked number evenly distributed, $Y(u)$ denotes the j^{th} whale or location of vector F at the iteration u , and RV is a random number value that falls in $[0,1]$. The value of $\text{sig}[rv - 0.5]$ has three values in and of itself: $-1, 0$ and 1 . Because each step's distance will be at its most significant value, Eq.(10), which employs the random walk approach, helps the whale explore the search space effectively. The levy flight in a random walk is expressed by Eq. (11).

$$\text{Levy} = v = \frac{1}{s^h}; 1 \leq h \leq 3 \quad (11)$$

Using random step generation with length w that resembles levy flying behaviour, Eq. (12) is used to imitate h stably.

$$w = \frac{\gamma}{|v|^{1+\alpha}} \quad (12)$$

Considering that w is the step length in every flight, $\text{Lev}(h)$ equals $h + 1 + \alpha$.

NUMERICAL RESULTS AND DISCUSSION

This section explains how the NS2 can be used to develop the novel bubble whale optimizer (BWO)-based energy-efficient clustering strategy. There are 100–500 sensor nodes (SNs) worldwide. The suggested study compares the BWO scheme with existing approaches. The performance characteristics considered are energy consumption, cluster, remaining energy, and energy usage.

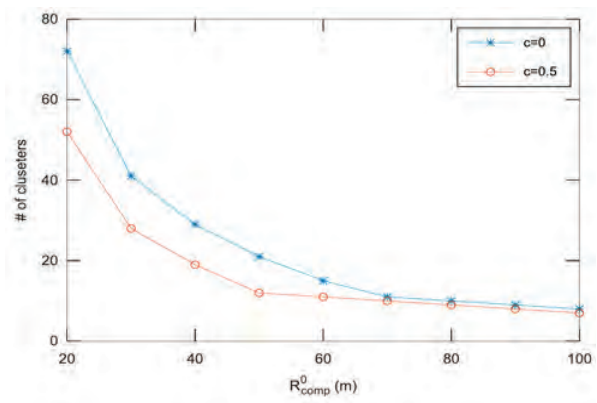


Fig. 2 No. of clusters

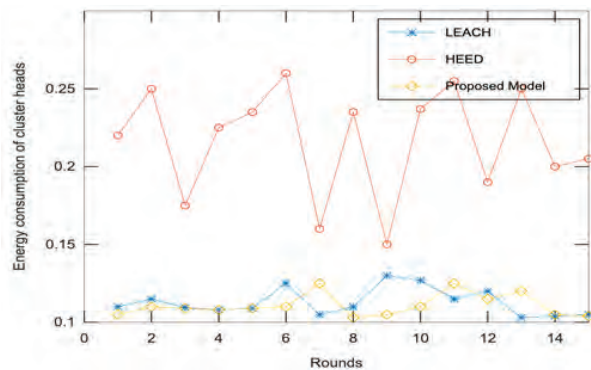


Fig. 3 Energy consumption of CHs

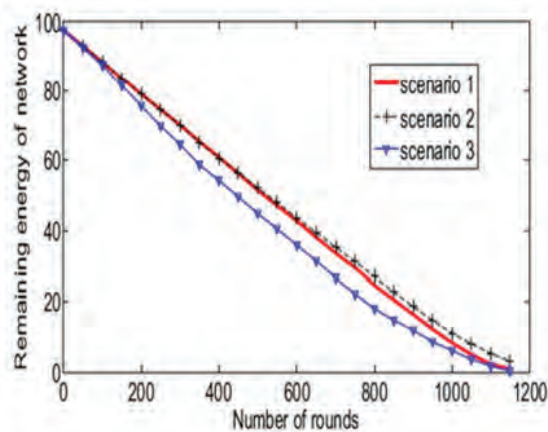


Fig. 4 Remaining energy of network

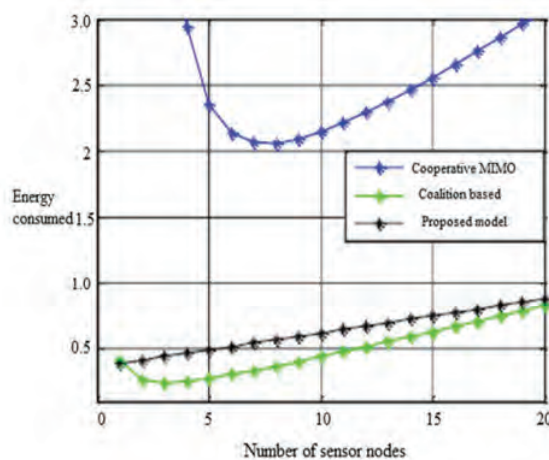


Fig. 5 Energy consumed vs. no. of SNs

Researchers have used multi-objective functions to build energy-efficient clusters, and the dynamic selection of CHs has resulted in a minimal delay parameter for the BWO method. Additionally, in our process, RNs are

given priority for quickly sending packets via the best path with no route interruptions, which selects RNs based on energy-efficient criteria. For the best outcome, our research has moreover used meta-heuristic algorithms, which can manifest as dynamically determined cluster heads and optimal cluster formation. Therefore, there is also little chance of re-forwarding data in our proposed strategy. As a result, there needs to be more overall time spent using the communication mechanism, supporting our claim of less latency.

Throughput depends on several variables: control overhead, packet drop, and delay. The suggested architecture has reduced packet drops, control overhead, and delays. As a result, our scheme has a higher throughput. Additionally, utilizing numerous energy-efficient criteria, including energy consumption, congestion rate and energy metric, our proposed approach chooses a dependable and ideal method for data transmission. With current systems, there is a high probability of selecting inefficient nodes for data routing, which reduces throughput. With decreased energy use and a shorter communication range, our suggested approach effectively selects the following forwarders. As can be seen from the above picture, our proposed strategy has a lower energy consumption parameter. The creation of non-optimal clusters causes the amount of energy used to rise. The proposed research also produces the ideal number of clusters, which aims to use the least energy possible using a meta-heuristic algorithm. Furthermore, with ideal nodes selected as the following forwarders, our suggested technique has low computing and communication costs. In light of this, the proposed plan uses the least energy compared to current schemes.

CONCLUSION

Research has suggested a bubble whale optimizer (BWO) method to provide a creative and energy-saving clustering for wireless energy-gathering sensor networks. The novel energy-efficient clustering approach dynamically selects CHs and forms the optimal number of clusters. Relay nodes are also chosen with energy efficiency as a primary consideration before being prioritized. The BWO algorithm suggested here performs energy-efficient clustering. It selects the CH node dynamically among numerous cluster nodes by

utilizing the different objective functions to calculate the ideal number of clusters. The BWO technique performs better when multi-objective functions are used to solve the fitness function. Many parameters are used to pick the relay nodes that will help the destination. These relay nodes are then ranked after that. Lastly, the new BWO protocol's remaining energy consumed and clusters are compared to the existing approaches. The results show that the BWO-based clustering scheme efficiently outperforms the other currently used methods.

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Provisioning an Anti-Safety System for Establishing Vehicle Safety

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ABSTRACT

In recent days, vehicle theft crimes are rising at a rapid pace. Approximately 10 million cases are recorded annually. One of the most common types of crime seen worldwide is vehicle crime. The owners of the vehicles are experiencing anxiety due to potential financial losses and psychological distress. Numerous researchers have implemented several security precautions for the fleet to stop this. The current development is a step toward giving owner-controlled automobiles security. IoT platforms are used to implement the suggested work to ensure the cars' security and safety. By installing a GPS module over the vehicle, the current job is put into practice. The owner receives a notification on their mobile device as soon as the car goes missing. The geographic coordinates of the vehicle were obtained in the message. After alert warning, the owner opens the mobile app, triggers stop button and immediately locks the engine. The current project attempts to protect cars from theft, protect owners from significant losses, and improve fleet management. The created system is a low-cost substitute for vehicle security.

KEYWORDS: *Vehicle theft, Tracking system, Anti-lock, Security, Automation.*

INTRODUCTION

Car theft has become a severe problem in recent years and needs to be tracked down and identified. The vehicle must be safe and secure. Many techniques are currently in use, but each has shortcomings, such as high cost and complexity [1]. It follows that an effective security system is required. There will be numerous solutions to fleet management problems, particularly concerning car owners, as information and communication technology (ICT) advances. The Internet of Things (IoT) allows us to communicate with devices without human interaction. Transportation, medicine, home automation, and other areas can all benefit from this IoT platform [2]. The theft of automobiles could be reduced by implementing appropriate circuits and utilizing IoT in the vehicle. Various researchers created

vehicle security with microprocessors, Arduino boards as control circuits, ARM processors [3], and GSM/GPS modules for communication[4]. Incorporating this technique to track down automobiles and issue public service announcements will help even government authorities.

Vehicle theft is a significant issue that must be considered and stopped in light of its recent growth. Safe and secure transportation is essential. There are numerous currently used mechanisms, but they come with a price tag and certain limitations [5]. Thus, it is necessary to possess an efficient security system. Arduino is the main component in the DC motor user interface, GPS, and GSM systems. They utilize Global Positioning System (GPS) and Internet of Things (IoT) where the car is determined using the ESP 8266 Wi-Fi

module, where GPS provides the stolen electronics. This space-based navigation technology follows the vehicle in all weather [6]. The latitude and longitude of the car are used in a message that alerts the user and provides information through the Internet of Things. When we park the vehicles outside, a switch that controls the entire system is activated via GPS antenna; it transmits the device's latitude and longitude coordinates.

The above procedure is completed, the data is uploaded to the internet, and the DC motor kicks when the automobile is stolen. This automobile tracking and prevention system is installed in the client's vehicle as rescue and theft prevention equipment. Modern techniques to deter theft are being implemented by automakers to enhance the security features of their cars, mainly since cars are highly susceptible to theft [7]. According to reports, many vehicles are stolen annually worldwide, even with the plethora of technologies that have lately been created to track and deter auto theft. Cars totalling 1,192,809 were reported stolen, resulting in \$7.9 billion in damages, based on the National Crime Information Centre (NCIC) [8]. Numerous security and monitoring systems are available for organizations with a large fleet of cars and an assortment of uses. A fleet management system can assist in cutting down on employee costs and time spent on assignments away from the office. Assignments may also be scheduled according to the vehicle's current position [9]- [10]. Therefore, to meet the diverse needs of their clientele and boost output, all major corporations must have central fleet management. Still, these technologies have some security vulnerabilities. For instance, they are powerless to prevent auto theft, assist in recovering stolen vehicles, or notify users of the whereabouts of stolen cars. Users are not allowed to use the vehicle online, even after they discover their car has been reported stolen for wireless data transmission. There is a shared functionality across all mobile network service providers. Thanks to its low cost, Wi-Fi technology has become more widely used.

RELATED WORKS

This research uses a smartphone-based anti-theft car tracking system with two units. These are units for users and vehicles. Two microcontrollers are utilized to detect vehicles and enable real-time monitoring, along

with one GPS and one GSM module. This device has a camera to take pictures and a smartphone to email the owner. GPS is employed to track the coordinates of a particular place, and GSM is used to provide the user with car information [11]. A car tracking system was implemented so the owner might use their phone to send and receive text messages. If the owner would like to reply, he can use his phone to send another text message requesting access to the GSM modem. This essay investigates tracking a car by texting its owner from his mobile device. The GPS module and GSM model of the monitoring system that has been created are interfaced with the Arduino microcontroller. If the Arduino receives a TRACK SMS from the user using GSM, it tracks the user's location using GPS. The next generation of RFID vehicle monitoring was created with ubiquitous computing and cyber-physical systems in mind. Subsequently, an autonomous tracking system was designed, featuring a smart car monitoring system currently used in a few smart cities. This caused the transportation industry to alter [12].

Subsequently, big data applications use the online Smart Vehicle tracking method for security applications (AMOTSSA). A data analytical algorithm establishes study goals to handle large amounts of data. The statement "Anti-theft Protection by GSM & GPS with Fingerprint Verification over the vehicles" was made by [13]. It is entirely dependent on a two-way GSM module and microcontroller. The fingerprint module verifies the user's access. The owner or driver must confirm the fingerprints before starting the car. The owner will receive an SMS if the fingerprint does not match a specified one. The car's owner can lock the car. The school bus tracking system, which compares the current path with the planned route, is presented in this paper. It was created for the protection of schoolchildren. A warning is sent out if they disagree. Regrettably, this system cannot display the car's routes within a specific time frame. Generally speaking, there are three VAT systems: satellite-based tracking systems, wireless passive tracking systems, and cellular tracking systems. Based on either of these, a workable VAT system is created. The cellular tracking system employs cell phones to send fleet location data. Users of the wireless passive tracking system must pay a one-time fee when the device is purchased and installed. The primary

drawback is accessibility data is only available when parked at home. Even in areas without mobile phone coverage, the satellite-based monitoring system can provide comprehensive reports and real-time updates on enterprise fleets; nevertheless, it comes at a high cost, with a monthly service fee [14]. A microcontroller-based system with GPS and GSM has been developed. With a GSM modem, two-way communication is available. This study also examines the use of the driver's fingerprint verification and the biometric protection system to prevent auto theft. Verifying two human fingerprints match over automated behaviour is known as fingerprint recognition or authentication. One of the various biometrics to predict people and verify their identities is the fingerprint. It is widely acknowledged that each individual poses distinctive fingerprint image [15].

METHODOLOGY

This study developed a gadget prototype by employing the project development study approach. The advocates planned, analyzed, created, assembled, tested, and reviewed.

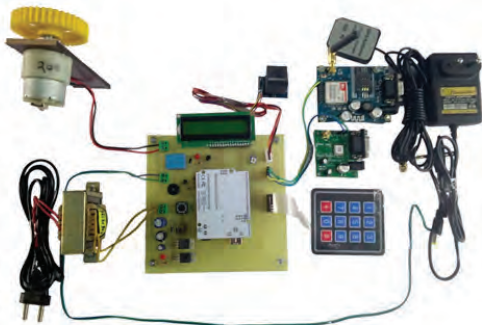


Fig. 1 Vehicle security with GPS

Design

The motorcycle anti-theft and safety device's system design layout is displayed in this step. It will be possible for the researchers to devise a functional arrangement. The system design layout of the device is shown in Fig 2. The helmet with the receiver inside, the Arduino UNO, and the fingerprint scanner that will provide the signal to start the motorcycle engine are used in the figure to demonstrate how the gadget will work. Conversely, the model shows the motorcycle anti-theft and safety device's circuit diagram. The gadget with an AT 328

circuit board that processes and transmits signals to the motorcycle and helmet is seen in the figure, along with its sensors and relays. The device comprised seven main parts: an Arduino UNO, a remote control sensor, a power source, a fingerprint scanner, a helmet, an LED, and wiring. The device utilized these parts to send and receive data.

The motorbike anti-theft and safety gadget employed the following materials and system components: The ATmega328-based microcontroller board is known as the UNO. This Arduino includes 14 digital input/output pins, 16MHz quartz crystal, power jack, USB port and reset button. This acts as the project's central nervous system. Conversely, Fig 3 displays the fingerprint scanner compatible with Arduino, a biometric security system utilized in the motorcycle anti-theft device. The gadget was installed in a conventional helmet. The proponent also consulted specialists in the field to guarantee that the helmet's safety features won't put the wearer in danger. The protective head covering of the helmet is often constructed of a robust substance to withstand impact at the area where the sender was installed. A semiconductor diode, employed explicitly in electronic devices, emits light when a voltage is applied.

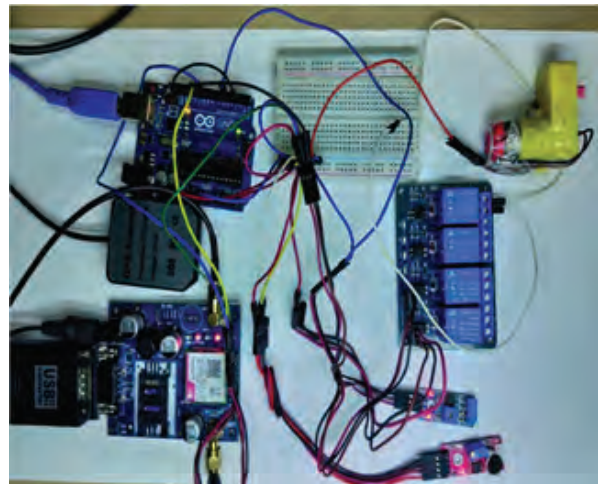


Fig. 2 Arduino micro-controller

In the work, it serves as an indication. Finally, the wires connecting the device's system components are seen. It serves as the devices' voltage supply connector. The motorbike anti-theft device's parts underwent preliminary testing according to material and

technological specifications. This diagram illustrates how Arduino and other gadget cases are made. The proponent is drilling a piece of metal for the component's housing. The process of placing a cable tie into the Arduino case is illustrated. The proponent is setting up and installing the device's electrical components. Careful installation guarantees that the wires are correctly crimped and wired. This graphic depicts the researchers testing the power supply connections. The motorcycle's parts were installed.

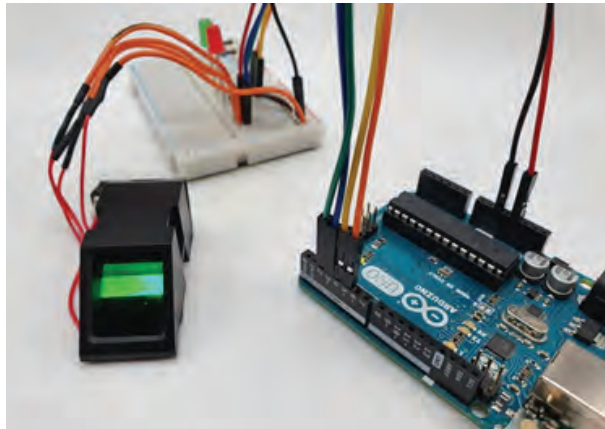


Fig. 3 Fingerprint sensor module

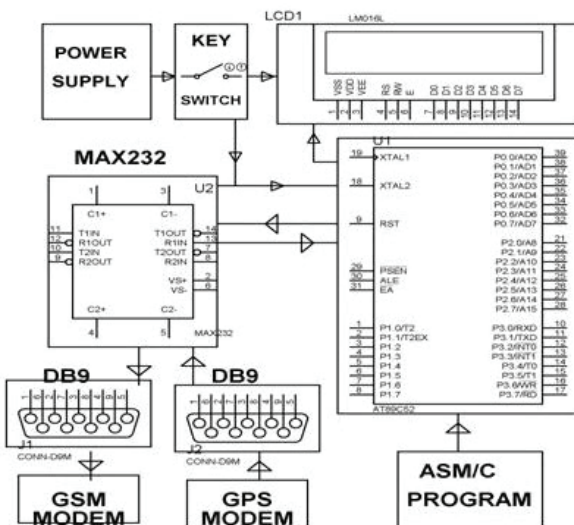


Fig. 4 Circuit configuration

NUMERICAL RESULTS AND DISCUSSION

The supporters of the Motorcycle Anti-Theft and Safety Device test every one of the study's components

beforehand to guarantee that the final product is operational and in good working order. The device was tested by the technology's proponents following manufacture. The framework is indicated to be operational by a red and green LED indicator light situated atop the aluminium case's surface. The red LED went out when the scanner detected the owner's fingerprint. Furthermore, the motorcycle can be turned on, and the green LED turns on when the owner wears the safety helmet. The device's safety feature prevents the bike from starting if the owner is not wearing the perfectly set up helmet to work with it. The Land Transportation Office, motorcycle enthusiasts, riders, and specialists from the National Police were invited by the device's supporters to assess the device's accuracy, dependability, and safety. The accuracy of the motorbike anti-theft system is displayed in Table 1. The table indicates that all accuracy criteria were highly acceptable, with averages ranging from 3.68 to 4.00. The device is highly satisfactory, as indicated by the composite mean of 3.81. Conversely, Table 2 illustrates the device's durability.

Table 1 Accuracy analysis on anti-locking automation

Lemma	Mean value	Interpretation
Scan the finger accurately of the owner	4	Proper interpretation
Accurately analyze the system process	3.5	
Proper programming required	3.7	
Mean value	3.8	

Table 2 Durability analysis on anti-locking automation

Lemma	Mean value	Interpretation
Protects the vehicle components	3.5	Proper interpretation
This leads to good maintenance of materials	3.6	
Durable components	3.7	
Mean value	3.7	

Table 3 Safety analysis on anti-locking automation

Lemma	Mean value	Interpretation
Provides safety features based on the insulating materials	3.8	Proper interpretation
Provides proper equipment to eliminate short circuit	3.7	
Deals with control measures and troubleshooting	3.6	
Mean value	3.6	

The table indicates that the updated system box, materials, and parts are excellent, with a mean between 3.6 and 3.8. The composite mean of 3.7 yielded the same meaning as well. This indicates that motorcycles' anti-theft and safety technology was robust enough for motorcycle riders. When a physical product faces the difficulties of everyday use throughout its design lifetime, durability refers to its capacity to continue operating as intended without the need for extensive maintenance or repair. Based on how the product is used, several metrics, including years of life, hours of use, and operating cycles, can be used to evaluate its durability. Finally, Table 3 displays the motorbike anti-theft device's safety according to three parameters. All criteria were highly acceptable based on the means from the table stated above. Furthermore, indicating that the project's safety is highly acceptable is the composite mean of 3.7. A safety device, such as this prototype, is a piece of machinery designed to lessen loss or damage from accidents.

The Anti-Theft and Safety Device was assessed to ascertain the societal value for the intended users. The primary concentration was on the motorcycle safety with helmets serving as the primary means of protection. Due to the usage of the user's or owner's fingerprints and a scanner, the gadget additionally increases user security. Regarding technological viability, the student researcher concluded that resources and the necessary technologies are readily available. The trainer parts can be bought in Manila or Batangas City for upcoming researchers and project creators. More significantly, labour, software, hardware, testers, debuggers,

programmers, and hardware were available in either local or generic form.

The economic and financial reliability of encouraging the adoption of motorcycle anti-theft and safety devices was examined using financial and economic viability. The 17 per cent internal rate of return (IRR) offered more proof in favour of this net present value (NPV). The percentage above indicates that a project's desirability as an undertaking increases with its internal rate of return. Since IRR is consistent across various investment kinds, it is applicable for comparing and contrasting several potential projects a company is contemplating. The trainer's 19% IRR suggests that stakeholders should consider the initiative. This component was evaluated to comprehend how the introduction of the technology will affect the environment. No smoke or other air-polluting pollutants will be used in this work. Additionally, sound will only be produced upon activation of the ultrasonic sensor and electric buzzer. Because most materials can be used for applications, they can be recycled or included in the university's Material Recovery Facility to reduce land contamination. Finally, since no trash would be dumped into the water system, water pollution will not occur. This was employed to evaluate the political significance of advancing the technology among stakeholders, including the Land Transportation Office. The student researchers discovered that the trainer is very well-liked after conducting an unstructured interview with stakeholders and surveying them to gauge the device's political acceptability.

CONCLUSION

Even though car theft is less invasive than violent crimes, the victims suffer more financial losses as a result of it. Furthermore, the suggested method successfully and economically detects theft to ensure vehicle safety. An anti-theft vehicle locking system was developed and tested. It was designed by integrating every hardware component that was utilized. Each module's presence has been thoughtfully chosen and arranged to help the unit function at its best. The work scope may be expanded in the future. GPS position and alert messages should be given to law enforcement if a car is stolen, in addition to a few other informational features already included in vehicle security systems. AI can send a

voice message to the owner and even notify the burglar seated in the automobile.

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Predict the Movement of Humans Over the Disaster Region using Drone-Based Inputs

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ABSTRACT

Drone-based technologies are our primary means of locating people, especially when we detect distress signals such as human screams. This study is highly pertinent in situations after natural disasters, including hurricanes, earthquakes, military operations, wildfires, etc. Drones may hover over disaster areas that is confronting for workers to reach directly, allowing them to spot potential trap sites. Drones are more efficient at covering more significant regions faster than ground-based rescue operations who have received specialized training for searching. Drones, sometimes known as unmanned aerial vehicles (UAVs), are widely used in disaster relief operations for search and rescue tasks. Drone images taken from the air are frequently used to evaluate the damage and determine the disaster scope. It explores the difficulties in locating people using aerial acoustics in our talks. It should also be able to distinguish different patterns associated with signal rescue troops. Artificial intelligence (AI) can solve this problem by analyzing sound frequencies and recognizing standard audio signatures. These features can be used to train the network to filter out noise from environmental elements like drone motors. Furthermore, using signal processing methods like microphone array-based direction of arrival may increase the precision of identifying the noise source.

KEYWORDS: Drone-based technique, Noise, Image, Video, Unmanned aerial vehicle.

INTRODUCTION

Natural disasters are serious events that put many people's lives in jeopardy. Under such conditions, communication systems frequently sustain damage that hinders the efficiency of search and rescue efforts and demands a substantial investment of time and money to repair. During harsh weather and natural disasters, search and rescue efforts become critical to reducing threats to human life and the environment [1] – [2]. Damaged telecommunication systems must be repaired immediately to enable essential information sharing between search and rescue teams and support real-time

infrastructure recovery activities. During large wildfires, the investigation process is a flexible method that improves the effectiveness of operations. Its capacity to get findings more quickly than current approaches gives it an advantage [3] – [4]. Ongoing monitoring of the crisis can yield immediate results, especially when it comes to rapidly modifying the incident's locations and coordinating a work whose flexibility and excellent visibility make it beyond the reach of human beings. After the discovery, the coordinates are quickly decrypted, the data is examined [5] – [6] and the information is processed before being forwarded to the

relevant organizations. Preventing and minimizing loss of life is crucial [7], even before the arrival of appropriate rescue teams. Constant observation allows us to stay in control of the situation and be aware of it, allowing us to respond appropriately [8] – [10]. This capacity acts as a safeguard against impending tragedies. This strategy will entail the deployment of several drones, at least two of which must be deployed to provide continuous territory observation. The significant contribution is to propose a novel feature intersection for system detectors based on drone images that can predict the life and dead human beings for analyzing the pose and peak of the subjects.

The work is organized as follows: section 2 gives a wider analysis of diverse approaches. Section 3 elaborates on the methodology. Section 4 explains the numerical outcomes, and section 5 concludes.

RELATED WORKS

There are a lot of ongoing initiatives related to search and rescue operations. The effectiveness of intelligent edge computing's network supported by UAVs is evaluated by [11] to expedite search and rescue (SAR) operations. Rescue operations during a disaster may benefit from this technology's quick deployment capabilities. The author presents a system for managing crises and disasters that optimizes efforts using a swarm optimization algorithm (SOA) [12]. Operating under the delay tolerant network (DTN) architecture, the UAV search and rescue team facilitates effective exploration capabilities within this system. The main uses of UAV networks in disaster relief are highlighted by [13], who also discuss important research questions in UAV-assisted damage control. The integrated system created in our earlier study has two separate sensing systems, making it possible to precisely locate and identify people and animals in real-time, even in areas with a lot of smoke. This enhances firefighters' situational awareness as they respond to emergencies. The author used a system in the patent application for an expanded version of this work. Researchers describe how our team employs UAVs and neural network algorithms to battle massive wildfires, with the primary goal being to minimize human losses drastically. According to [14], UAV technology is essential for reducing the effects of emergencies and quickening efforts to rescue

and recover people. Our primary responsibilities are promptly identifying and reporting any disaster to all relevant law enforcement officials. Responding quickly to these kinds of events offers a great chance to prevent the wildfire from spreading further, and every second counts when it comes to minimizing the scope of the catastrophe.

In addition, researchers thoroughly investigate voice recognition algorithms, conduct comparative analyses, and discover their possible uses in various environmental scenarios. Using a sophisticated microphone array, our UAVs are set up to pick up audio signals and identify the source's orientation. Researchers begin signal processing after obtaining the data using neural network voice recognition techniques. After putting microphone array technology, which uses voice and sound recognition algorithms through extensive testing using UAVs, researchers have validated its efficacy. With this technology, sound sources may be precisely located and identified [15]. During the surveillance process, Thanks to the deployment of cameras, we can identify the source of the disaster, gauge its severity, and ascertain the incident area's approximate initial coordinates and advanced deep neural network-based image processing techniques. Researchers will use approaches for detecting, interpreting, and processing auditory signals to gain more specific position coordinates once the calamity has been initially detected. Using a microphone array, researchers will be able to obtain precise information on the location of the tragedy. Deep learning techniques will be used to process this data, incorporating speech recognition methods. Our investigation used two different NN techniques: image processing and sound recognition [15]. Every algorithms has a specific function, and when we use them all together, we may effectively handle and complement each other's shortcomings.

METHODOLOGY

The suggested system's schematic diagram is shown in Fig 1, which uses video data shot by a drone to identify live signals. The chest wall motion brought on by heart activity in live people is directly responsible for variations in the reflected intensity values in the image sequences. There are numerous algorithms for processing images and videos in this work to

automatically detect this motion by analyzing and extracting interesting brightness values from the video.

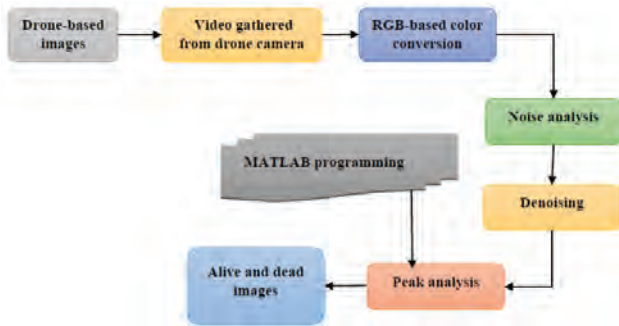


Fig. 1 Schematic representation

Before additional processing, every video is transformed into an image sequence before being saved on a personal computer (PC) in the joint photographic expert's group (JPEG) file format. The drone camera recorded red, green, and blue (RGB) video. Therefore, as the brightness component, the picture intensity data can be obtained by the colour model was created from the RGB model by utilizing the MATLAB built-in function and the subsequent formula:

$$\begin{bmatrix} Y \\ C_b \\ C_r \end{bmatrix} = \begin{bmatrix} x_{11} & x_{12} & x_{13} \\ y_{11} & y_{12} & y_{13} \\ z_{11} & z_{12} & z_{13} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} x_i \\ y_i \\ z_i \end{bmatrix} \quad (1)$$

Therefore, the values of chrominance, ranging from 16 to 240, are represented by the C_b and C_r components, and the luminance values, which range from 16 to 235, by the Y component. Second, a body joint estimate technique was used to automatically identify the part of the most visible location of the cardiopulmonary action in the chest. The pose generates body posture parses of high quality at negligible computational cost, which is an effective and reliable solution to the problems posed by unconstrained or numerous subjects. Using a single image, the colour technique can predict every individual's critical points in bodily joints. However, we only selected the chest region using the torso joints, which comprise the neck, the left and right shoulders, the hips, and the left and right hips. Following the joints discovered to communicate upper body position were identified, there were two sections of the body: the torso, both upper and lower. Our feature intersecting region was seen in the following:

$$Feature_{average}(t) = \frac{\sum_{x,y \in feature_{intersection}} I_{(x,y,t)}}{|feature_{intersection}|} \quad (2)$$

Thirdly, the image sequences selected for $feature_{intersection}$ were averaged over the brightness pixel values from component Y where $|feature_{intersection}|$ denotes the size of the chosen features and $I_{(x,y,t)}$ represents luminance pixel value at (x,y) over time (t) from image sequences. To lessen the noise produced by motion artefacts ($Y_{avg}(t)$ signal) during the video recording due to the drone's movement, they employed a moving average filter in the smoothing signal approach and an empirical Bayesian technique in the wavelet signal denoising approach. First, the signal was denoised using the built-in MATLAB function. This was accomplished by fusing the level-dependent denoising method known as a universal soft threshold with the wavelet Daubechies (dbN) family. With this approach, the noise variance at each resolution level is computed using wavelet coefficients. Second, as shown, the denoised signal was smoothed using the "smooth" function that comes with MATLAB. Lastly, the periodicity was ascertained using the wavelet transform-based peak identification, positions, and the amount of the smoothed signal's peaks. The wavelet transformation definition is the scalar multiplication of wavelet function (ψ) copies that have been scaled and shifted and the input signal ($Y_{avg}(t)$). It is a signal at position (x,y) that is the mathematical representation of a CWT.

$$W_{(x,y)} = \int_{-\infty}^{+\infty} Y_{avg}(t) \psi_{x,y}(t) dt, \psi_{x,y}(t) = \frac{1}{\sqrt{x}} \left(\frac{t-y}{x} \right) \quad (3)$$

Where $\Psi_{x,y}(t)$ is $\psi(t)$ translated by scale x and transformed using y , and $Y_{avg}(t)$ is the signal following smoothing and denoising. CWT coefficient values exhibit periodicity and peak patterns that can be used to calculate the quantity, locations, and peak intensities of sizes comparable to $\Psi_{x,y}(t)$. By altering x in $\Psi_{x,y}(t)$, which yields wavelets with different widths, all the peaks independent of their width may be located. Our proposed method may use peak patterns and periodicity to determine the target subject's vital signs.

NUMERICAL RESULTS AND DISCUSSION

The action camera used to record the movie is the GoPro Hero 4 Black. Reducing the field of view and

eliminating the fish-eye effect required adopting a second lens (5.4 mm, 10MP, infrared IR cut filter). A 2D Robotics Solo gimbal with three axes held the camera. To comply with ISO standards, the movies were recorded at a frame rate of 25 frames per second. With an image sensor sensitivity of 400 and a 3840×2160 pixels resolution. Fig 1 to Fig 5 illustrates how the experiment was conducted with all volunteers in four distinct positions: the side that is facing the camera, the side that is not facing the camera, the back position, and the stomach position. Eight human participants and one dummy are included in Table 1, which shows the live detection findings based on motion caused by heart activity at the locations indicated. The results in Table 1 demonstrate that for all five human subjects and one mannequin in various stances, the number of motion peaks in each shot may be utilized to determine whether a subject is alive or dead. Motion sensing from the chest region can be used successfully and effectively. To record vital signs for many subjects, the researchers showed the genuine person and the mannequin in a video lying side by side on the ground.

Table 1 Experimental outcomes

Subject	Poses	No. of peaks	Alive	Dead
1	1	12	✓	
	2	12		
	3	11		
	4	11		
2	1	8		
	2	8		
	3	7		
	4	6		
3	1	10		
	2	10		
	3	10		
	4	11		
4	1	7		
	2	7		
	3	7		
	4	6		

5	1	1		✓
	2	0		
	3	1		
	4	0		

As demonstrated in Fig 2 to Fig 3, the suggested approach successfully identified these participants' life signs and told which ones were dead or living. In daylight, under calm conditions, and with the assistance of a human operator and a powerful PC loaded with MATLAB software, our suggested system effectively identified live participants from a dummy. There is a limit to each of these requirements. Many combinations of gender and look were not explored, even though the participants made up a respectable portion of humanity. At approximately 8 meters, the same range as the most extended ranges tested, humans can tell that the mannequin is not human, even though it was pretty realistic. Since the studies were conducted between 4 and 8 meters above sea level, the upper-torso area's size provided sufficient information to accurately detect the breathing-induced body motions. Due to inadequate image details and tiny features at our recorded resolution of 3840×2160 pixels, the movies captured above 8m height could have been more detailed. Consequently, for feature-intersection of a respectable size, the range of altitudes mentioned above was the only one where data was recorded. Even with the proposed method's good performance, challenging scenarios would surely arise due to field conditions and subject partial occlusion.

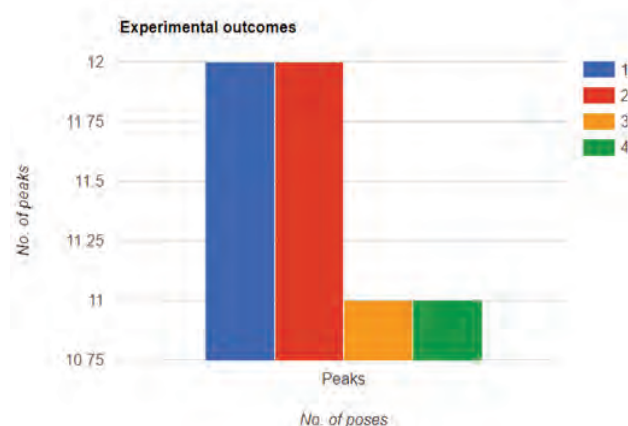


Fig. 2 Experimental outcomes with Subject 1

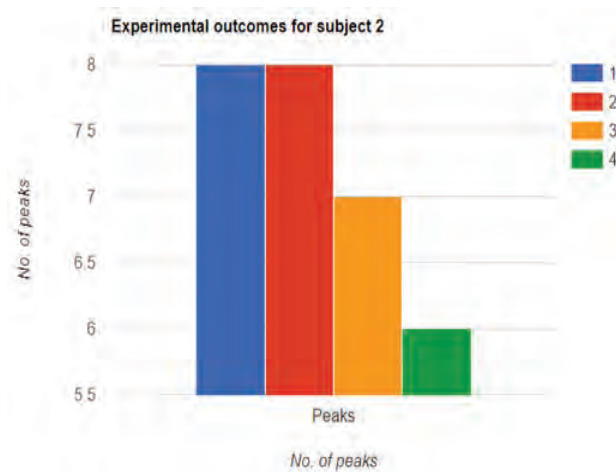


Fig. 3 Experimental outcomes with Subject 2

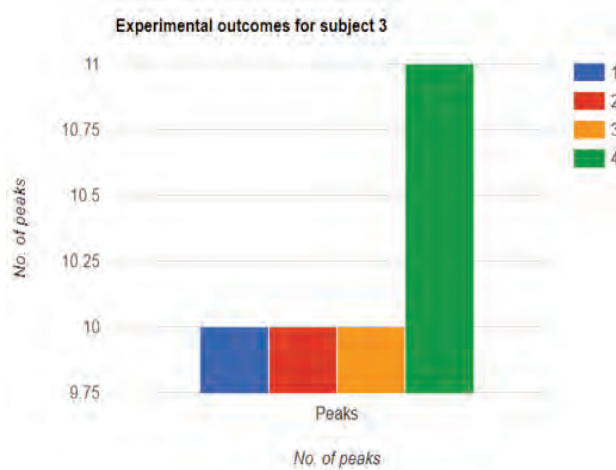


Fig. 4 Experimental outcomes with Subject 3



Fig. 5 Experimental outcomes with Subject 4

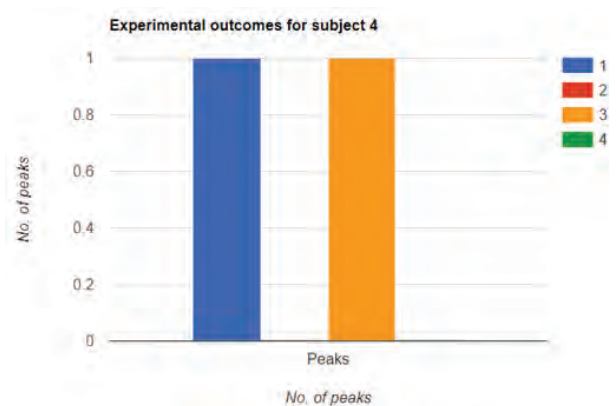


Fig. 6 Experimental outcomes with Subject 5

CONCLUSION

Our examination of the application of drone-based systems for people identification using the proposed feature^{intersection} model focuses on distinguishing human screams from other forms of distress communication. This work has a lot of application in post-disaster circumstances because drones are typically used to capture aerial photos to evaluate the extent of an occurrence and structural damage. They also use body heat signatures detected by thermal imaging equipment, which helps in a personal location. Researchers explore different aspects of the problem of locating people using aerial acoustics. It also examines how signal processing methods like arrival direction on microphone signals might be used to locate human noise sources more precisely. A thorough examination and conversation about this rescue system's architectural layout has occurred. In addition, we highlight challenges with UAVs, like the wireless network's susceptibility to disturbances, assaults, and synchronization problems. Researchers also discuss potential future initiatives, like improving sound analysis in loud environments and creating real-time systems.

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Innovative Approach to Vehicle Speed Control: Fuzzy Logic and Deep Learning Integration

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ABSTRACT

In response to the global challenge of vehicle collisions, often caused by factors such as reckless driving and speeding, this study introduces an innovative approach integrating Fuzzy Logic and Deep Learning for vehicle speed control. Collisions remain a pervasive issue, leading to injuries, fatalities, and substantial property damage worldwide. Among the contributing factors, speeding emerges as a critical element. This article proposes a Fuzzy Logic-based algorithm designed to proactively prevent and manage vehicle speed, aiming to enhance collision avoidance measures. By leveraging Deep Learning techniques alongside Fuzzy Logic, the system achieves a sophisticated integration capable of effectively controlling vehicle speed dynamics. Fuzzification of the speed variable enables a nuanced approach to speed regulation, ensuring adaptive and responsive control mechanisms. Moreover, the study employs recurrent neural networks (RNN) and other deep learning algorithms to predict traffic patterns and assess traffic frequency in real-time scenarios. This predictive capability, supported by IoT infrastructure, enhances the system's ability to detect and respond to traffic conditions promptly. Ultimately, this integrated approach promises not only to mitigate the risks associated with speeding but also to optimize overall road safety through proactive speed management strategies.

KEYWORDS: *Fuzzy logics, Speed control, Collision avoidance decision making, Deep learning.*

INTRODUCTION

Serious consequences for society, public health, and the economy can result from vehicle collisions, which are sometimes called traffic accidents or crashes. Worldwide, automobile accidents are a leading source of death, injury, and property damage. The leading cause of car accidents is driver error, which includes things like being distracted, being drunk or high, going too fast, and being irresponsible. Poorly maintained roads and adverse weather conditions, such as rain, snow, ice, and fog, might elevate the likelihood of accidents. One

of the leading reasons for accidents involving vehicles is this [1]. Mechanical problems, such as worn out tires or brakes, can cause accidents. Junction problems, inadequate signaling, traffic jams, and intersections are additional potential causes of collisions. Automobile accidents are a prominent contributor to worldwide mortality rates, particularly impacting those between the ages of 15 and 29. According to the World Health Organization (WHO), it is estimated that 1.35 million individuals lost their lives in transport accidents worldwide in 2018 [2].

Lost income, medical expenses, property damage, and legal fees all add up quickly in the event of a car accident. The National Highway Traffic Safety Administration (NHTSA) projected that motor vehicle accidents incurred a cost of approximately \$242 billion to the US economy in 2010 [3]. Vehicle collisions result in substantial harm or fatality to a considerable number of persons each year. The severity of these injuries can vary, ranging from slight to severe, and in certain instances, they can result in long-term impairment. The National Highway Traffic Safety Administration stated that a total of 38,800 individuals perished in automobile collisions in the United States in 2019.

Vehicle safety technology, including advanced driver assistance systems (ADAS), has proven to reduce accident severity and accident occurrence. Among these features are automatic emergency braking, lane departure warning, and adaptive cruise control. An additional method for lowering or eliminating the occurrence of automobile accidents is vehicle ad hoc networks (VANETs). A vehicle-to-vehicle (VANET) communication network is one kind of wireless network that enables data transmission between vehicles and other part of the road infrastructure, such traffic signals and signage [4]. Wireless communication between automobiles and roadside devices is made possible by virtual area networks (VANETs). Onboard units (OBUs) allow data transmission and reception in every vehicle in the network. Vehicular Ad-Hoc Networks (VANETs) enable the immediate transfer of information, including the precise position, velocity, and heading of a vehicle, along with any critical emergency notifications [5]. Potentially reducing the number of accidents and increasing road safety, VANETs could do the following:

System for preventing collisions: VANETs, which stand for “vehicle area networks,” provide real-time data interchange between vehicles regarding their location, velocity, and heading. This information might be used by collision avoidance systems to forewarn drivers of approaching collisions or even assume autonomous driving duties. So that other vehicles can react and avoid a collision, it may sound an alarm if one vehicle suddenly stops or encounters an obstacle. The use of VANETs can improve the efficiency of traffic flow control at intersections. Vehicles are able to display their intended routes and times at intersections. Modifying

the timing of traffic lights in response to real-time traffic information can help reduce traffic and lower the risk of collisions.

In 2017, it elaborated on a VANET information transport system that used Li-Fi. The data gathering and gearbox method was introduced to account for various vehicle circumstances. Li-Fi has received less attention because it is a relatively new problem. Using the framework, a multi-channel Internet of Things (IoT) system was developed. The setup of virtual computers allowed for the complete distribution of the data. Presently, there are two primary concerns: the over utilisation of transmission capacity and the lag time in data processing. The front vehicle’s driving aim was monitored by the driving goal recognition module. Furthermore, by employing vehicle-to-vehicle (V2V) communication, the leading vehicle conveys its driving intentions and any pertinent driving constraints to the following vehicle. In the replication test, the suggested framework performed better than the one with a fixed crash probability (TTC) edge by 6.34%, achieving an accurate admonition pace of 97.67%. The proposed framework demonstrated strong performance across a range of front vehicle operational circumstances for timely communication with the subsequent vehicle.

Mandated a comprehensive review of previous endeavors by grouping them according to the principles of distant communication, with a focus on VANET. To ensure the safety of sensitive data, ITS implemented an RC5 encryption method. Quartus Prime was familiar with the RC5 clone. The main goal was to guarantee its interoperability with the Intelligent Transportation Systems (ITS) and Field-Programmable Gate Array (FPGA) frameworks to protect consumer data. The research also included an examination of the test results and any unresolved difficulties that were found during the integration of VANET and SDN. An LTE setup can make better use of its enormous resources with the help of a vehicle-to-vehicle (V2V) conspiracy that can locate real-world car consumers. With the suggested method, a great deal of V2” “V traffic disclosure and management”—which primarily affects VANET cars and travelers—is eradicated. The analysis focuses on incidents that occur at automatic railway crossings between street vehicles and railroads on single-line rail-street sections. The research also aims to determine how

various risk factors might modify the expected danger elements in order to decrease the likelihood of street vehicle-train collisions at crossings.

PROPOSED SYSTEM

To implement speed regulation in a vehicle using a fuzzy logic system, it is necessary to develop a controller capable of making judgements that mimic human decision-making. Figure 1 illustrates the recommended technique of the system and outlines the data flow for smart autos. A proposed fuzzy logic system for controlling traffic speeds looks like this: You may get real-time data about your surroundings by equipping your vehicle with sensors like GPS, lidar, radar, and cameras. Weather, traffic lights and signs, vehicle density, lane markings, distance to the car ahead, road conditions (wet, dry, slippery), and vehicle speed are all possible pieces of information that may be included in the data.

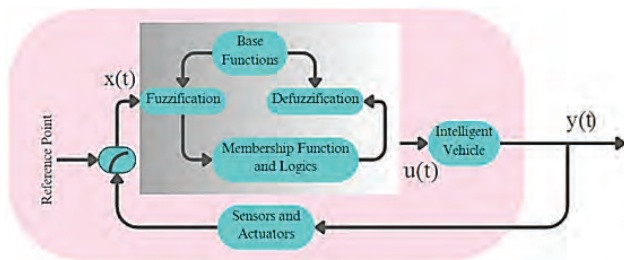


Fig. 1. Proposed methodology

Dataset Description

The traffic situation is becoming worse in every city across the world. Several factors contribute to this issue, including an increase in city inhabitants, an aged infrastructure, poorly timed traffic lights, and a dearth of real-time data. Notable results have been achieved. According to INRIX, a company that provides traffic monitoring and analytics, US commuters incurred \$305 billion in expenditures in 2017 due to transportation-related expenses, decreased productivity, and wasted fuel due to traffic congestion. Due to the impracticality and expense of building additional roads, urban regions must find alternative solutions to traffic congestion by utilizing innovative technology and creative thinking. This dataset's 48,120 occurrences and four attributes (datetime, junction, vehicle, and ID) provide the raw material for the input data extraction process.

Make use of the datetime properties to track the number of cars on a road or the volume of traffic in a certain area over a short period of time. The values of four individual junctions are stored in an extra attribute called "junction" in the dataset. The amount of traffic that flows through a certain intersection in a given hour may be determined by this vehicle attribute. The unique identification for each vehicle is determined by the number of entries. In most cases, both past and present traffic data are included in the traffic forecast dataset. Because of this, models and algorithms that can foretell how traffic will behave in the future may be created. Planning for metropolitan areas, managing traffic, creating routes, and preventing accidents are just a few of the many uses for these databases.

RESULTS AND DISCUSSION

The experimental results indicate that the models for speed control and traffic frequency prediction exhibit unique characteristics. The results obtained using a recurrent neural network (RNN) are displayed in Figure 2, depicting the predictions made by the RNN both before and after.

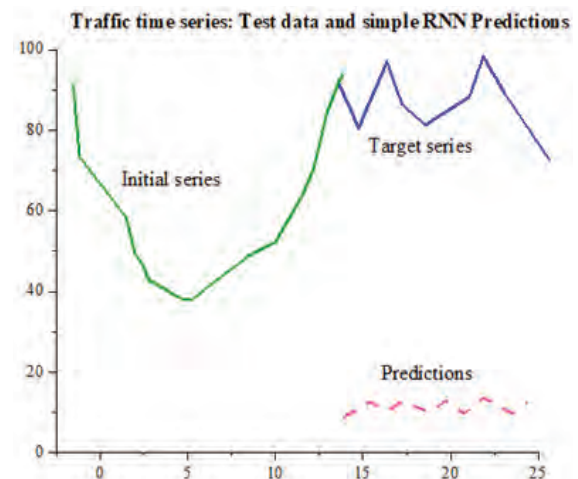


Fig. 2. Traffic information prior to RNN forecast

Figure 3 shows the hourly, daily, and monthly distributions of the tag data collected at different junctions.

The root mean square error (RMSE) values of the custom or suggested model at junctions 1, 2, 3, and 4 are compared to those of a variety of other models, such as the Multilayer Perceptron (MLP), Long Short-Term

Memory (LSTM), Gated Recurrent Unit (GRU), and Convolution Neural Network (CNN). The root-mean-squared error (RMSE) is a metric that quantifies the typical discrepancy between the predicted and observed values, as illustrated by Equation (1).

$$RMSE = \sqrt{\frac{\sum_{i=1}^N (x_i - \hat{x}_i)^2}{N}} \quad (1)$$

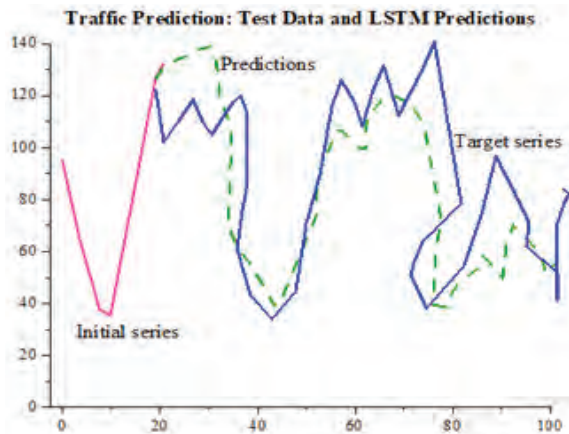


Fig. 3. Traffic information prior to RNN forecast

Prior to the implementation of Recurrent Neural Networks (RNN), the expected time series was of such a minimal magnitude that it was incapable of discerning any discernible patterns from the traffic data. Utilising the RNN method results in the formation of a discernible pattern in the predicted data refer as shown in the figures 4 and 5, establishing a relationship between the initial series same refer the figures 6 and 7, the desired series, and the generated predictions.

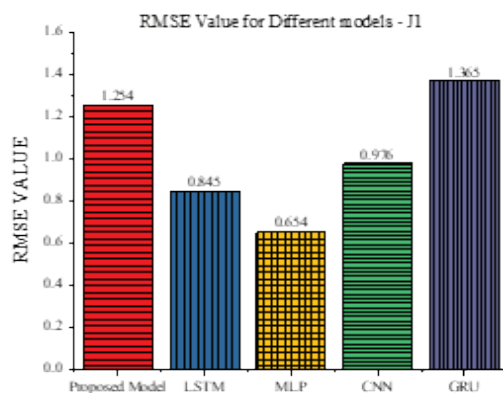


Fig. 4. Comparing the RMSE for each unique model at junction 1

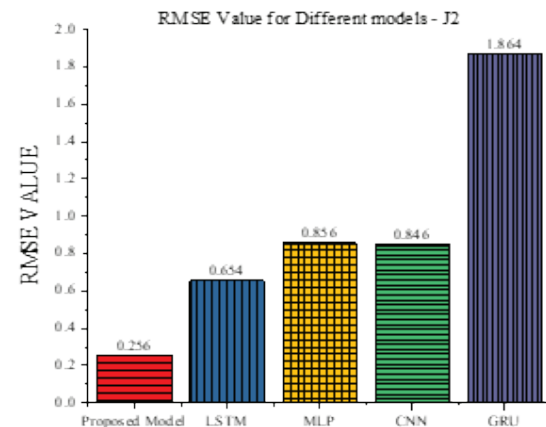


Fig. 5. RMSE comparison at junction 2 using a different model.

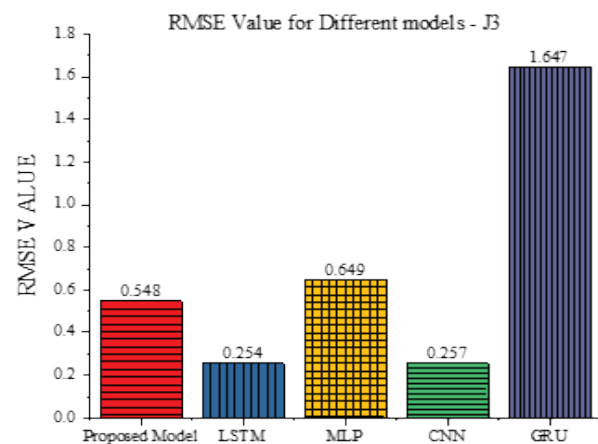


Fig. 6. Comparing the RMSE of a different model at junction 3.

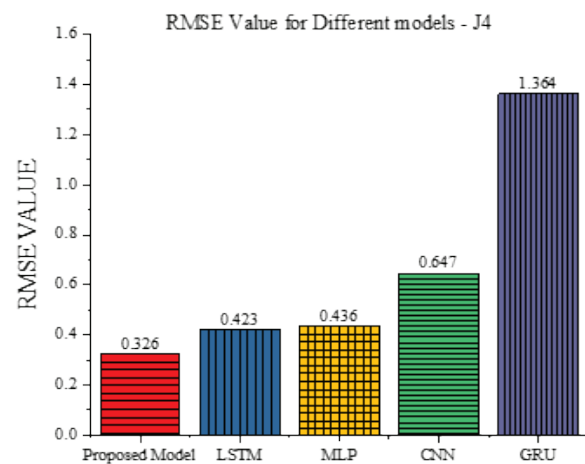


Fig. 7 Comparing the RMSE of a different model at junction 4.

Where the anticipated values for N rows are shown by x_i , while the actual values are represented by x_i . The results for the root mean square error (RMSE) are shown in Table 1. at various intersections where the proposed model outperforms the current techniques.

TABLE 1. Ratio of Root Mean Squared Errors at Junctions

Model	Proposed Model	LSTM	MLP	CNN	GRU
RMSE J1	1.254	0.845	0.654	0.976	1.365
RMSE J2	0.256	0.654	0.856	0.846	1.864
RMSE J3	0.548	0.254	0.649	0.257	1.647
RMSE J4	0.326	0.423	0.436	0.647	1.364

CONCLUSION

In conclusion, the integration of Fuzzy Logic for vehicle speed control represents a promising advancement in enhancing road safety and driving efficiency. Fuzzy Logic's capacity to model intricate and uncertain relationships offers a robust framework for replicating human-like decision-making processes in speed management. By effectively regulating vehicle speeds, this technology holds significant potential to reduce accidents and optimize driving conditions. The application of a Fuzzy Logic-based algorithm not only improves road safety but also enhances overall driving efficiency by dynamically responding to changing traffic conditions and environmental factors. Its real-time data processing capabilities make it a valuable asset in modern vehicle control systems, paving the way for smarter and safer transportation solutions. However, successful deployment requires comprehensive testing, user acceptance, and adherence to safety regulations to fully harness its benefits. Future implementations could leverage real-time data collection and physical setups to further refine and optimize the system's performance, ensuring continual advancements in driving safety and experience.

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IoT-Enabled Real-Time Accident Detection and Automated Rescue System

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ABSTRACT

Our lives have been greatly simplified by the exponential growth of both technology and infrastructure. In response to the escalating challenges posed by road accidents and delays in emergency response, an innovative IoT-enabled accident detection and automated rescue system has been proposed. This system aims to mitigate the loss of life by swiftly identifying accidents and expediting the dispatch of emergency medical services. The system employs an accelerometer sensor to detect abrupt changes indicative of a collision. Once an accident is detected, the IoT-based platform equipped with a Wi-Fi module transmits real-time location data to designated guardians and emergency response teams. This immediate notification mechanism significantly reduces the time it takes for medical assistance to reach the accident site, thereby enhancing chances of survival for victims. Key components of the system include a microcontroller (ATmega328), which coordinates the accident detection process, and a GPS module for precise location tracking. Upon detecting a severe accident, the system triggers an alert through the Wi-Fi module, enabling emergency responders to swiftly navigate to the accident location. This design integrates seamlessly into existing emergency response infrastructure, leveraging IoT technology to provide timely and effective assistance during critical situations. By leveraging accelerometer-based accident detection and IoT communication, this system represents a crucial advancement in enhancing road safety and emergency medical response capabilities.

KEYWORDS: Rescue system, Accident detection, Internet of Things (IoT), GSM, Vehicular ADHOC Network (VANET), RF signal.

INTRODUCTION

The foundation of this system will be the Internet of Things (IoT), a system that allows everyday objects to connect to one another and communicate with one another in a fully autonomous fashion. Its broad use has led to its official classification as a “Infrastructure of Information community.” Notable examples of its application include home automation systems, raspberry pi, internet of things (IoT) home security models,

smart water metres, and several more. A physical item can be assigned an IP address to enable data transfer over an IoT system when electronic components like sensors, ARDUINO software, and networking gear are installed. In contrast to the Internet of Things (IoT), the Internet enables any item with an embedded circuit to communicate with any other thing utilising the current Internet infrastructure, going beyond just Internet access. By 2020, all technology will be reliant on the

Internet of Things (IoT) due to its exponential growth in breadth. This will allow for previously unimaginable technological advancements.

In contrast, users may create a more tailored experience by connecting and controlling their own gadgets. The real-world use and performance of manufactured commodities are profoundly affected by manufacturers, who are also economically powerful. In this essay, we will learn how to clean the trash can using IoT. It is crucial to implement an accident detection and monitoring system in growing cities since accidents are a primary cause of death in these areas. This system will make use of ultrasonic sensors.

This paper explains how to use Internet of Things devices to lessen or prevent accidents. In order to achieve this, internet-of-things (IoT) sensors are strategically placed in high-risk areas to monitor traffic and gather data from the surrounding area. When one of these sensors detects an automobile that is travelling at excessive speeds or exhibits any other unusual behaviour, it communicates with the driver's IoT device to provide an alert. The device notifies the proper authorities in the case of an accident, allowing for quick aid.

What follows is the structure of the rest of this work. Examining a few pertinent research on this subject is the focus of the second section. The suggested method is presented in Section III. Section IV presents the system architecture and design. Section V delves into the discussion of the outcomes and findings. The gratitude is included in Section VI. Lastly, Section VII provides the last thoughts and where the study is headed moving forward.

LITERATURE SURVEY

The demand for vehicles connected to the internet of things (IoT) is rising in tandem with the exponential growth of the human population [1]. When it comes to VANET, RF communication transmission is also an option for non-networked regions. Sending an urgent communication becomes a formidable obstacle of This alert packet is lost. Using 5G technology, the article tries to address emergency concerns and covers the Transportation System (ITS), the Internet of Things (IoT), and intelligent messages delivered to a specialised health centre and fire station.

Majority of the world's fatalities are caused by road accidents, which are exacerbated by the absence of timely assistance [2]. For minimal latency, the suggested system employs a GSM and GPS module, which is appropriately supplemented by an RF module at traffic lights. For the purpose of detecting any malfunction, specialised vibration sensors are employed. In the event of an emergency, the ambulance is alerted and the traffic lights are managed using radio frequency transmission. Because of this, the patient can receive treatment faster.

The report suggests a possible solution: equipping vehicles with accident detection equipment that instantly calls for help. There are ways to notify the authorities, loved ones, or an ambulance using the Internet of Things. The GPS coordinates are also known, and the treatment has been carried out [3].

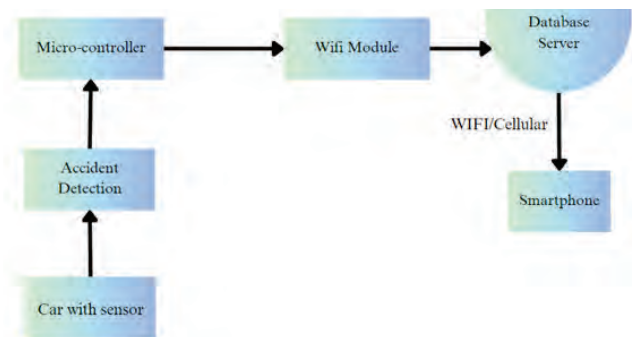


Fig. 1. System Architecture Under Consideration

Starting with sensors in the vehicle unit, the whole operational architecture of the suggested system is illustrated in Fig. 1. [4]. Thanks to the Internet of Things (IoT), the system can identify car accidents and send out instant notifications. A car's built-in microprocessor and smart sensors do this. Finding the individual also makes use of other modules, such as GSM and GPS [5].

PROPOSED SYSTEM

Establish a procedure for rescuing people in the event of an emergency, such as an accident or a fire. The individual is rescued by the system with the aid of smart technology[6]. The car can be located with the help of the GSM and GPS modules as shown In figure 2.

Embedded System

It all starts with a microcontroller and wifi module that collect data from a database server, which then

uses that data to detect irregularities and transmit crisis signals to the smartphone. The process of detecting abnormalities and sending distress signals via a database server begins with a micro-controller equipped with sensors, such as temperature or motion detectors, that continuously gather environmental data. This micro-controller is connected to a WiFi module, facilitating wireless transmission of collected data to a central database server[7]. Within the database server, algorithms and rules analyze incoming data in real-time to detect anomalies, such as sudden temperature spikes or unauthorized access attempts. Upon detecting these anomalies, the database server triggers a series of actions, including the generation of distress signals. These signals are then relayed to authorized users' smartphones through push notifications or other designated communication channels[8]. This integrated approach ensures that potential threats or critical events are promptly identified and communicated, enabling swift responses to mitigate risks or address emergencies effectively[9-10].

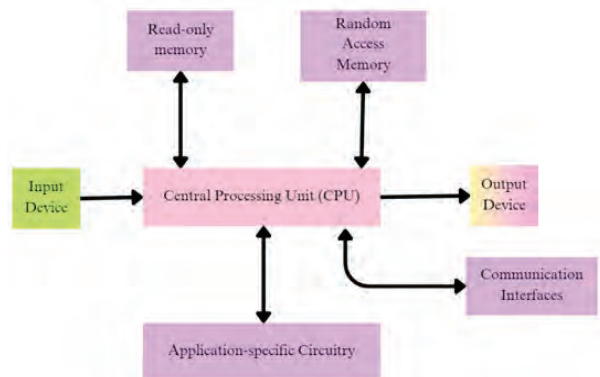


Fig. 2 Hardware Block Diagram

SYSTEM DESIGN AND ARCHITECTURE

Hardware and System Function:

A microcontroller, microprocessor, or digital signal processor could make up the central processing unit, or processor, in short. A microcontroller is a small, inexpensive computer. One of its main selling points is that it will have several extra components on a single chip, such as memory, an interface for serial connections, and an analog-to-digital converter. Therefore, because of the abundance of external, a microcontroller is the optimal choice for small applications. A limited number

of components are needed for the integrated system that we are developing. Contrarily, microprocessors are more powerful, but they need a plethora of additional components. DSP finds its most common use in signal processing applications, including video and audio processing.

Memory A few of varieties of memory are read-only memory (ROM) and random access memory (RAM). Memory (RAM) contents are erased when power is removed from the chip, while read-only memory (ROM) contents are preserved. Consequently, the ROM stores the firmware. At power-on, the central processing unit (CPU) accesses the read-only memory (ROM) and runs the programme.

When compared to desktop computers, the input devices used by an embedded system are far more limited in their capabilities. It will be impossible to connect to the embedded system without a keyboard and mouse. Pressing a single key on a small keypad allows you to give a specific command on many embedded systems. When using a keypad, you can only input numbers. In process control, many embedded systems don't have any kind of human-interface input device; instead, they take readings from transducers or sensors and forward those signals on to other systems. Embedded systems also have restricted alternatives for their output devices. Light Emitting Diodes (LEDs) are often used in embedded systems in tiny numbers to visually display warnings or illustrate the state of the system's components. Further, some crucial parameters may be shown on a compact Liquid Crystal Display (LCD).

Devices for the transfer of information: Interaction between embedded devices or data transmission to a desktop computer is a distinct possibility. The inclusion of a communication interface—such as RS232, RS422, RS485, USB, IEEE1394, Ethernet, etc.—in embedded systems enables this.

The ARDUINO board utilises a microprocessor based on the ATmega328 (datasheet). The device is equipped with a 16MHz ceramic resonator, 14 digital input/output pins (with the ability to use six of them as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All the necessary components for starting to work with the microcontroller are included. Simply connect it to a computer via USB or utilise the

provided AC-to-DC converter or battery for power. The Uno board distinguishes itself from previous boards by utilising an Atmega16U2 (or an Atmega8U2 in the case of R2 interpretation) as its USB-to-serial converter, instead of the FIDI USB-to-serial converter chip. The second modification of the Uno board simplifies the process of entering DFU mode by including a resistor that connects the 8U2 HWB line to the base. In order to facilitate the adaptation of the securities to the voltage of the board, the third revision of the board incorporates the following further characteristics. In the future, securities will be compatible with both 3.3 V ARDUINO Due boards and AVR-based boards operating at 5 V. The approaching use of the alternate bone, a distinct appendage, is forthcoming.

A piezoelectric sensor is a device that uses the piezoelectric effect to transform mechanical properties like acceleration, strain, temperature, or pressure into an electrical charge. One kind of detector that can identify and react to the presence of fire or flame is a flame sensor. At 433 MHz, the flame is observed; at lower frequencies, it is not. An alarm is triggered and a message is sent to the flame station upon flame identification. One inexpensive digital sensor that can measure both temperature and humidity is the temperature sensor. You can instantly detect humidity and temperature with this sensor by connecting it to any microcontroller, such as ARDUINO or Raspberry Pi.

Micro-Electro-Mechanical System, or MEMS for short, is a technology that relies on chips. Sensors work by placing a mass in suspension between two capacitive plates. As the sensor is tilted, an electric potential difference is generated by the hanging mass. A change in capacitance, sometimes called a tilt sensor, is used to measure the difference. You can describe this set of biases by looking at their size and design mode. The dimensions of these detectors might be anywhere from one micrometre to one hundred. These prejudices can be as basic as a building or as complex as an electromechanical system with a plethora of moving components managed by internal microelectronics.

A liquid crystal display, more often known as a television, is a great tool for both providing an interface for stoners and for medical uses. The majority of us have probably encountered such displays at PCOs or calculators in the

course of our daily lives. Character grounded LCDs that are compatible with Hitachi's HD44780 regulator or similar models are the most popular. Right now, 1 Line, 2 Line and 4 Line LCDs with a single regulator and support for up to 80 characters are all the rage, however LCDs with support for more than 80 characters utilise two HD44780 regulators.

RESULT

This project demonstrates the process of developing an automated system for detecting and notifying about car accidents using the Internet of Things. This idea is a system that can quickly detect accidents and relay that data to a nearby medical Centre.

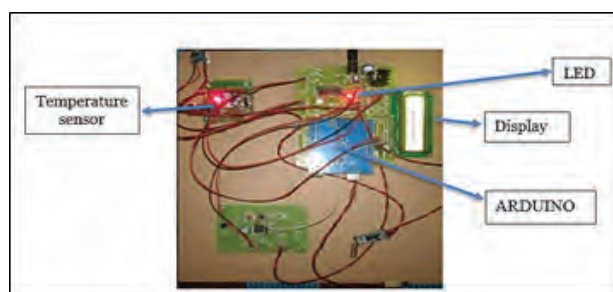


Fig. 3 The module that transmits

The project is reliable and easy to use. The suggested approach will be very useful to the car sector. In the future, traffic conditions will be monitored in numerous areas through data logging and analysis. In the most effective way possible, this method addresses the issue of inadequate emergency assistance provided to victims of traffic accidents. The Internet of Things Vehicle Unit is the basis of this project's automated accident detection and alerting system:

Commuter Unit

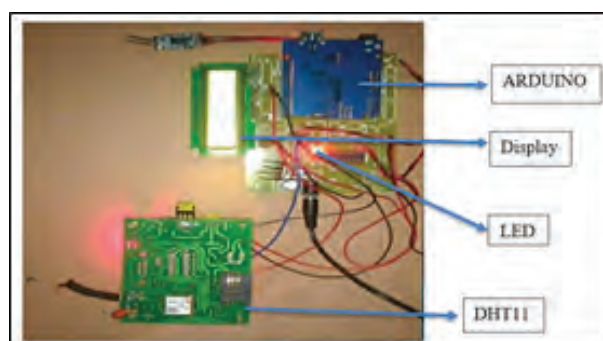


Fig. 4 Module for receiving signals

In the most effective way possible, this method addresses the issue of inadequate emergency assistance provided to victims of traffic accidents. The Internet of Things Vehicle Unit is the basis of this project's automated accident detection and alerting system recommended in table 1 and 2:

Table 1. Functionality Evaluation

Test Case	Observed Result	Expected Result	Test Result
Everyone using this system should be able to get SMS messages without any problems.	message sent	SMS must be delivered	Pass
The spot where the mishap happened should be clearly visible to the user.	The spot where the accident happened may be seen.	You should be able to see where the accident happened.	Pass
It is important that ambulances can get directions to the scene of the accident.	The required notice is obtained.	Timely notification of ambulances is essential.	Pass
Modifying the server data should be within the authority's capabilities.	Changes to the server's data are possible.	You can change the data on the server.	Pass

Table 2. Current System vs. Suggested System Comparison

Test Case	Existing System	Proposed System
Detection Mechanism	Detection type sensors are not utilised by the majority of other systems.	Various sensors are employed in the detecting process of the proposed system. Examples include piezoelectric, flame, and microelectromechanical systems (MEMS).
Providing immediate directions to the accident Site	This feature is not available in current systems.	As in this proposed system the reare GSM, GPS and Wi-Fi modules. So providing the directions is much easier.

Cost Effectiveness	The majority of commonly used frameworks make use of costly mechanisms such as Bluetooth.	The use of low-cost GSM and WiFi chips has resulted in a significant cost savings in terms of development.
Radio Frequency(RF) module	This feature is not available in current systems.	Our Proposed System consists RF module which will work in networkless areas within the range of 55 m.

CONCLUSION & FUTURE

The escalating toll of casualties from road collisions underscores the critical need for timely rescue efforts, potentially saving countless lives. Our exploration encompassed diverse strategies not only for detecting accidents but also preventing them. Central to these strategies were advanced sensor technologies including accelerometers, shock sensors, and pressure sensors, complemented by sophisticated machine learning methodologies such as neural networks, support vector machines, and representation learning. These innovations aim not only to detect accidents promptly but also to prevent them through mechanisms like identifying drunk or drowsy drivers, regulating vehicle speeds, and maintaining safe distances from obstacles. Post-accident, these systems excel in pinpointing collision locations precisely and facilitating streamlined rescue operations. Despite their efficacy, integrating such systems into vehicles can entail substantial costs, albeit with the invaluable benefit of transmitting real-time accident data to emergency services for swift intervention. These advancements promise significant advantages in mitigating road hazards. However, a notable limitation of current systems lies in their dependency on hardware and software technologies, which are susceptible to damage in accidents and may produce inaccurate readings. Thus, there is a pressing need for frameworks that reduce reliance on such technologies while enhancing reliability and effectiveness in accident detection and rescue operations.

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Building and Launching A Network of Wireless Sensors to Track and Report on Water Quality in Real-Time

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ABSTRACT

In recent years, the demand for effective water quality monitoring systems has grown significantly due to environmental concerns and regulatory requirements. Traditional methods are often limited by their high cost, labor-intensive nature, and inability to provide real-time data. In order to overcome these obstacles, this study suggests creating a system to monitor and notify users of changes in water quality using Wireless Sensor Networks (WSNs). The system utilizes low-cost sensors deployed in a network configuration across a water body or distribution system. These sensors measure various parameters such as pH, turbidity, dissolved oxygen, temperature, and conductivity. Data collected from these sensors are transmitted wirelessly to a central server for real-time processing and analysis. The proposed system aims to provide continuous monitoring capabilities, enabling prompt detection of water quality deviations or anomalies. Upon detection, the system triggers automated notifications to relevant stakeholders via email or SMS, facilitating timely intervention and mitigation measures. Key components of the system include sensor nodes, communication protocols (such as Zigbee or LoRa), data aggregation techniques, and a user-friendly interface for data visualization and management. The deployment of such a system is expected to enhance the efficiency of water management practices, improve environmental sustainability, and ensure compliance with regulatory standards.

KEYWORDS: *Wireless Sensor Network (WSN), Water quality monitoring, Real-time notification system, Environmental monitoring, Sensor nodes, IoT (Internet of Things), Data analytics, Water resource management, Smart cities, Environmental sustainability.*

INTRODUCTION

Every living thing needs water, and we use it constantly [1-3]. Having a method to quickly identify any pollution in the water and ensuring that water is free of pollutants for human consumption are both of the utmost importance. The first step in water purification is determining which contaminants are in the water. The analysis of water contaminants is mostly

done in a laboratory setting. If the contaminants in the water can be detected, there are other methods that may be used to isolate them [4, 5].

The two main ways to test water for contamination are microbiological and physiochemical tests [6,7,8]. In contrast to the relatively inexpensive examination of physiochemical data, the analysis of microbiological measurements requires the use of expensive laboratory

equipment [9,10]. Analysing and receiving data from physiochemical measurements is faster than microbiological tests [1]. The use of electrical sensors and other online devices allows for the assessment of physiochemical parameters [12].

We can learn more about the water's quality, the presence of dangerous compounds, and the possible effects on human health if we analyse it for contaminants [13,14]. That is why you should always check the water supply before drinking it.

An approach to water quality testing is detailed in this research. There was also a notification systems that provided updates on the water's safety and purity for human consumption. Using the 315MHz HYF RF modules, a wireless communication system was set up. The pH, EC, Tb, and FR of the water were measured in this study. Electrical sensors allow for the measurement and analysis of the selected water properties, which are physiochemical in nature. This is due to the fact that analysing and processing microbiological parameters takes a considerable amount of time and requires the use of microscopic instruments, Flow rate (FR), turbidity, electrical conductivity (EC), pH (potential hydrogen), and chlorine content are the designated water properties. In a nutshell, these are the parameters:

The standards are regulations that have been reviewed by several bodies in order to guarantee that drinking water is safe for human consumption. To ensure the water is safe to drink throughout the analysis and notification process, this research will use the water quality metrics criteria listed in Table 1. Incorporated a system for tracking water quality that accounts for EC, pH, ORP, turbidity, temperature, FR, and chlorine content among other elements. We used well-established signal processing techniques to correctly condition the analogue data readings of sensors that were particularly created based on fundamental principles [15].

The newly-built system primarily consists of two nodes: the sensor node and the notification node. Using ZigBee radio modules, the two nodes were able to establish wireless communication. A PIC microcontroller, programmed in the MPLAB IDE (Integrated Development Environment), served as the computational heart of each node. When water quality indicators go over the range specified by the World

Health Organisation (WHO) for drinking water, an audio alert system activates at the notification node, which also processes data. This is where you may see the results of the sensor's operation, which include voltage, resistance, and current. These results were generated by the signal processing circuits of each sensor.

We achieved our goals by building the sensor from the bottom up. The sensor's Internet of Things (IoT) implementation includes communication based on Internet Protocol (IP), a platform for wireless sensor networks (WSNs), and a system for radio frequency identification (RFID). This gadget is designed to keep an eye on the water quality. A number of markers of water quality have been investigated, including temperature and pH. At the campus lake of Universiti Sains Malaysia, the WQM system was put to the test in a real-life setting. Because of its capacity to lessen signal attenuation, the ZigBee radio module—which runs on the Digi Mesh Protocol and operates at 920 MHz—was chosen. It allows the sensor unit and the processor unit to communicate wirelessly in an Internet of Things environment.

Because it reliably collects data in real-time monitoring operations, Internet of Things (IoT) technology sees significant use. There are two ways in which Internet of Things systems communicate: between devices and between devices and the cloud. Cloud storage and the device-to-cloud communication method were employed in this project. The system's sensor node and network gateway are two separate subsystems. The pH and temperature sensors, along with a 32 kB flash ARM CPU and a 3.3 V ZigBee regulator, made up the sensor node. The microcontroller was connected to every part. The ZigBee radio module, a computer with a LAN module, and the Internet Access Point were the same components used to construct the sensor node and the network gateway node, respectively [12].

Constructed an inexpensive apparatus for monitoring and analysing water quality parameters, such as turbidity (Tb), pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), and free chlorine concentration. We consulted the WHO's guidelines for potable water quality in order to establish a reasonable range for all relevant parameters. By measuring the pH, ORP, and temperature, we were able to determine the

concentration of free chlorine. A measurement node, a control node, and a notification node were the three main components that went into making the system. To make sure the microcontroller got accurate analogue data, the sensors included signal conditioning. Three ZigBee radio modules allowed for wireless connection, which was utilised to keep tabs on all the nodes. A ZigBee module is separate from each subsystem.

SYSTEM DESIGN AND IMPLEMENTATION

The water supply, measurement, and analysis and notification subsystems were combined to create the water quality monitoring system.

Water Supply unit

The water supply unit's pipe included two valves that could be adjusted to manage the water flow rate. The LDR was placed on the outside of the water tank because to its light-sensitivity, which allows it to detect changes in water colour. Conversely, the pipe contained the pH sensor. We coated the water tank in white A4 paper to eliminate colour changes and measurement mistakes so that the Light Dependent Resistor (LDR) could be accurately measured inside and outdoors. While testing the device, a one-liter water tank was used because of its portability and its ability to save water. The drainage container was used to collect the water after the analysis. Figure 1 depicts the water supply system conceptually.

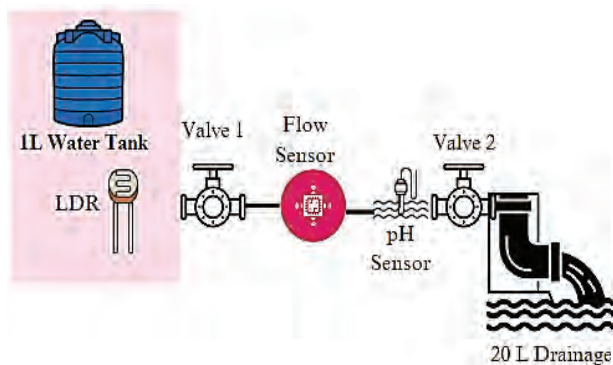


Fig. 1. Subsystem for water supply equipped with sensors

Assessment Method

The sensors were chosen according to their cost and availability. The goal of developing a low-cost system was to avoid using costly sensors because of their

influence on the allotted budget and their propensity to raise overall expenditures.

Microcontroller Unit

The Arduino Uno R3 was selected as the microcontroller because to its affordability, excellent specifications, and ample number of pins that fulfilled our design needs. Its input voltage range is compatible with the working voltages of all the listed sensors, and it facilitates simple sensor connection. If you follow the instructions in the libraries or code, you may link wireless communication modules to specific pins on the Arduino Uno R3. An analysis and alerting subsystem and a measuring subsystem were implemented on separate Arduino Uno R3s for the purpose of the experiment. The Arduino Uno R3 kit is shown in Figure 2.

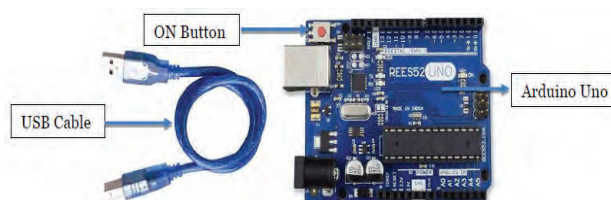


Fig. 2. The Arduino Uno R3 is equipped with a USB power and programming cord

PHsensor

Simple circuitry, compatibility with Arduino, power ratings, and operating temperature range (room temperature) were the deciding factors in the classic glass electrode pH sensor's selection. The pH sensor with glass electrodes is shown in Figure 3. A load resistor (4.7 kilohms, k Ω) was utilised to attain the best possible signal conditioning. It was connected to the sensor's signal pin via the resistor.



Fig. 3. Kit for measuring pH using a traditional glass electrode sensor

Conductivity

A conductivity metre with an LCD display was used instead of a cheap conductivity sensor with a wide measuring range because the former was not available. The conductivity range of water quality, which is 500-1000 μ S/cm and beyond, is covered by the metre's 0-1999 μ S/cm range. We were able to accurately measure the solute particle content in the water using this method in all of our experiments. The Primo 5 is a battery-operated, handheld conductivity metre.

The Primo 5 conductivity metre has to be submerged in water between the two extremes shown by the white marking on the black rod. You must calibrate the metre using the solution that comes with it before you can take any readings. After the metre has been calibrated, it is ready to be used for collecting measurements.

Data Analysis and Alerting Platform

The sensors and output components of the analysis and notification subsystem were written using the Arduino IDE software. A Microsoft (MS) Excel spreadsheet was used to store and show the data that was collected via MegunoLink. A red and green LED, as well as a piezo buzzer, made up the notification components. When the water sample is determined to be unsafe for human consumption, a synchronised buzzer and red LED will go off. Thus, the red LED will light up and the green LED will remain off whenever the buzzer is turned on. When the green light turns on, it means the water is safe to drink. So, with the green light on, disable the buzzer and the red LED.

Mobile Data Transmission

Because of their affordability, ease of use, and long-range transmission capability, HFY radio modules were used to wirelessly link the measuring subsystem to the analysis and warning system. The module's transmitter and receiver pins are designed to perform separate roles for data transmission and receiving. The module's transmitter and receiver pins are designed to perform separate roles for data transmission and receiving. The radio modules were programmed using the Radio Amplitude Shift Keying library. The receiver and transmitter were linked to the Arduino Uno R3's data pins 11 and 12, respectively. For the HFY radio modules, we used the Arduino IDE software to

programming them. Both the measurement subsystem and the analysis and notification subsystem included the transmitter and receiver, respectively. You can see the HFY RF modules in Figure 4.

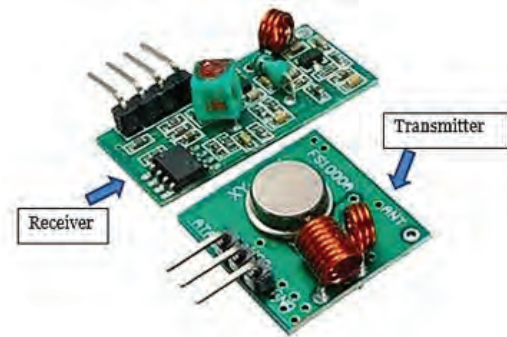


Fig. 4. HFY Radio Modules, consisting of a transmitter and receiver.

Developed a water quality monitoring system with notification capabilities

This part shows how all the subsystems that were discussed and shown in the previous sections work together. the connections of the planned system. The sensors' output measurements were clearly apparent, thus resistors were used for signal conditioning. To limit the amount of electricity that could flow through the sensors, resistors were used. The idea stands out from other studies because it uses the LDR to assess turbidity and incorporates LEDs into the alerting system.

Measurement and analysis of consumption risk have encountered an error

We calculated the measurement error by comparing the actual results with the expected values of the water parameters in 26 separate experiments. The purpose of computing this was to evaluate the system's efficiency. The data was compared to the water quality parameters in order to estimate the consumption hazard (CR). It measures the degree of risk associated with drinking the water by quantifying the percentage deviation of a water parameter. Excel was used to conduct both of these analyses. Here are the steps that were taken to complete both calculations equation 1 to 3 :

Let, θ Specify any water parameter.

θ_M = Quantified value of a water parameter.

θ_L = The lower limit of the water quality standard.

θ_H = Maximum limit for water quality standard.

CR - Computed using θ for all the aforementioned terms under two circumstances.

Condition 1: if ($\theta_M < \theta_L$)

$$CR = \frac{\theta_L - \theta_M}{\text{Total Scale of parameter}} \times 100\% \quad (1)$$

Condition 2: if ($\theta_M > \theta_H$)

$$CR = \frac{\theta_M - \theta_H}{\text{Total Scale of parameter}} \times 100\% \quad (2)$$

Measurement inaccuracies detected

$$e_m = \frac{\text{Fault in measurements}}{\text{Total measurements}} \times 100\% \quad (3)$$

FINDINGS FROM THE EXPERIMENT

In order to begin, we checked the system's efficacy and that the tap water's attributes were in line with the water quality requirements outlined in the literature study. This experiment used four different contaminants: dirt, chlorine, salt, vinegar, and washing powder. The soil was selected for this project due to its potential to pollute water in the case of a breach in the water supply and distribution system. The decision to use chlorine was based on industry standards for overtreatment and the provision of treated water without adequate testing. The LDR, pH response, and conductivity were tested using salt since it dissolves in water. Since this water is unfit for human consumption, the system must be able to detect the impacts of highly dissolved chemically-contaminated water. Its soapy feel is a certain indicator that washing powder is alkaline. This pollutant was chosen because we were interested in testing the system's ability to manage water containing soapy compounds. Vinegar has a very acidic flavor that is easily identifiable. The last choice was to see how the system handled acidic chemicals in water. The development of an acidic material often happens near pipelines that are susceptible to corrosion. Next, researchers will add each of the aforementioned pollutants to the water supply one by one in order to investigate the system's reaction to several contaminants. Equations 1-3 were used to analyse and build upon the findings. The findings of the conductivity metre test, which was done prior to conducting any more tests, are detailed in the section that follows.

Functionality of an Electrical Conductivity Meter

Captures three readings to show how the Primo metre works. What occurs when polluted water has a conductivity more than $1999 \mu\text{S}/\text{cm}$ is shown by the right measurement, whereas the left and middle readings indicate water quality within and beyond the permissible limit, respectively. The quality of the water coming out of the tap was tested on the left. In the middle reading, vinegar-contaminated water was used. The proper reading was represented by pollutants made of a vinegar and washing powder combination.

Measurements of Pure Tap Water

All of the measured water parameters were well within the acceptable range for this experiment. Consistent with the fact that pure tap water is colourless, the light-dependent resistor (LDR) was within the expected range of light resistance. Despite a measurement mistake, the pH was within the range of 6.5 to 8.0. The conductivity varied between 600 and 800 $\mu\text{S}/\text{cm}$, and the Light Dependent Resistor (LDR) was determined to be 300 to 312 k Ω . For the LDR, these numbers represent the standard for water quality. An error rate of 3.85% was determined from the data analysis, with just one inaccuracy out of 26 measurements. Also, for pH, the risk of ingestion was determined to be 1.43%.

Tap water contaminated with soil

Among the several water quality indicators measured in this experiment, only the LDR resistance was found to be within the acceptable range. Because dirt darkens water, it was expected that the LDR resistance would measure 169k Ω in darkness. Despite a measuring mistake, the pH readings were in the range of 6.0 to 8.0. It all depends on the soil type used for the measurements. Keep in mind that fertiliser-enriched soil may provide different results, although with the same level of LDR resistance. A range of 800 to 1000 microsiemens per cm was observed for the conductivity. After looking over the numbers, we discovered that one out of twenty-six measures was off by 3.85%. For pH, the risk of ingestion was determined to be 0.2%, and for turbidity, it was 26.29%. Observations show that the Light Dependent Resistor (LDR) reacts to changes in water colour and particle addition.

Tap water contaminated with chlorine

In this experiment, every water measure was found to be beyond the acceptable limits. There was a measuring mistake, but the pH values were between 8.0 and 9.5. The Light Dependent Resistor's (LDR) resistance was found to be 325 kilohms (k Ω). In microsiemens per centimetre (μ S/cm), the conductivity varied between 1800 and 2000. Analyses revealed that there was a single issue with a 3.85% error rate out of 26 measurements. A pH of 2.89%, conductivity of 42.22%, and turbidity of 2.56% were determined to pose a danger of ingestion. Our expectations were borne up by these data, especially in the pH range and conductivity. The LDR's resistance suggests that adding more chlorine has little effect on the water's hue. On the other hand, chlorine's properties make it possible for particles to enter the water. In addition to showing that chlorine is very conductive, the results show that the system can detect alkaline chemicals in water.

Tap water contaminated with salt

Every single one of the experimental water parameters were beyond the legal limits for water quality. The pH values were inaccurate, however they were in the range of 8.0 to 9.0. The Light Dependent Resistor's (LDR) resistance was found to be 365 kilohms (k Ω). From 1764 to 1880 microsiemens per centimetre (μ S/cm) was the conductivity range. The data analysis revealed a 19.23% error rate for pH alone, with 5 out of 26 values being incorrect. The pH level was determined to be 1.77%, the conductivity to be 40.57%, and the turbidity to be 10.66% in terms of the danger of consumption. For every one of the water parameters, these findings are in line with expectations. According to the LDR resistance, when there is dissolved salt in water, the water turns a little whiter, which in turn causes the resistance to rise. According to the pH scale, salt water is in the same range as saltwater. These results show that the device can detect alkaline compounds in water. Because it dissolves easily in water, salt also has a high conductivity.

Tap water has been found to be contaminated with washing powder

Every single one of the experimental water parameters were beyond the legal limits for water quality. Despite a

few measurement mistakes, the pH readings were within the expected range of 8.0 to 9.0. It was found that the Light Dependent Resistor (LDR) has a resistance of 246 kilohms (k Ω). The conductivity was between 1600 and 1750 microsiemens/cm. The data analysis revealed that out of 26 measurements, 3 were unsuccessful, giving a pH-specific error rate of 11.54%. There was a 4.79% consumption risk for pH, a 34.52% conductivity risk, and a 10.88% turbidity risk. For every one of the water parameters, these findings are in line with expectations. In the presence of soapy substances in the water, the LDR's resistance is diminished, leading to a deeper colour. Soapy water is alkaline, according to the pH scale. It is worth noting that these soapy compounds display high conductivity, and the results show that the system can recognize alkaline chemicals with soapy characteristics in water.

CONCLUSION

In conclusion, the development of a Wireless Sensor Network (WSN) based water quality monitoring and notification system represents a significant advancement in environmental monitoring technology. By leveraging IoT (Internet of Things) principles and low-cost sensor technology, the proposed system offers several advantages over traditional monitoring approaches. These include real-time data collection, continuous monitoring capabilities, cost-effectiveness, and scalability. The ability to promptly detect water quality issues and communicate them to relevant stakeholders enhances decision-making processes and enables timely intervention to protect water resources and public health. Furthermore, the integration of advanced data analytics and communication protocols ensures efficient data management and enhances system reliability. Future research directions could focus on expanding the sensor capabilities, improving energy efficiency, and integrating predictive analytics for early warning systems. By addressing these challenges, WSN-based water quality monitoring systems have the potential to play a crucial role in sustainable water resource management and contribute to the development of smart cities and resilient communities.

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Comprehensive Review of UAV Applications in Wildfire Wildlife Monitoring: Technologies, Challenges, and Future Directions

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ABSTRACT

The devastating impact of wildfires on ecosystems and wildlife has necessitated innovative approaches for monitoring and rescue operations. Unmanned Aerial Vehicles (UAVs), commonly known as drones, have emerged as a promising technology for real-time monitoring of wild animals during wildfires. This survey explores the state-of-the-art in UAV-based wildlife monitoring, focusing on its applications, challenges, and technological advancements from 2020 to 2022. UAVs equipped with thermal and optical sensors enable rapid aerial surveys, facilitating early detection of wildlife in distress and guiding rescue efforts. Key challenges such as flight endurance, payload capacity, and regulatory constraints are addressed through advancements in drone technology and navigation algorithms. The survey discusses various UAV platforms, sensor configurations, and image processing techniques used to detect and track wildlife in dynamic wildfire environments. Furthermore, the integration of artificial intelligence (AI) and machine learning algorithms enhances the capabilities of UAVs for automated wildlife detection and classification. Case studies and experimental validations highlight successful deployments of UAVs in wildfire scenarios, emphasizing their role in minimizing wildlife casualties and aiding conservation efforts. Future research directions include enhancing UAV autonomy, optimizing sensor performance, and addressing ethical considerations to maximize the effectiveness of UAV-based wildlife monitoring systems.

KEYWORDS: *Unmanned aerial vehicles (UAVs), Drones, Wildlife monitoring, Wildfires, Thermal imaging, Optical sensors, Artificial intelligence, Machine learning, Conservation biology, Disaster response, Environmental monitoring.*

INTRODUCTION

Forests contain a wealth of genetic material associated with biodiversity [1]. Forests cover 31% of the Earth's surface. Reducing emissions of greenhouse gases and improving the sustainability of forests are two goals of effective forest management [2]. Forest fires are becoming more common and more destructive annually. However, fires may be very deadly, destroying

homes and claiming the lives of many animals [3]. Forests throughout the globe are under danger due to the dramatic rise in forest fires in the past few decades, which are primarily the result of human activity [4]. Climate change and the alarming pace of deforestation are linked to this current upsurge. In the not-too-distant future, wildfires will become more common due to climate change-related increases in both temperature and dryness [5].

About 9 million acres of land were burnt in the US in 2018 [6]. The Amazon rainforest was once again the scene of a terrible fire in January 2019. This forest fire consumed an area of almost 906,000 hectares. Massive fires destroyed 5.8 million hectares of mostly temperate broadleaf forests in eastern Australia's New South Wales and Victoria between early January 2020 and September 2019. Some Australians have referred to this as "Black Summer" [7]. About three billion terrestrial creatures, mostly reptiles, were impacted, forcing several endangered species to abandon their homes. At its peak, the air quality in the whole southeast and southern region deteriorated to an unsafe level [8]. Multiple flames ignited and raged for weeks, finally engulfing an area more than 100,000 hectares.

Unintentional human activities, such as the ignition of wildfires, may devastate forest ecosystems. Over the last ten years, 67,000 forest fires have burned an average of 7.0 million acres every year [3]. For many ecosystems, fire is a necessary evil that keeps processes and populations from crashing to pieces. But, ecosystems may be irrevocably changed by the effects of fires of varying forms and frequencies [9].

In most cases, animals that come into direct contact with open flames are unharmed. Monster flames are the only way for humans and other huge creatures to perish in the wild. Sometimes, the less obvious effects of flames may have far-reaching and disastrous implications. A crown fire is a good example of this. It completely alters the forest's terrain and wipes out the pre-fire wildlife. There is a new group of animals that have settled here after a fire. Through mechanisms such as local extinction and repopulation, the structure and size of post-fire habitats impact the composition and organisation of animal metapopulations [10].

Everyone knows that forest fires, caused by human activities that alter the forest's structure, are the worst thing that can happen to forest creatures. For example, specialists in the primary forests of Sumatra have recorded the total extinction of squirrels, a few of monkey species, and a multitude of bird species from the burnt forest and nearby regions [11]. Approximately 70% of Russia's acreage is reserved for forests, making it a huge nation. Russia is a veritable ecological powerhouse, home to a quarter of the world's trees

and half of its coniferous plantations. The absence of comprehensive statistical data on the annual frequency of forest fires has made it difficult to form a realistic general prediction [12].

It is more economical and energy-efficient to prevent fires from starting in the first place. Because Russia's forest monitoring system isn't up to snuff, the origin of a natural fire is often unknown. Thus, every year, fires wipe up the country's forest complex, endangering animal habitats and causing economic losses worth billions of rubbles. The monetary impact may be estimated in a variety of ways, but the environmental impact is notoriously difficult to pin down [16]. Various animals may experience varying degrees of damage from fires. Indirect causes, such as forest fires, habitat degradation, and devastation, have a more noticeable and long-lasting impact on forest animals. The micro-environment is being disturbed as a result of changes in the local natural environment, which are caused by changes in fauna and the removal of plants. Controlled burns benefit herbivores including elk, bison, mule deer, and bighorn sheep by improving their food supply. Research on the effects of forest fires on ungulate habitats in the study region may be aided by studying how elk react to these disasters.

Changing weather patterns and global warming are making forest fires more frequent, more intense, and longer-lasting, posing a threat to animal and human populations alike. The movement and dispersal patterns of herbivores are being altered by climate change, as shown by several sources. Warming temperatures caused permafrost to melt, which in turn drove tree plantations and elks further northward. This work aims to investigate the feasibility of employing drones to keep tabs on huge animals in case of fires. Currently, these animals are often categorised according to their main quantitative ontogenetic features, which include length, weight, height, etc. Concerns concerning the safety of employing unmanned aerial vehicles (UAVs) to keep an eye on the environment and put out wildfires before they spread are considered. Drones can't be used to their full capacity in emergency circumstances unless there are well-established techniques and processes for looking for and monitoring wild animals during fires. Suitable tools for monitoring untamed creatures or

blazes should serve as the cornerstone of these plans and processes.

WORK METHODOLOGY

Using Drones to Monitor Endangered Species

Fire detection systems installed on the ground are triggered the moment smoke and flames are detected. However, cameras situated on the ground or in towers often fail to detect the first indicators of a forest fire. Autonomous drones, sometimes called unmanned aerial vehicles [24], can find fires far faster, even in dangerous or inaccessible areas. Although they are susceptible to weather changes and have limited endurance, drones with fixed or flexible wings can observe a vast region. A number of sensors, including inertial measurement units and global positioning systems (GPS), high-resolution cameras, and infrared cameras equipped with charge-coupled devices are common components of drones. Wild animal populations must be monitored on a regular basis in order to evaluate population dynamics in relation to possible climate changes, human activities, and other factors. The sheer breadth of these regions prevents the observation of wild animals in their natural habitats, and it may be difficult to search for specific species over such broad natural territory. The growth and composition of the population are controlled using conventional monitoring procedures, which rely on observations conducted from the ground.

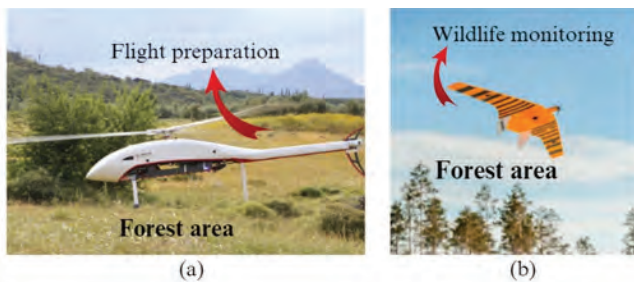


Fig. 1. Drone Supercam S250: Launch and Wildlife Monitoring

Drones, which are unmanned aerial vehicles, aircraft, and systems that are remotely controlled and outfitted with equipment like cameras and sensors, allow for the rapid and inexpensive surveying of vast regions due to their accessibility and user-friendliness. In open, homogenous areas where animals are not hidden, optical (RGB) cameras fitted on drones may identify them well

during surveys. There is more room for innovation in the use of infrared cameras on drones when the light is emitted straight from the source, rather than reflected. When an animal exhibits homeothermic endotherms, its skin or fur temperature is greater than the surrounding air temperature. The creature takes on the appearance of a luminous object when its MDP waves are lengthy. Infrared cameras, in contrast to RGB ones, may be utilised at any time of day and can even recognise photos taken at night. When keeping tabs on wildlife at night, such as birds and animals, or poachers, this becomes very important.



Fig. 2. Mudumalai National Park and Wildlife Sanctuary

Still, things aren't always black and white. To determine the efficacy of these types of investigations counted life-size seabird replicas placed in clusters in open areas that stood in stark contrast to their natural surroundings. Counts taken from drones were found to be far more accurate than those taken from the ground when it came to the quantity of bird replicas. Table 1 shows that our animal monitoring investigations have had comparable findings. We utilised an aircraft-type drone called the 'Supercam S250' from LLC 'Unmanned Systems' in Izhevsk, Russia. It has a wingspan of 2.53 metres, a maximum flight time of 3 hours, a maximum flight range of 180 kilometres, a speed range of 65 to 120 kilometres per hour, a permissible distance from the operator (radio line range of action) of 50 to 70 kilometres, a flying height range of 50 to 500 metres, a permissible wind speed of up to 15 metres per second, an air temperature range of -50°C Utilising a thermal imager and a series of cameras, we processed the images using the TIOF programme, which was created by the researchers from the KemsU Institute of Digitalization. Thermal imaging can reliably detect the presence of an animal

as long as there is a notable temperature differential between the animal and its surroundings (up to 30-40°C), but it cannot differentiate between species that

have comparable body mass and shape. In this scenario, identifying individuals of a certain species requires algorithms that have been modified (Figure 3).

Table 1. Monitoring Wildlife in Mudumalai: Traditional vs. Digital Methods (2021-2022)

Object of Study	Number of Individuals								
	I			II			III		
	1	2		1	2		1	2	
	2021	2021	2022	2021	2021	2022	2021	2021	2022
Maral deer	5	5	9	1	5	8	74	56	56
Roe deer	35	32	25	56	42	45	65	21	23
Elk	25	65	35	85	99	26	23	75	45
Wild boar	15	45	26	24	0	48	15	36	76
Sable	45	69	45	59	691	36	410	48	85
Badger	63	586	78	63	159	59	25	50	156
Fox	56	51	25	51	41	10	110	24	325
White hare	85	23	13	100	398	562	140	89	154

Drone Use in Fire Detection and Monitoring

Environmental crises on a worldwide scale have never been more pressing than they are now. The frequency and severity of natural catastrophes have been on the rise in recent years, making them a more serious threat to wild woods. The most catastrophic natural disaster is a widespread forest fire that alters the weather and way of life throughout a whole area. Thoroughly organising and planning preventative actions is crucial for reducing the negative impact of fires on both people and the environment. Fires have an impact on ecosystems on a local and global scale; they destroy infrastructure and kill people, but they may be lessened if firefighters are able to see them early and accurately monitor their characteristics (kind, degree, and magnitude). If not entirely stops fires, then at least lessens their devastating effect, early fire detection and monitoring of high-risk regions may help. Human observation from fire towers, using rudimentary instruments, is the conventional method of identifying forest fires, although it is inefficient and relies on human error. Fire sensors that are set up to detect smoke, flame, temperature increase, and gas show a delayed response since they need to be activated by the right particles. Given their small field of view, a multitude of these sensors would be needed

to keep tabs on expansive regions. The writers all agree that operator safety and dynamic mobility are the primary benefits of using drones for fire detection. They also all agree that the pattern recognition algorithms used and/or adjusted have the greatest impact on the quality of the incoming data.



Fig. 3. Drone Forest-Fire Monitoring Mission

RESULTS AND DISCUSSION

Drone Monitoring of Wild Animals during Fires

The ways in which wild animals travel are influenced by a variety of ecological variables, including the characteristics of the species itself, the surrounding environment (including biotic and abiotic influences),

and the many phases of the life cycle . It is well-established that animals' spatial and temporal mobility is dictated by their many objectives, such as their daily foraging for food, settling and moving within their home area, migrating vast distances, etc. .Environments that undergo periodic changes, as those with regular fires, highlight the need of movement. Fire destroys plant matter, altering the structure and content of plants while eradicating succession processes. Vegetation structure and composition, as well as resource features (such as food and habitat availability, number and quality of shelters, and other similar factors) undergo changes during post-fire recovery . Consequently, interventions that promote mobility and enhance the likelihood of individual and population resilience should be prioritised in fire-prone areas due to their dynamic character. After a fire, animals move around for two main reasons: first, to avoid burns [67], and second, to find materials for vegetation regeneration. The future danger and ease of population mobility are

determined by landscape parameters that are affected by fires, including composition, area, spatial layout of sites, and the frequency and severity of fires across the landscape .

Understanding the patterns of these activities as the landscape changes has been achieved using traditional techniques of direct ground observation of the migration of tiny animals. Data from reel-and-line devices were used to study the influence of vegetation type on the tortuosity of marsupial didelphids in the Brazilian Atlantic Forest .In order to track the small-scale movements of geckos and quantify the effect of grass height on their perception range, . used a fluorescent pigment. Drones equipped with specialised equipment may therefore be employed in regions prone to flames using established procedures and technology (Tables 2 and 3). For rare movements in fire histories, such as assessing emigration signals, quantifying the ranges of perception using these approaches may be particularly crucial.

Table 2. Types of Drones and Equipment for Wildlife Monitoring

Drone Type	Equipment	Shooting Type	Object of Observation	Features	Sources
The Firefly hexacopter from AscTec	Sensors that rely on visual input; onboard computer, inertial measurement unit, and u-Eye wideband camera	Video	Elephants, rhinos	Drone type impacts image quality; adaptive tracking algorithm	[12]
Quadcopter Splashdrone	Canon stabilised lens	-	Marine mammals known as humpback whales	Interactions with animals must be frequent.	[13]
drone with a fixed wing ScanEagle	Digital reflex camera made by Nikon; Standard Definition Electro-Optical Camera made by Electro-Optical Imaging, Inc. in West Melbourne, FL, USA	Spectroscopy	Marine mammals known as humpback whales	Possibility of gathering further geographical data; restricted camera coverage; It becomes more difficult to accurately gauge population number when animals are moved around in a systematic manner; using a global positioning system	[14]

None of the publicly available publications mentioned the use of remote sensing or drones to keep an eye on animals in the event of a fire. I see your point. Animal rescue takes a back seat as a forest fire escalates into a natural catastrophe. Nobody puts their life on the line to save animals. Drones and other equipment aren't very useful for animal monitoring when the weather is hot and they can only fly at a great distance. In other phases, such as before or after a fire has been put out, drones fitted with technology that monitor both flames and animals are very beneficial. While thermal monitoring technologies have their benefits, they may be practically worthless both during and after a fire. For animals, particularly those that have been burned, the outside temperature is a better indication than their inside temperature. Modifying current approaches and creating new, condition-specific algorithms for pattern identification is of the utmost importance.

CONCLUSION

In conclusion, the use of UAVs for monitoring wild animals during wildfires represents a significant advancement in disaster response and wildlife conservation efforts. The capabilities of UAVs in providing real-time aerial surveillance, coupled with advanced sensor technologies and AI algorithms, offer unprecedented opportunities to mitigate the impact of wildfires on biodiversity. Despite notable progress, challenges such as operational limitations and regulatory frameworks require continuous attention from researchers and policymakers. Looking ahead, further advancements in UAV technology, including increased flight endurance and sensor integration, are crucial for enhancing the efficiency and scalability of wildlife monitoring systems. Collaborative efforts among academia, industry, and government agencies are essential to address these challenges and capitalize on the full potential of UAVs in safeguarding wildlife and ecosystems during wildfire events.

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Wireless Power Transfer for Dynamic EV Charging: Current Status, Challenges, and Future Directions

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ABSTRACT

Wireless Power Transfer (WPT) technology has emerged as a promising solution for electric vehicle (EV) charging, particularly in dynamic charging scenarios where continuous power delivery is required while the vehicle is in motion. This paper presents a comprehensive review of recent advancements in WPT systems tailored for dynamic charging applications of EVs from 2020 to 2022. The study explores various aspects of WPT systems, including transmitter and receiver designs, power electronics, electromagnetic field optimization, and efficiency enhancement techniques. Key components such as resonant coils, magnetic coupling methods, and frequency control mechanisms are discussed in detail, highlighting their impact on system performance and safety. Challenges such as power transmission efficiency, alignment tolerance, and regulatory compliance are addressed through advancements in coil design, control algorithms, and system integration strategies. Case studies and experimental validations illustrate successful implementations of WPT systems in real-world dynamic charging scenarios, demonstrating their potential to enhance EV usability and reduce infrastructure costs. Furthermore, the integration of smart grid technologies and vehicle-to-grid (V2G) communication protocols expands the functionality of WPT systems, enabling bidirectional power flow and grid stability management. Future research directions focus on improving WPT efficiency, scalability, and interoperability with evolving EV platforms and infrastructure standards.

KEYWORDS: *Wireless Power Transfer (WPT), Electric vehicles, Dynamic charging, Resonant coils, Power electronics, Electromagnetic field optimization, Smart grids, Vehicle-to-grid (V2G), Energy efficiency, Sustainable transportation.*

INTRODUCTION

Pollution of the environment is becoming an increasingly critical issue, and our fossil fuel reserves are running low. One way to lessen the impact on the environment is to switch to electric cars (EVs). In most cases, electric vehicle chargers are now situated in designated areas, such as homes, offices, or public charging stations. Nevertheless, chargers that need

a power outlet pose a risk of electric shock and other hazards. Wireless charging, which relies on wireless power transfer (WPT) technology, simplifies and enhances the usage of electric vehicles (EVs) by making them more convenient and secure [1]. Dynamic wireless charging (DWC) and static wireless charging (SWC) are the two primary categories of wireless charging. Electric cars can only be charged using the SWC system if they are parked parallel to the transmitter. Battery

capacity and energy density, however, impede SWC advancement [2].

Electric vehicles are able to charge without stopping in the DWC system. Consequently, electric vehicles have the potential for extended range, reduced weight and battery capacity, and enhanced transportation efficiency [3]. Research and development of DWC systems may therefore facilitate the advancement of EVs in the long run. But there are a lot of problems with the design and control system that arise while EVs are in motion [4].

According to [5], the magnetic coupler's design is a crucial component of the DWC system. Two magnetic components make up the DWC system: a transmitter channel often placed under the road and a receiver coil fitted underneath an electric vehicle. It is possible to broadly categorise the transmitter lanes in DWC systems as either short-track or long-track. A low resonant frequency, low coupling coefficient, and large inductance characterise the long-track transmitter architectures [6].

Because of this, the efficiency of these transmitter lanes is poor, and the EMI is considerable [7]. Efficient and less susceptible to electromagnetic interference (EMI) short-track transmitters [8]. The size of a pad in the SWC may be equivalent to that of a short-track transmitter. A series of interconnected short-track transmitters create the transmitter lane. The transmitter line may be easily customised and extended since each transmitter coil has its own compensating circuit. The location of the EV may also be used to turn on and off individual short-track transmitters. Consequently, this transmitter lane has better efficiency and EMI [8].

A plethora of compensating circuits, power converters, and EV location detecting circuits are necessary for this system's complexity, albeit [9]. In addition, when the EV travels down the transmitter lane, the coupling coefficient changes. Because of this, the output power is pulsating and drastically decreased when EVs change their misaligned direction, which impacts the life of the battery [10]. There have been several investigations into potential solutions to lessen the oscillation in the output. To lessen the power pulsation, the spacing between neighbouring transmitters was modified in [11]. This results in a shorter overall lane length for the transmitter. The receiver length has been changed in

order to minimise the fluctuations in output power for a three-phase dynamic IPT system equipped with a dual pick-up coil, as described in reference. To reduce the oscillation of the output power, the authors of propose using FEA modelling to optimise the dimensions of the transmitter coils and position them in close proximity. Reducing pulse power is the goal of these studies, which optimise the size of transmitters and receivers.

The survey findings, however, are only processed in the event that EV travels in a straight line. There has been no documentation about the features of coupling coefficients based on positions when EVs move in the direction of misalignment. When planning and operating a DWC system, it is a crucial component. It is also difficult to achieve optimal efficiency when designing compensating circuits without taking the impedance matching issue into account.

This work utilises finite element analysis (FEA) simulation to optimise the design of the magnetic coupler, aiming to minimise the variance in coupling coefficient during dynamic charging. When electric vehicles (EVs) become misaligned, evaluations of the properties of the coupling coefficients are conducted. These assessments serve as the foundation for sophisticated controls, such as output power management and impedance control (referenced in [16]). The compensation circuit is specifically designed to fulfil the impedance matching requirement, hence enabling the achievement of optimum transfer efficiency.

Due to the air-to-energy transfer mechanism, DWC systems have a high leakage inductance. As a result, there is a poor transfer efficiency and a large reactive power. Modifying the system's resonance frequency, decreasing the power electronics converter's reactive power, and increasing transfer efficiency are all tasks that call for compensation circuits. To counteract the leaking inductance, capacitors are coupled to the coil at kHz. It is possible to classify compensation circuits as either series-series (SS), series-parallel (SP), parallel-series (PS), or parallel-parallel (PP). It is straightforward to create these compensating circuits since they are basic. Nevertheless, the restriction is quite sensitive to changes in the parameters. Changes in load disentangle transfer power and efficiency traits. Resonant frequency of SP, PS, and PP compensating circuits is dependent

on coupling coefficient [22]. Hence, dynamic charging systems, where the coupling coefficient varies with the EVs' positions, are incompatible with these compensation circuits. These drawbacks are eliminated by the LCC compensation circuit that is suggested.

The coupling coefficient, load impedance, and MOSFET soft-switching condition do not affect the resonant frequency. Like the SS compensation circuit, the LCC compensation circuit has these features. While both the LCC and SS compensation circuits use the same amount of power in their designs, the LCC circuit uses smaller elements. In the context of high power system design, it is practically significant. The primary compensation inductances of the LCC compensation circuits used for dynamic wireless charging are twice as big as the secondary compensation inductances, as described. Consequently, the design point is not the optimal value for transfer efficiency. In order to maximise transfer efficiency, this study suggested a technique for computing the parameters of the compensating circuit based on the ideal load value. Consequently, the transfer efficiency is maximised throughout a large frequency range provided the load impedance is maintained constant at the optimal load value, as shown Figure 1. Additionally, in order to enhance the efficiency of the inverter, the frequency may be adjusted to around 85 kHz using methods such as zero phase angle tracking control, as described.

The first prototype of the 1.5 kW dynamic charging system has been built. Efficiency while dynamic charging may achieve an average of 89.5%. The output power exhibits a fluctuation of 9.5%. Section 2 provides a comprehensive description of the system's architecture and the magnetic coupler. The methodology for developing a highly efficient LCC compensating circuit is further upon in Section 3. The results of the tests and simulations are detailed in Section 4. Finally, Section 5 displays the findings.

ELECTROMAGNETIC COUPLER AND SYSTEM DESIGN

Framework of the system

The two major and secondary sides make up the DWC system, as seen in Figure 1. Several DWC transmitter modules with three main side coils may be powered

by a single inverter, reducing the number of inverters required. Each transmitter coil is corrected using its own LCC compensation circuit. A moving wireless charging lane is formed by an array of transmitter coils. There are a number of advantages to the transmitter's modular design. Improving system efficiency and reducing electromagnetic interference (EMI) are two potential outcomes of using the EV's position to control the modules' ON/OFF states. Furthermore, no structural modifications are required to add additional lanes to the transmitter. The receiver is located on the underside of the electric vehicle's chassis. The magnetic coupler is in charge of conducting current from one terminal to another. Reaching resonance with the secondary LCC compensating circuit improves efficiency and power transfer. After acquiring the AC voltage, the following step in charging the battery is to correct it.

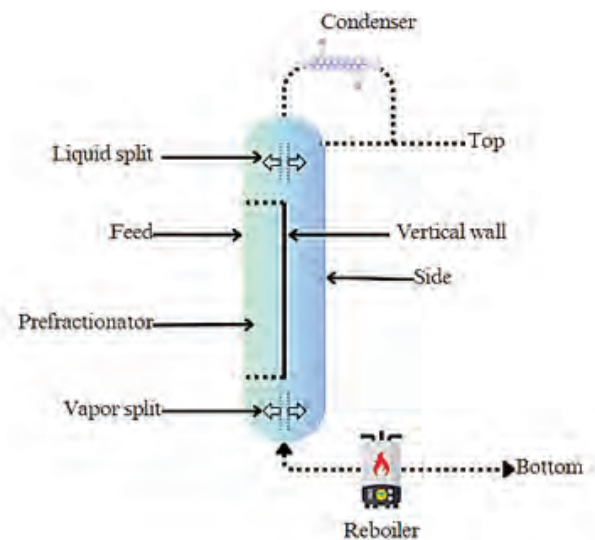


Fig. 1 Schematic of the DWC system's basic components

Design of a magnetic coupler

The DWC module's 3-dimensional maxwell magnetic coupler model. Three distinct layers make up a magnetic coupler's structure. Stranded wire coils form the uppermost layer. To further enhance the magnetic coupling, ferrite bars are used in the second layer. Sheets of aluminum, used to seal off magnetic field leakage, make up the bottom layer. The approach used to design the coil is cited in of this publication. Every DWC module has three closely spaced unipolar transmitter coils on the main side. Each individual transmitter coil

is 400" × 400" × 42" mm in size. There are 10 turns in each coil, and the spacing between them is 150 mm. One definition of the receiver's x-direction displacement is When the T1 transmitter and receiver are aligned with their centers, the result is zero. The distance between the centers of the T1 and T3 transmitters is 800 mm. Thus, d_r is measured from 0" "mm to 800" "mm." When the receiver's and transmitter's centers are in perfect alignment, the y-direction lateral misalignment is said to be zero.

The coupling coefficient determines the output power in a WPT system. The coupling coefficient also fluctuates during charging in a DWC system. The goal of this design is to minimise the dynamic charging output power pulsation by reducing the volatility of the coupling coefficient.

DESIGNED FOR MAXIMUM TRANSFER EFFICIENCY: LCC COMPENSATION CIRCUIT

This study presents a concept for a dynamic wireless charging system that incorporates an LCC compensating circuit on both ends. To accomplish gentle switching of the power electronics devices and lower the power converter's volt-ampere rating, the main side has a compensation circuit. Maximizing transfer efficiency is the goal of the secondary side's compensating circuit. The transmitter coils in this setup exhibit self coupling. The design of the parameters for the compensating circuit has to take into account all of the self coupling. In accordance with the J2954 standard, the resonant frequency is 85 kHz, which is the switching frequency (f_{sw}).

Analysis of resonance circuits

An examination of the resonance circuit's operation is conducted using the fundamental harmonics approximation. The rectifier input voltage and inverter output voltage are both expected to come from sinusoidal sources. Voltage sources that are stimulated show that the coils are magnetically coupled. If the components in the circuit have absolutely no power loss, then... To get these formulas, use the procedure for examining the resonant circuit .

Below you can see the self-inductance and mutual

inductance of the transmitter coils L1, L2, and L3, which are identical in design.

$$\begin{cases} L_1 = L_2 = L_3 \\ M_{ik} = M_{ki} (i, k = 1, 2, 3, i \neq k) \end{cases} \quad (2)$$

Here is the connection between the parameters of the receiver side compensating circuit:

$$C_{fr} = \frac{1}{\omega^2 L_{fr}} \quad (3)$$

$$C_r = \frac{1}{\omega^2 [L_r - L_{fr}]}$$

The coupled voltage of the transmitter coils is represented at the transmitter side by:

$$U_{Mi} = \sum_{k=1, k \neq i}^3 j\omega M_{ik} I_{Lk}; i = 1, 2, 3$$

The parameters of the transmitter side compensation circuit are related in the following way:

$$C_{fi} = \frac{1}{\omega^2 L_{fi}} \quad (6)$$

$$C_i = \frac{1}{\omega^2 (L_i - L_{fi} + M_i)} \quad (7)$$

Optimal circumstances for load transfer to achieve maximum efficiency

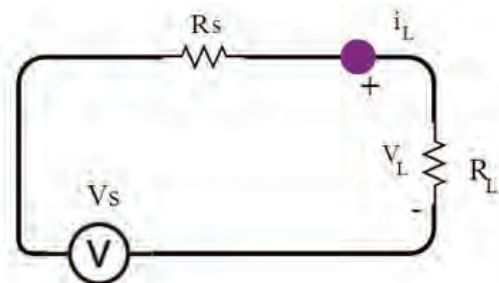


Fig 2. maximum power transfer theorem for equivalent circuits

Electric vehicle (EV) dynamic charging system design based on wireless power transfer Considering the transmitter and receiver resistances results in the same circuit shown in Figure 3. The transmitter's resistance is denoted as R_i , whereas the receiver's resistance is R_r . A diode bridge rectifier is often used to connect the

battery to the coil in dynamic wireless charging. The battery's resistance, R_b , is defined as U_b divided by I_b , where U_b and I_b are the voltage and current of the battery, respectively. You may use the formula $R_L = 8R_b/\pi^2$ to get the equivalent AC side resistance.

4. DISCOVERIES FROM EXPERIMENT AND SIMULATION

The outcome of the simulator

Multiple resonances exceeding the intended frequency are characteristic of high-order systems. When the settings are changed, this may have a major impact on how efficient the system is. This calls for investigation into and consideration of input impedance properties. Figures 8, 9 show the results of the ANSYS Electromagnetics simulation. The input impedance characteristics simulated under various situations are shown in Figure 8. Whereas R_L ranges from 10Ω to 140Ω , Figure 8a displays the input impedance characteristics when d_r is 0" "mm. Based on the findings, it is evident that the system exhibits numerous resonance frequencies, one of which is 85 kHz and is independent of the load value. The input impedance characteristics are shown in Figure 8(b) for d_r ranging from 0" "mm to 500" "mm) when R_L is $R_{L(opt)}$. Almost all of the distinctive lines overlap, according to the results. No matter where the receiver is, there is a resonance frequency of 85 kHz. Zero Voltage Switching (ZVS) is the recommended method for switching MOSFETs in high-frequency converters in order to minimise switching losses. As can be seen in Figure 8a, the ZVS area undergoes load-dependent modifications. At an ideal load impedance value, the ZVS area remains constant regardless of the receiver's location, as shown in Figure 8(b).

Figure 9 displays the outcomes of the simulation under various parameters regarding the features of transfer efficiency. With d_r set to 0 mm and load R_L ranging from 10Ω to 140Ω , the transfer efficiency parameters are shown in Figure 9a. The findings demonstrate that, under ideal load conditions, the transfer efficiency reaches its greatest potential. At frequencies close to 85 kHz, the transfer efficiency drops significantly for all other load levels. The features of the transfer efficiency are shown in Figure 9b for d_r values between 0 and 500 mm and R_L as $R_{L(opt)}$. The findings

demonstrate a high degree of overlap in the features of transfer efficiency. In the 83 kHz to 89 kHz frequency band, a high transmission efficiency is attained. The maximum transfer efficiency was 94.6%.

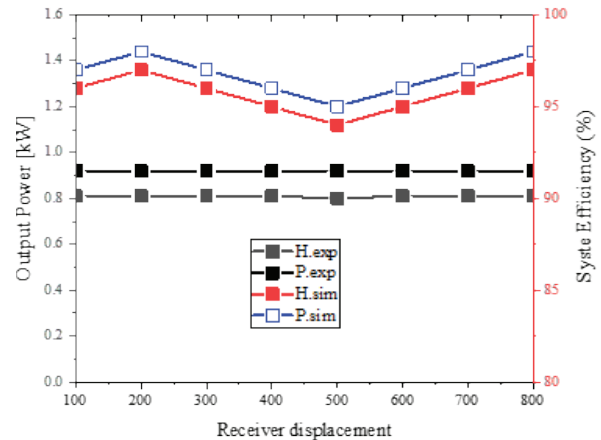


Fig. 3. Results from both theoretical and practical investigations into the system's efficiency and output power

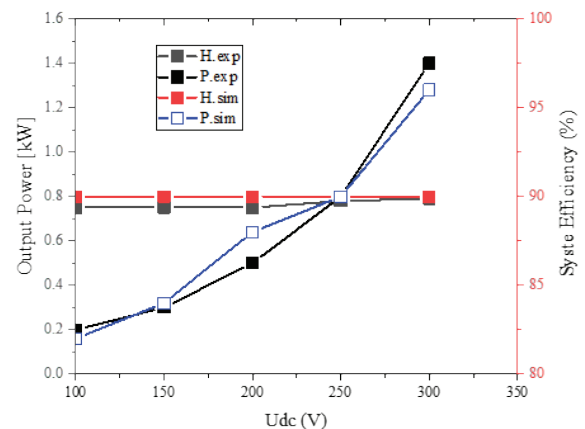


Fig. 4. The output power and system efficiency at various U DC values, as simulated and experimentally measured

To simulate the efficiency from the inverter's DC input to the output ideal load, a model was constructed in LTspice. When creating models for simulations, the Spice-model of the MOSFET CMF20120D is used. The results of the waveform simulation for the inverter's output voltage and current at a receiver location of 0" "mm are shown in Figure 10. It is evident from this outcome that the MOSFET has attained the ZVS state.

Figure 4 shows the simulation results for the output power and system efficiency when the receiver goes

straight down the dynamic wireless charging lane (solid line). With a variance of $\pm 10\%$, the average output power is 1.4 kW. This result demonstrates an improvement in the output power pulsation. With an average inverter efficiency of 97% and a transfer efficiency of 94.6%, the overall system efficiency reaches 91.8%. Theoretical examination of the maximum transfer efficiency in section 3.2 is consistent with this outcome. Using an input voltage range of 100" "V to 310" "V and a receiver location of $l_m = 0$ mm, Figure 12 (solid line) displays the results of the simulation for both system efficiency and output power. The calculated output power ranges from 0.14 kilowatts to 1.4 kilowatts, as shown in the results. My bad! Could not locate the referenced source. A system efficiency of 91.7% is achieved on average. At various amounts of transfer power, this result demonstrates that the system is quite efficient.

Observed experimental findings of system efficiency and output power while the receiver goes straight down the dynamic wireless charging lane in Figure 4 (dot line). The fluctuation in the average output power is $\pm 9.5\%$, and it is 1.38 kW. Efficiency levels average 89.5%. Findings from the experiments corroborate those from the theoretical study and simulations. Figure 12 illustrates the experimental findings of the output power and system efficiency as the inverter input voltage changes from 100" "V to 310" "V. The simulated findings (solid lines) and the experimental results (dashed lines) are quite similar. From 0.129 kW all the way up to 1.33 kW, the output power may range. The average efficiency of the system is 89.3 percent.

CONCLUSION

In conclusion, the development of Wireless Power Transfer (WPT) systems for dynamic charging of electric vehicles represents a significant step towards sustainable and efficient transportation solutions. The advancements in WPT technology from 2020 to 2022 have demonstrated promising results in overcoming technical challenges and improving system performance. By enabling on-the-go charging without physical connections, WPT systems enhance EV usability and address range anxiety, thereby accelerating the adoption of electric mobility. However, several challenges such as efficiency optimization, standardization of WPT protocols, and interoperability with existing

infrastructure remain critical for widespread deployment. Collaborative efforts among researchers, industry stakeholders, and policymakers are essential to address these challenges and pave the way for the commercialization of WPT-enabled dynamic charging solutions. Looking forward, future research should focus on advancing WPT efficiency, reducing costs, and integrating advanced control strategies to maximize the benefits of dynamic charging for both EV users and grid operators. By leveraging these advancements, WPT systems have the potential to revolutionize urban mobility and contribute significantly to global efforts towards sustainable transportation.

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A Smart Home Wireless Doorbell System Developed and Cut Out Using IoT Technology

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ABSTRACT

The integration of Internet of Things (IoT) technology in smart home devices has revolutionized traditional household systems, enhancing convenience, security, and energy efficiency. This paper explores the design and implementation of a smart home wireless doorbell system leveraging IoT advancements from 2020 to 2022. The system incorporates wireless communication protocols, sensor technologies, and cloud computing to enable remote monitoring and control of doorbell functions via smartphone applications. Key components such as IoT-enabled doorbell units, motion sensors, camera modules, and cloud-based platforms are discussed in detail, highlighting their roles in enhancing home security and user interaction. The system architecture facilitates real-time notifications, video streaming, and two-way communication between homeowners and visitors, thereby improving accessibility and safety. Challenges such as power management, network security, interoperability, and user privacy are addressed through advancements in IoT protocols and encryption techniques. Case studies and experimental validations demonstrate the practical implementation and benefits of IoT-based doorbell systems in modern residential environments, emphasizing their role in smart home automation and integration. Future research directions focus on enhancing system scalability, energy efficiency, and user experience through AI-driven analytics and integration with smart home ecosystems. By leveraging IoT technologies, smart home wireless doorbell systems have the potential to redefine residential living standards and contribute to the evolution of interconnected living spaces.

KEYWORDS: Smart home, Internet of Things (IoT), Wireless doorbell, Home automation, Security systems, IoT Sensors, Cloud computing, Remote monitoring, Smart devices, Residential IoT.

INTRODUCTION

The security of the home is significantly impacted by the door. If the door is easily accessible, the thief may find it easy to pilfer the house's belongings. Initially, a tangible key may be used to access a door. The digital door was developed in subsequent years as technology progressed. In the absence of a physical key, we may manipulate the digital door to either secure or unfasten

it. Despite being an innovative technology, the digital door remains vulnerable to break-ins while the house is unoccupied. Only until the locals return to their homes do they really comprehend this. It is essential for the homeowners to always secure the door while they are absent in order to guarantee the safety of the property. In addition, homeowners may sometimes neglect to secure the door or may have doubts about whether they have

properly secured it or not. The initial objective of this research was to provide a versatile, feasible, energy-efficient method for ensuring safety at entryways, with the ability to respond in real-time. The inclusion of the IoT ecosystem and cloud computing is essential as the device continues to develop. The goal was to create a versatile Wi-Fi door security system that allows the user to get visitor picture identification and make an educated choice on whether to provide that individual entrance to their property. In addition, if required for certain research initiatives, the data obtained via a cloud server may be accessed. The enhanced tools must be functional and user-friendly.

The Internet of Things (IoT) uses sensors equipped with the capability to detect. Furthermore, the data collected utilising a cloud server may be accessed if needed for specific research endeavours. The revised tools must exhibit high efficiency and be user-friendly. They have had inside contact. The sensors include of passive infrared sensors (PIR), magnetic sensors, and internal touch sensors. The Internet of Things (IoT) also utilises technologies such as microcontrollers, which have the ability to manage and control other devices. A MOSFET transistor, sometimes referred to as an automated switch or an electric strike digital door lock, may manifest in either one or both of these configurations. The device allows for remote locking or unlocking without the need of a physical key. It also has an alarm system that may be activated or deactivated based on user input. Additionally, the device has the capability to control the activation or deactivation of LED lights.

Previous research on smart home technologies have used IoT to enable remote operation and monitoring of various appliances, such as fans, air conditioners, gas and water heaters, and fire appliances. Several studies specifically examine efficiency as a means to reduce energy use. Multiple investigations have been carried out on residential security systems, including the ones described below. The HDSL technique has the potential to free people from feelings of worry and boredom. The HDSL system has two primary functionalities: "Home Security," which enables surveillance of those outside the door, and "Smart Locking," which allows homeowners full control over the locking mechanism using a mobile device. This system necessitates a Raspberry Pi

to operate and manage hardware components like as cameras, motion detectors, and electronic locks. The locking mechanism is controlled via Bluetooth in the technique of this investigation. Upon the completion of a handshake, the system automatically unlocks the door, and then secures it after a predetermined duration. In the absence of a Bluetooth handshake, the system will verify if any messages have been received. Upon receiving the instruction "unlock door," the system will proceed to unlock the door. Similarly, when it gets the message "lock door," it will promptly lock the door.

In the absence of a message, the system will explore the potential presence of a visitor. When the bell is triggered, the system will use the camera to capture images and transmit them to the user's email. In the absence of a bell signal, when the motion sensor detects movement, the system will use the camera to capture images. These images will then be sent to the user's email as a cautionary measure, while simultaneously sending an alert message over the internet to notify the user of a potential intruder. Nareshkumar, Kamat, and Shinde's study describes a system that utilises smartphones and mobile devices to control the operation of doors. This project requires the following components: a mobile phone, a Raspberry Pi Model B3 with an integrated WiFi/GSM module, a camera, a PIR sensor, and a biometric system. Upon detecting a person in front of the entrance, the camera will capture an image and transmit it to

The proposal recommended implementing a remote access control door entry system for both residential and commercial buildings. A remote access control system, facilitated by the internet, allows users to remotely oversee and control furniture, electronics, and other objects in their homes or workplaces. The equipment used comprises a Raspberry Pi board, a camera for visitor verification, a solenoid, a speaker set, and a bell switch. Upon the arrival of visitors, they will activate the bell switch, triggering the speaker to play a sound recording and prompting them to pose for the camera. The picture will thereafter be sent to the main host email with the subject line "Someone at the door," and, if required, to the backup host as well. Subsequently, the picture will be sent with the subject "Someone at the door" to both the main host email and, if required, the

backup host. To provide access to the visitor, the main host might respond to the email using the subject line "Allow person". In the event that the main host chooses not to open the door, they have the option to respond to the email without making any changes to its contents. The main host has a restricted timeframe to choose whether to unlock the door or not. When the system detects that the main host is unresponsive, it transmits a picture of the visitor to the backup host and notifies the guest. Email may be accessed on other servers without any modifications to the content.

Suggested the installation of a Passive Infrared (PIR) motion sensor as an integral component of a residential security system. Upon detecting movement, the device will initiate a vocal communication with the homeowner. The proprietor must thereafter determine if the individual is an intruder. Kodali2016's query remained unanswered as to how the prototype would assist the owner in differentiating between a guest and an invader. Nevertheless, it is said that next investigations will use the camera. The model of a home security system designed by Sahoo and Pati included an IP camera for verification purposes and PIR motion detection for generating alerts. The device uses the Zigbee protocol and may transmit SMS messages to the homeowner's mobile phone via GSM. In addition, Tanwar et al. suggested the implementation of an intrusion detection system based on IP. The simulation utilises a solitary Raspberry Pi minicomputer that establishes connections with a diverse range of sensors distributed across a residence or any other edifice. Upon detecting motion, the Raspberry Pi sends an email notification to the user. Kumar et al. proposed a concept for smart home security that incorporates sensors to detect intruders, as well as fire and gas hazards. One sensor will notice an occurrence, and the GSM module will use the owner's phone to transmit an SMS or voice call to notify them. The study conducted by Kodali2016, Sahoo, Tanwar, and Kumar did not address methods for securing or opening doors. Instead, it primarily concentrated on detecting intruders and sending remote alerts to Prabakaran, et al. On the other hand, Prabakaran, et al. explored the development of intelligent homes that integrated security components, including alarm systems and door locks.

The homeowner's mobile device is linked to the MQTT-based prototype via the GSM module. From a home security standpoint, the mobile phone has the capability to both secure and unsecure the door, as well as get an alert in the event of a possible intruder. Nevertheless, there is no correlation or connection between these two security-related properties. The alarm buzzer and the door lock/unlocker remain distinct entities. The study conducted by Pandit, et al. use a magnetic sensor to determine the state of a door, whether it is open or closed. An incursion is detected when a door that should be secured is found to be unsecured. The magnetic sensor is further used to automatically secure the door upon closure. Furthermore, the use of an IP camera enables the identification of individuals using facial recognition, while the authentication process for door entrances is also implemented.

PROPOSED SYSTEM

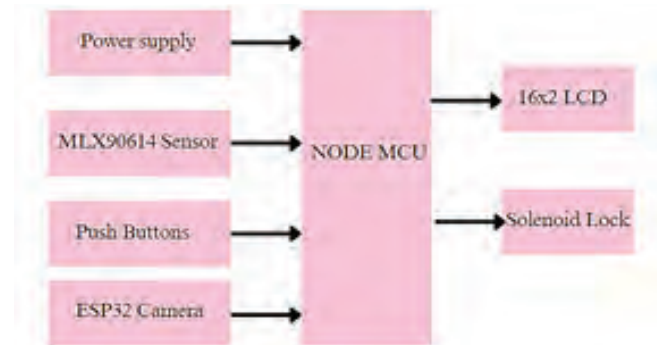


Fig. 1 . Node MCU Architecture diagram

Whether it's personal safety or the security of their data, everyone is concerned about security these days. The proliferation of the Internet of Things and other technological advancements have led to the widespread use of digital door locks. A digital lock that can be opened using a variety of biometric data (RFID, fingerprint, Face ID, PIN, password, etc.) has mostly replaced traditional key systems. Using these various technologies, we have already built other digital door lock applications. Here, we'll show you how to use the ESP32-CAM to set up a digital door lock that can be controlled by Face ID. A 5" "V power supply and all of the digital pinouts are located on the ESP32-CAM, which is installed on a daughter board. It would be possible to attach the ESP32-CAM to this daughter board for easy connection. The relay controls the solenoid valve and is linked to the digital

pin of the ESP32-CAM. Additionally, the toggle button is connected to the ESP32-CAM digital pin. With this digital pin, we can alert the Telegram app when you make a request. Once we press this button, the Telegram app will notify us and send us a snapshot.

NODE MCU

The NodeMCU is a popular development board based on the ESP8266 Wi-Fi module, designed for IoT (Internet of Things) projects and applications. It features a microcontroller unit (MCU) and built-in Wi-Fi capability, making it versatile for wireless communication and remote control. The NodeMCU is compatible with the Arduino IDE, allowing developers to use familiar programming languages like C++ to code applications. It supports various sensors and peripherals through its GPIO pins, enabling it to interface with a wide range of devices. The board's ease of use, cost-effectiveness, and robust community support have made it a preferred choice for prototyping and deploying IoT solutions, from home automation and smart devices to industrial monitoring systems. Its integration with cloud services and platforms like Blynk and MQTT further extends its capabilities, making the NodeMCU a powerful tool for creating interconnected and responsive IoT ecosystems.

MLX90614 Sensor

The MLX90614 is a non-contact infrared temperature sensor that operates by measuring the thermal radiation emitted from an object. This sensor utilizes the infrared detection technology of the Melexis company, offering precise and reliable temperature measurements without the need for physical contact with the target object. It can measure temperatures within the range of -70°C to $+380^{\circ}\text{C}$ (-94°F to $+716^{\circ}\text{F}$) with a high accuracy of $\pm 0.5^{\circ}\text{C}$ at room temperature.

2.2.1 The MLX90614 consists of two main components: an infrared thermopile detector and a signal conditioning ASIC (Application Specific Integrated Circuit). The thermopile detects the infrared radiation emitted by the object, and the ASIC processes the signal to convert it into a temperature reading. This digital output can be easily interfaced with microcontrollers like Arduino or ESP8266/ESP32, making it suitable for integration into various IoT and electronic projects. One of the standout

features of the MLX90614 is its ability to compensate for ambient temperature variations, ensuring accurate temperature measurements in different environmental conditions. It operates on low power consumption, making it suitable for battery-powered applications. Common uses of the MLX90614 include temperature monitoring in industrial processes, HVAC systems, medical devices, and consumer electronics.

Overall, the MLX90614 infrared sensor combines accuracy, ease of integration, and non-contact operation, making it a versatile choice for applications requiring precise temperature measurement without physical contact with the object being monitored.

DESIGN AND DEVELOPMENT

Listed below are the components of the circuit: the FTDI board, the relay module, and the solenoid lock. Since the ESP32-CAM does not have a USB interface, the FTDI board is used to flash the code into it. Through the use of the relay module, the solenoid lock may be turned on and off. Attached to the FTDI board and relay module, respectively, are the VCC and GND pins of the ESP32-CAM. Connecting the ESP32's TX and RX to the FTDI board and the relay module's IN pin to IO4 on the ESP32CAM make up the system.

For this project, you will need the following hardware components: -

This study used an experimental installation-based overall method to investigate hardware-cloud server interactions and Wi-Fi LAN remote data transmission for control and monitoring applications. The hardware used in this project is an ESP32CAM board, which is a budget-friendly, high-performance computer platform that comes with Wi-Fi and an inbuilt digital camera. Many general-purpose input/output (GPIO) ports allow it to connect to many external devices. A solenoid lock, +5 V and +12 V DC, a buzzer, a two-channel relay module, an infrared proximity sensor module, a tactile push button, a USB TTL UART Convertor to software ESP32-CAM board, and lastly a smartphone with a "Blynk" account are all components that have been utilised to construct the proposed device here. The results of the hardware setup's experiments should back up the artwork. The investigators will collect datasheets on different additives used to produce the gear so they

can supply information. The overall design was based on data collected from such research initiatives,

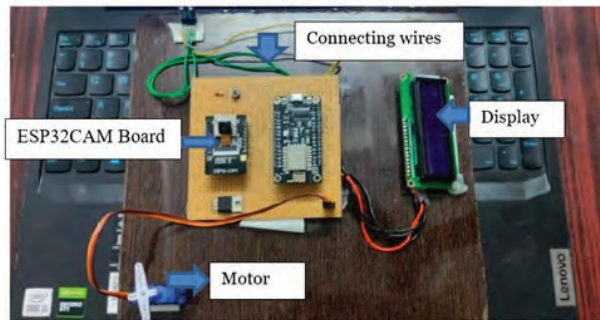


Fig. 2 Hardware Components

RESULTS AND DISCUSSION

The provided picture is a preview of what the final product will look like. We built a video-surveillance smart door lock using an ESP32CAM, an Arduino, and a Bluetooth module as part of an Internet of Things (IoT) and Bluetooth-based project model. After pushing the doorbell in this functional form, the owner may see who is there by going to the ESP site (192.168.43.27 in our case). The owner may use speech, gesture, and touch ways to open the electric door lock after authentication using the Bluetooth Arduino Controller App on an approved mobile phone. The provided picture is a preview of what the final product will look like. We built a video-surveillance smart door lock using an ESP32-CAM, an Arduino, and a Bluetooth module as part of an Internet of Things (IoT) and Bluetooth-based project model. After pushing the doorbell in this functional form, the owner may see who is there by going to the ESP site (192.168.43.27 in our case). The owner may use speech, gesture, and touch ways to open the electric door lock after authentication using the Bluetooth Arduino Controller App on an approved mobile phone.

Table: 1s

ESP32-CAM	5V	UOR	UOT	ESP32-CAM	5V	GND	IO4
FTDIBoard	VCC	GND	TX	RX	RelayModule	VCC	GND

Before you submit the code, be sure you connect IO0 to ground. To find out whether the ESP32 is flashing, you

may use IO0. The ESP32 enters flashing mode when GPIO 0 is linked to GND.

Process

Every time a guest arrives at the property, they are required to press a button on the door. The ESP32 CAM will capture the visitor's image and transmit it to the host using the Telegram app. Furthermore, the Blynk app will be able to detect the visitor's temperature and show it to them. Below, you can see the technique.

Use Bot Father in Telegram to create a name.

To create a bot name using Bot Father in Telegram, start by searching for "Bot Father" in Telegram's search bar and open a chat with it. Follow the prompts to create a new bot using the /newbot command. You'll be asked to provide a name for your bot, which should be unique and not already in use. After choosing a name, Bot Father will guide you through selecting a username for your bot, ensuring it ends with "_bot". Once confirmed, Bot Father will provide you with an API token necessary for bot development. This streamlined process ensures your bot is properly registered and ready to be configured for use on Telegram.

An order will be issued

An order will be issued typically refers to a formal directive or instruction that will be officially communicated to individuals or entities. This phrase is commonly used in administrative, military, legal, or organizational contexts to indicate that a decision has been made and will soon be conveyed to those affected. Depending on the context, an order could involve instructions regarding tasks to be performed, protocols to follow, or changes in procedures. The issuance of an order often signifies a structured approach to ensuring compliance or action based on established rules or decisions.

Build a user interface in the Blynk app and link it to our contacting Bell bot

To build a user interface in the Blynk app and link it to the Contacting Bell bot, follow these steps: First, download the Blynk app and create an account. Next, start a new project and select the appropriate hardware device (e.g., Arduino, Raspberry Pi). Design the user interface by adding widgets like buttons or sliders

to control the bot's functions. Use Blynk's API and webhook features to link these controls to the Contacting Bell bot, enabling users to interact with the bot directly through the app's interface. Test the integration to ensure seamless communication between the Blynk app and the bot for efficient user interaction and control.

The Blynk app can display the current temperature and a photo may be transmitted over Telegram.

The Blynk app offers versatile capabilities such as displaying real-time temperature data using sensors connected to microcontrollers like Arduino or ESP8266/ESP32. This is achieved by configuring the Blynk interface to receive and display sensor readings in an easy-to-read format. Additionally, the app supports sending photos via Telegram through integration with the Telegram API. This allows users to capture and transmit images directly from connected devices to Telegram chats, enhancing communication and remote monitoring capabilities through a simple and intuitive interface provided by Blynk.

You may transform this setup into an Internet of Things project by adding a Wi-Fi module and an Ethernet Arduino. The ability to manage it remotely and get input from the appliances allows for even greater energy savings. A dual safety mechanism is made possible by this circuit. By using registered faces and facial recognition, we can manage door locks with AI. Guests may see a message we sent them by putting an LED sign on the entrance. You can regulate several doors and curtains with the android app, and you can also monitor the future temperatures of the guests. If there is ever a power outage, the two circuits should still be able to function thanks to the battery backup.

CONCLUSION

In conclusion, the development and deployment of IoT-enabled wireless doorbell systems represent a significant advancement in smart home technology, offering enhanced security, convenience, and accessibility for homeowners. The integration of IoT principles from 2020 to 2022 has resulted in robust wireless communication protocols, advanced sensor technologies, and cloud-based services that optimize doorbell functionalities and user interaction. Despite

notable progress, challenges such as network reliability, data privacy concerns, and interoperability with existing home automation platforms require ongoing research and development efforts. Collaborative initiatives among industry stakeholders, researchers, and policymakers are essential to address these challenges and promote the widespread adoption of IoT-based smart home doorbell systems. Future research should focus on enhancing system intelligence through AI-driven analytics, improving energy efficiency through low-power IoT devices, and expanding interoperability with emerging smart home standards. By advancing these areas, IoT-enabled wireless doorbell systems can further enhance residential security, streamline home management, and foster sustainable living environments.

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Supervised Neighbor Model for Bug Tracking Analysis and Prediction

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ABSTRACT

Cloud systems are also facing significant bugs and problem-tracking threats. It is necessary to build a devoted framework with the features of an entirely flawless, lightweight process, and it should offer a high degree of association, operational flexibility, and rapid and accurate decision-making capacity. The main ambition of software engineering is to facilitate enhanced software with low cost and timely delivery of software for cloud technology. Reduced quality in the outcome and more execution time happen due to the flaws in the current Cloud-Based tracking system. Thus, it is necessary to verify the superiority of the developed software through the testing process; in turn, software testing is also expensive and time-consuming because of the complexity and high demand by the users. This difficulty is more burdensome in the designing of software architecture. All the accessible resources are utilized efficiently and powerfully by the prior identification of frequently error-occurring components, and these recognized components are given more concentration at the time of testing. This study was inspired by requirements like reducing time and fund consumption necessary for Cloud-based error tracking software verification using Supervised neighbor model (SNM) for general purposes and embedded software while assuring the deliverance of enhanced quality software within the time constraints in the cloud. Even though multiple ML techniques are widely employed for constructing software fault detection systems, obtaining improved performance is still complex. This tends to examine the machine learning techniques for software tracking systems of the cloud to detect defects with enhanced accuracy which is our principle objective.

KEYWORDS: *Modification, Bug tracking, Prediction, Supervised, Neighbourhood model.*

INTRODUCTION

Software is an indispensable tool in the routine life of individuals because of its simplicity and speed. Several sectors, like finance, transportation, health, manufacturing, and trading, use embedded software on a large scale. The benefits and significance of software can't be exaggerated [1]. It improves productivity, makes rapid decision-making, converts manual processes systematically, and facilitates improved

user experience. Software updates are essential to cope with the ever-changing and developing consumer requirements resulting in the discovery of more complex software [2]. The propagation of IoT has revealed modern needs for designing the embedded program. The ecosystem in the Internet of Things uses three groups: high-end, middle-end, and low-end tools. Microcontrollers are encapsulated at the low-end components, with restricted random access memory of

less than 50 kB and a flash storage capacity of about 250 kB. Even the low-end components are categorized into three types and they are 8-bit framework, 16-bit architecture and 32-bit framework. Different real-time OS like RIOT, Zepher, Contiki, freeRTOS, and tinyOS are generated for low-end components [3] – [4].

The primary aim of software engineering in the IoT system is to develop and deliver efficient and accurate software to satisfy consumer requirements in the provided time and cost. The quality of the developed software can be evaluated using several non-functional characteristics. The software quality mainly relies on the metric reliability [5]. To assess the reliability of the software, it is essential to recognize and estimate the number of defects present in it. It is necessary to minimize the identified flaws to construct reliable software [6].

So, the fewer the defects, the more consistent the software is. Reliability, security, maintainability, and scalability are non-functional software features that assess software quality. The working performance of the system is estimated by scalability along with the model's outstanding workloads. Reliability describes the system's quality characteristics that cannot fail for a specific period of time in a given situation. It explains the possibility percentage of the proposed technique. The security measure measures the system's safety and components and protects it from malicious or unauthorized users. Maintainability describes the system's time requirement and components required to be modified, upgraded to enhance performance, or adjusted to the transforming field. Various factors can cause defects in software, such as general incompleteness, noncompliance, and misinterpretation of the requisites [7]. Error or inaccuracy averting the functions of the software is defined as a defect or threat that stops the software from satisfying its needs. It is easy to develop software that works 100% accurately, so it is necessary to identify and correct the threats present in the software. This flawless software can provide the perfect product to consumers. The software testing phase is vital in software production to ensure its quality. The defects in the software should be identified by the testing team at its initial stage to assure software quality [8]. At this production phase, many difficulties exist. Thorough testing of components in the software

is affected by factors like high cost, restricted resources, and extended period requirements [9].

Creating intelligent tools capable of detecting defective software components in the testing phase is paramount [10]. The research community is witnessing rapid advancements in software defect prediction and detection. Software defect detection involves creating models that can be utilized during the early testing phase to identify faulty components within the software [12, 13]. It is a self-learning approach that significantly improves the test process. The research aims to develop a software error detection model with Supervised neighbor model (SNM), a machine learning technique for enhancing its exactness in detecting defects. The research also evaluated the proposed model performance to evaluate other approaches to deep learning technology. The research objective of this study contains:

1. To investigate the ML techniques to identify software threats and detect consumer software threat datasets to train software threat detection techniques.
3. Proposal of a technique of detection with the Supervised neighbor model (SNM) and evaluate the performance and experimental outcomes.

The work is drafted as: section 2 discusses the existing method analysis and methodology in section 3. The numerical outcomes are discussed in section 4 and summary in 5.

RELATED WORKS

It has been proven that improving a high-precision software bug identification model is a difficult task. Several methods have been proposed, but most still need to meet the standards of accuracy of prediction and detection of threats. According to [11], introducing network technologies such as on-demand computing facilitates users worldwide and supply network-based service delivery system.

This storeroom service facilitates consumers' transfer of large amounts of local data to low-cost distant storage servers, reduces costs, and protects data integrity. Block chain has proved in preventing data leakage. Unwanted dependence on trusted third parties and significant

overhead are various difficulties addressed by block chain, permitting the secure production and distribution of watermark content [12]. As network storage services have become widespread, emerging performance and safety issues impact scalability. High costs, dependence on third parties, and repeated data audits are some of the problems present data audit methodologies face. To overcome this difficulty, a de duplication scheme based on blockchain has been proposed to verify there liability and credibility of data in the audit results. Deep learning isa hierarchical construction composed of several neural layers and can extract and study data to produce reconstruction characteristics from input information through layers of neural processing. Many benefits include linguistic understanding, image recognition, and network threat identification. A capable attribute-based model [13] was proposed to avoid breaches of the subject privacy of access in the decision-making process by initiating a binary search tree. Still, they are threatened by the environment. Most of the transmission mechanisms are based on centralized organizations. Still, the experts attempted to solve this problem by introducing a blockchain-based transmission system for RES systems. In computing, deep learning is the most required method. Because of its changing nature, it isn't easy to construct a deep learning system. A widespread review of DL methods in [14] is proposed considering various tasks, such as supervised and unsupervised tasks, and their actual implementation field. The author presents the latest techniques for evaluating and extracting large quantities of information from high dimensional data spaces, thus providing a broad view of software devices. The author have shown that DL methods can be utilized to resolve various issues in the real world.

METHODOLOGY

Dataset

One of this research's significant concerns is using five diverse public data sets to detect new data sets on software errors. The datasets are chosen from online available Github repository. The characteristics of the preferred dataset contain several code measurements present in the actual dataset; the code measurements count is computed using OSA, defective counts, number of entire instances, and non-defective instance count.

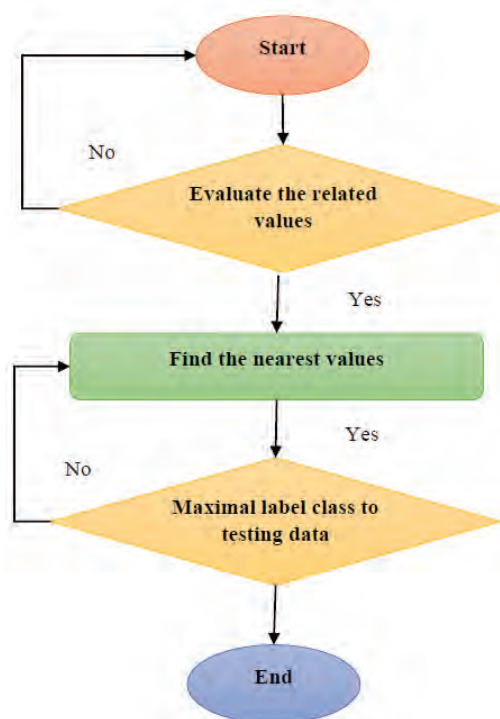


Fig. 1 Proposed model

Supervised neighbor model (SNM) for prediction

k-NN is a supervised learning approach. It is easy to use and is used in numerous applications such as classification and regression. The result of this algorithm is produced if the input features are labeled and marked. A specific function is used by the algorithm's learning procedure that uses input data. The SNM method is a non parametric basis, which generally produces accurate results, considering that these documents are classified. K-nearest points are generated to do this task. Data files are commonly categorized using various methodologies based on the nearest points from the previous step. It can take into account the weight-related distances. In these cases, the value of selected k is crucial because it significantly impacts the classification process. Fig 1 represents the implemented mechanism. Other forms of data files are required by this algorithm, such as vectors or magnitudes, which indicate analytical values. Because it is mathematical, various distance-related functions are applied to obtain classified records. After that, the remoteness between the test data and data points is evaluated. This is done to identify the data points closer to the test data. The probable distances

are computed by some of the functions like Euclidean, Makowski, and Manhattan.

$$\text{Euclidean distance} = \sqrt{\sum_{i=1}^k (x_i - y_i)^2} \quad (1)$$

$$\text{Manhattan distance} = \sum_{i=1}^k |x_i - y_i| \quad (2)$$

$$\text{Minkowski distance} = \sum_{i=1}^k ((|x_i - y_i|^q))^{1/q} \quad (3)$$

Where the coordinate is given as (x,y), k indicates the number of points, q takes the value from 1 to 2.

NUMERICAL RESULTS AND DISCUSSION

The k-fold cross-validation method is employed in this research. Initially, the value of k was taken as 10, which indicates a 10-fold validation procedure was applied to obtain an assessment outcome and compute the flaws present in the system. The actual data set is arbitrarily partitioned into ten subsets of similar lengths. The training and verification are executed concurrently ten times on the extracted dataset. There are four outcomes produced by a confusion matrix for binary categorization, and they are True Negative (TN), True Positive (TP), False Negative (FN) and False Positive (FP).

True Positive (TP): points out the number of positive cases predicted perfectly as positive.

False Negative (FN): points out the number of positive cases that are predicted inaccurately as unfavorable.

False Positive (FP): points out the number of negative cases that are forecasted inaccurately as positive.

True Negative (FN): points out the number of cases identified accurately as unfavorable.

Multiple performance metrics are applied to verify the proposed configurations of a SNM system and identify the threats present in the software. Some measures are accuracy, F-measure, precision, ROC curve, and recall.

A few constructed performance measures are given as follows:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \quad (4)$$

$$\text{Precision} = \frac{TP}{TP + FP} \quad (5)$$

$$\text{Recall} = \frac{TP}{TP + FN} \quad (6)$$

$$\text{F1-score} = \frac{TP}{(TP + (\frac{1}{2}) * (FN + FP))} \quad (7)$$

Table 1 Performance comparison

Approaches	Accuracy	Precision	Recall	F1-score
HOG	92	93	94	95
SVM	94	95	96	96.2
LDA	95	96	97	96.9
SVM	79	80	82	85
LBP	91	92	94	95
PCA	92	93	95	96.2
SNM	98	98.5	99	99.2

Table 2 K-fold validation comparison

Approaches	10-fold	5-fold	3-fold	2-fold
HOG	92.5	94	94.5	95.1
SVM	94.8	95.5	96.7	97
LDA	96	96.2	97.8	97
SVM	81	81	82.5	86
LBP	92	93	94.5	96
PCA	93	94	96	97
SNM	98.5	98.6	99.1	99.5

An accurate recall is represented by the value 1.0, whereas the worst recall is given by 0.0. The higher capability to identify TP as favorable is achieved if the forecasting methodology has increased recall measures. The value 1.0 shows the perfect precision, whereas the worst-case precision is represented by the value 0.0. The prediction with a lower rate of inaccurately classified cases is reported as high precision. Since the values of both precision and recall are enough to measure the complete capability of a model, F-measure incorporates these two metrics into a single unit by evaluating their

harmonic average. Thus, the F measure generates balancing weights of both precision and recall, which results in a complex training process if imbalanced data is applied. The experimental outcomes are evaluated in this section for entire system configurations based on five chosen datasets. Accuracy, recall, ROC curve space, precision, and F-score are the performance metrics employed to recognize the framework's efficiency. The accuracy percentage of forecasting for every SNM system is provided in Table 2. The SNM methodology depicting the enhanced classification accuracy with the provided datasets. However, a similar system configuration of facilitates the lowest classification accuracy with the Netty 3.6.3 dataset. The SNM providing superior prediction accurateness with the dataset Netty 3.6.3. The mean precision offered by this Supervised neighbor model (SNM) is 98%.

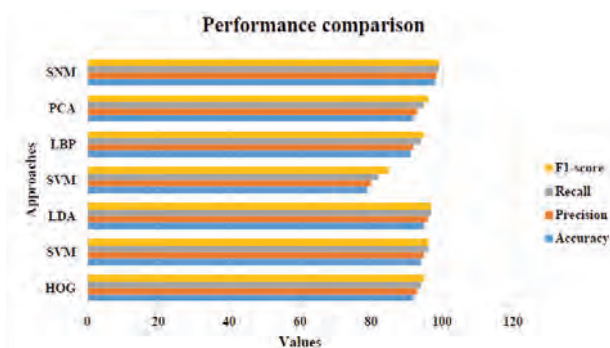


Fig. 2 Performance comparison

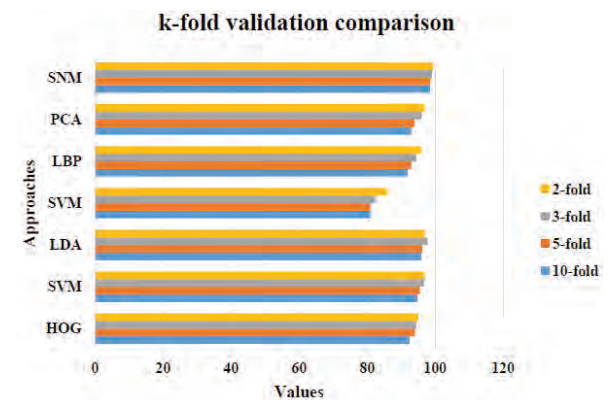


Fig. 3 Cross validation analysis

CONCLUSION

Software engineering primarily concentrates on providing enhanced quality software within a given time and cost. The delay in software delivery is caused

by the threats present in the developed software which minimizes the worth. This motivates us to detect defects in the early stage of software production and improve the quality by clearing all the bugs in the proposed Supervised neighbor model (SNM). The software testing procedures are costly and time-consuming because of their complex requirements and inefficiency in developing threat-free software. Prior identification of error-prone nodes in the software being produced helps to provide assured software quality in detecting the modules that need more attention at the training, thereby developing effective software with available components for software testing. Computerization of prior recognition of software error nodes has been a field of activity for several years. Error identification has also emerged as a new research field as various technologies evolve. Different methods like machine learning approaches, analytical techniques and ML methods are used to recognize software defects.

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Provisioning A Recruitment System Using Modern Intelligence Method

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ABSTRACT

Employers require the correct recruiting devices to occupy open places because conventional recruiting models cannot meet the talent competition in the global war for talent. Initially, exploring the transition from digital 1.0 to 3.0 enabled with artificial intelligence, a digital tool for business redesigning, is essential. The everyday routine of recruiters and recruitment efficiency are enhanced through AI technology. This research evaluates that artificial intelligence plays a vital role in every recruitment stage, like seeking a job, recruitment promotion, screening, coordination, application, and assessment. After interrogating artificial intelligence employment stakeholders (applicants, managers, and recruiters), the researcher discussed their approval norms for every recruitment phase; representatives also raised concerns about artificial intelligence (AI) employment. In conclusion, experts recommend that recruiters concentrate on the expense of artificial intelligence recruitment, legal security, bias existing in the recruitment process, and the probability of substituting managers.

KEYWORDS: *Recruitment, Prediction, Analysis, Artificial intelligence, Business.*

INTRODUCTION

Conventionally, organizations use low-tech strategies, such as newspaper advertisements or employee references, to attract qualified candidates. General recruitment techniques are now less effective because they involve a significant investment in time and do not result in optimal solutions [1]. Since the end of the 1990s, the worker market has faced economic challenges, and the request for highly qualified candidates has been high [2]. Only talent is needed if an organization wants to meet its customer's requirements through this competitive technology advantage [3]. Employment has changed from a vital individual source initiative to a planned concern for the organization due

to the change in its ability to be a supplier of commercial advantages.

In recent years, management has placed talent acquisition, selection and retention as their main strategic priorities [4]. The e-recruitment system is gradually developing, surpassing the conventional method. Artificial intelligence tools became popular among recruiters. Talent recruitment must be carefully carried out for enterprises to achieve management objectives. Talent selection is complex because decision-makers are limited to analytical, numerical, visual, and internal biases [5]. A novel recruitment era, with the power of AI, enables labourers to address employment challenges. Due to the virtual office, conventional working

techniques could be more efficient. Although the virtual office is very flexible, it poses many difficulties for human resource employment. This involves scheduling interviews and selecting suitable candidates, and direct interview is avoided by rejecting people's resumes. Researchers can apply artificial intelligence to resolve these challenges, as artificial intelligence can facilitate many services interrelated with HRM practices [6]. Nowadays, organizations are implementing a digital recruitment system 3.0. The core of the shift is the application of AI in recruitment processes. With AI, managers can manipulate a large amount of data to find the correct candidate, and recruiters can verify whether a candidate's personality traits and standard resumes match perfectly. AI is impartial and considers every candidate equal when evaluating their applications [7]. The prevalence of AI recruiting devices is based on the idea that they help create a smooth process and attain enhanced quality and optimal outcomes with limited time and costs compared to human resources [8]. AI system revolutionizes recruitment tasks by replacing repetitive tasks conventionally performed by professional managers in the early times [9] – [10]. However, there may be conflicts of management among human and self-directed applications. For instance, inconsistency may occur if drivers communicate with artificial intelligence-related support. This enables experts to expand the communication between recruiters and AI in various fields of applications with the latest methodology. Shared control situations are described by the Competence-Availability-to-Act (CAP). The autonomy based on CAP is divided into many shared control scenarios within workspaces. The application of driving cars authenticates the importance of this strategy.

The work is organized as follows: section 2 gives a broader analysis and methodology in Section 3. The outcomes are presented in section 4, with a summary in section 5.

RELATED WORKS

During World War II, Alan Turing, a British Mathematician and computer researcher, invented the concept of AI. If an individual operating with a tool does not recognize whether they communicate with a tool, they would imagine it to be innovative. McCarthy and

his teammates proposed that the Rockefeller Foundation provide economic support to their research to explore the probabilities of intelligent tool instalment. In this proposal, the term AI appears first. However, a detailed definition of AI is possible [11]. AI aims to construct a system that imagines and reflects like humans, studying and executing tasks that need human intelligence. This aims to allow human actions to be performed by tools and memorizing, understanding, perceiving, thinking, making decisions, recalling, comparing, deducing, taking actions, and making suggestions [12]. AI also expresses the code in the nerve cells and how the human brain works. Identifying user cognitive workloads is frequently a fundamental problem for human-computer applications, mainly if the study concentrates on AI-based work. The processing capacity of humans is always limited because of short-term memory in the brain, so they often use the environment to relieve cognitive burdens. AI supports individuals in solving problems and transmits human cognitive efforts to the worldwide brain. Information systems analyze cognitive effort in individual-system communication to achieve personalization and adaptation. Some scientists apply consumer perception to study consumers' cognitive work burdens and differences. High-level AI facilitates consumers to work with reduced effort. Job searchers with professional experience were motivated to participate in roles in the screening scenarios proposed by [13]. According to simulated interviews, individuals in systems with higher AI support experienced low-level cognitive workload. As a result, AI contributes to minimizing the human cognitive burden.

The study of neural networks is interrelated to the method we usually learn. Initially, we complete a specific quantity of workload and verify it with a superior to do the work in an enhanced manner than the previous one. The original and identified values are used to find the difference between them; an error value is computed and acknowledged by the application. Errors are evaluated in every network layer and used to change the following input's saturation level and weight. If the predicted value is near the original value, then it indicates the error level is low [14]. As the network learns, errors are reduced with each execution. This process is called reverse propagation and is followed constantly on the network until the flaw value

reaches its extreme minimum. Initially, the input layer of the system is fed with new information. In the first and second, hidden layers compute the node score. The output layer computes the output value; by estimating the variation between the original and identified values, we can calculate the error score and return it to the network (back-propagation). In this method, as the system learns continuously, the flaw in the system is minimized at every execution [15].

METHODOLOGY

Recruitment process

The interview begins with recruiting a candidate, followed by human resource evaluation, abilities, performance verification, and direct personal interviews. If a candidate completes all rounds, the job is offered to the person who can handle the workload. At last, the candidates selected for the position are computed. The number of candidates and conversion rates (in percentages) of every phase of the recruitment procedure for new candidates are given. Analyzing Fig 1, experts can identify that the supply to the screening percentage and the interview to the offer percentage are minimal for new candidates. The candidates offered with the job were less in count compared to the laterals.

Correlation analysis

As shown in Fig 1, the results of the correlation experiment depict an outstanding positive correlation between indices and the days of employment. Consequently, performance levels will also increase when the organization's working time limit increases, and employees understand the organizational culture and work procedures. So, experts can presume that performance results also constantly enhance as the organization's tenure improves. Also, a noteworthy positive correlation exists between ability and performance scores. Experts conclude that ability score is prominent when hiring.

Table 1 Selection parameters

Parameters	Rating
Previous experience	-0.08
Employed	0.45
Score achieved	0.36

Table 2 Selection parameters

Factors	New employees performance	Previous performance
Training score	0.56	0.25
10th marks	0.10	-0.09
12th marks	0.20	-0.12
Graduation marks	0.15	-0.03
Score	0.10	0.25

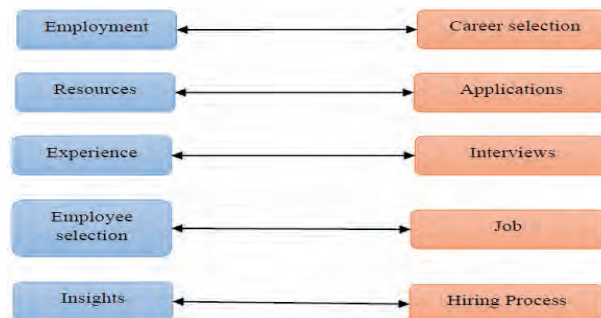


Fig. 1 Recruitment process

On the contrary, a negative correlation is examined between previous experience and performance ratings. However, it is not relevant, and we can ignore it. Table 1 shows that the correlation between training results and performance ratings is higher in new candidates, with 0.57, than in other candidates, with only 0.23. Recruiting new candidates and training fresh candidates can result in better performance. It was also found that the relative scores (speaking and aptitude tests) were positively correlated with the performance rate but were higher for the laterals than the new candidates. Thus, the reverse value cut-off scores can be increased for other candidates (laterals). Analyzing the organizational documents, we learned that candidates are recruited based on three sources: 25% through employee reference, 26% through consultants, and 24% through job portals. Data analysis shows that candidates chosen through consultants need to be considered adequate. The number of active and fired employees was calculated according to source information, indicating that consultants recruited the highest number of employees and that the firing rate (both voluntary and involuntary) was nearly 40 percent. The termination percentage was comparatively less in other sources, such as campus recruitment, job portals, and employee referrals. Thus, the organization can use these sources to hire employees.

With the conversion rates and correlation results from recruitment channels, we found that companies had opportunities to recruit more fresh candidates. To do this, they can target universities and can recruit in bulk. For high-quality new candidates' profiles, the recruiting team can consider the 10th, 12th and graduation percentages. The study found few differences in performance among employees with previous working experience, as explained in Table 2. Consequently, the organization suggests that when recruiting lateral employees, it should concentrate on candidates with a minimum of two years of previous experience. The significance of planning to construct a talent pipeline cannot be supported. The organization is responsible for recognizing and identifying complex roles, computing the number of vacancies, and analyzing the sources to target positions. We can determine the skills necessary for achievement in these roles based on the resumes of high-quality candidates. The organization can also evaluate both the internal and external skill pools. They must make significant efforts to develop relevant employer strategies to attract suitable candidates. It is recommended that companies maintain a unique storage space to store the entire employee profile to avoid inconsistencies and redundancies.

Table 3 Experience-based ratings

Experience	Rating	Employees
0 to 2	3.5	75
2 to 4	3.3	70
4 to 6	3.4	60
6	to 8	3.3
8 to 10	3.5	23
> 10	3.3	6
Total	3.4	274

NUMERICAL RESULTS AND DISCUSSION

Even though AI helps human biases, it can project decision-making, methodologies and datasets that influence AI. Decision-makers sometimes make spontaneous decisions related to a group of implicit preferences. Research into the decision-making process of artificial intelligence indicates that prejudices are one of the issues facing the development of AI. An artificially driven job ad systematically poses indirect bias. AI

requires facilitating recruiters with the capability to modify ads relative to factors like age, language, relationship status, gender, experience, and education. These described factors identify whether AI job advertising activities are biased or not. Discriminatory advertising reduces the opportunities for employment seekers in a diverse workplace and, to some extent, violates the right to equality. Organizations should facilitate intelligibility of the methodology progression procedure and program developer training to avoid unconscious biases. AI does not know partiality. During the execution of ML through artificial intelligence, human resource practitioners, or recruiters, irrelevant assumptions result in partial decisions. For instance, recruiters' previous decisions may cause anchoring partiality. Especially experts construct AI devices by scrutinizing current high-performance individuals to identify capable candidates' main competencies and skills. Earlier, some prejudices existed, such as education, age, gender, and race. These biases still exist in the high-performing companies that currently use them as a benchmark; algorithms would study these practices and perpetuate those prejudices.

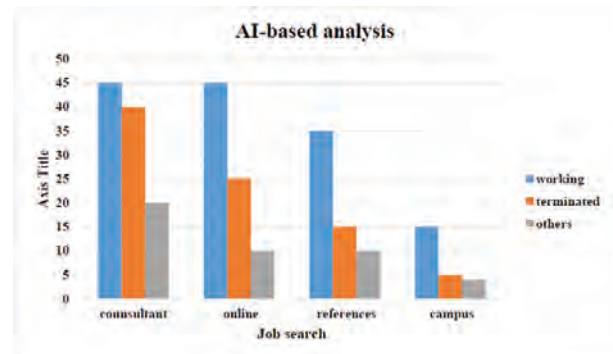


Fig. 2 AI-based analysis

Recently, Amazon's AI recruitment device has been reported to be biased towards women. Humans are the only source to create, develop, and train AI tools. The developer is responsible for constructing an algorithm with neutral factors like age, colour, ethnicity, race, religion, and gender. Because there was potential unconscious partiality in the early times, it is necessary to intentionally neutralize these prejudices by leaving AI to study and highlight novel methodologies to ensure that artificial intelligence employment devices are associated with human resource approaches. AI faces

a growing challenge of discrimination; organizations should guide non-discrimination laws to ensure that target groups meet recruitment necessities.

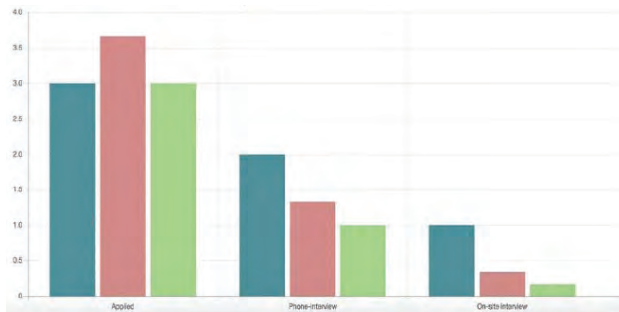


Fig. 3 Interview process

CONCLUSION

This research follows a method of application criteria attention. It evaluates and creates a methodology for using Artificial Intelligence devices in the employment procedure. The criteria for victorious employment based on AI are also proposed. Management's focus on AI employment, fairness, legal security, and price issues has been highlighted. Furthermore, this research shows that recognizing the cognitive task of users is the primary issue in the human-computer recruitment system. Analysis indicates that improved AI supports recruitment to effort less cognitively. To encourage human performance, manage online threats, and construct efficient automated aids, the research suggests considering integration and competition. The study also indicates that probable issues of shared control are present among human and automated employment applications. The communication between artificial intelligence and humans is expanded using state-of-the-art techniques during the recruitment procedure, which uses CAP to Act. Technical study, improved warning systems, and elimination of conflicts between human and AI tool intentions enhanced user consciousness of such contempt.

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Validating the Users' Facial Input-Based Attendance using Feature Extractive Vector Expression Classifier

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ABSTRACT

The application of recognizing and recording attendance with facial mask identification in an online system is presented in this research. The fundamental principle is to develop an efficient attendance application that depends on facial detection and facial mask recognition, which facilitates this as a browser interface in an online platform. This will permit everyone to utilize the application without installing particular software. Users must start the system's interface through the browser or any terminal. The details in this application permit users to record data quickly in a centralized online repository. Because face is employed as a biometric signature in this research, all registered users can load face image samples on their profiles. First, the training part of the model is carried out by the feature extractive vector expression classifier model (FEVECM) before face detection to develop a training structure that can achieve an accurate face detection mechanism. When evaluating the results, the pre-trained face recognition model achieved nearly 98% accuracy for face mask recognition.

KEYWORDS: *Face recognition, Feature extraction, Prediction, Mask identification.*

INTRODUCTION

The entire presence of participants is essential to achieving the program's objectives in the knowledge program. This is directly related to the educational procedure of the institution, and total presence is very significant to ensure that students are not left behind. According to [1], most institutions require a minimum attendance percentage. However, such principles are often not followed due to the issues existing attendance recording systems face. In the traditional process, the student's attendance is recorded manually by collecting the student's signatures in the attendance register [2]. In addition to the time spent obtaining signatures and preparing forms on hard drives, various other issues include possible loss or sheet damage. Many

applications are initiated for attendance measurement. The use of clicker and swipe ID cards is one of the methods used to track student's presence. Many types of research are implemented based on a similar context. One of them is the attendance management system based on RFID [3]. This technique is utilized to record students' presence; the chief objective is to minimize the time spent recording attendance. We have another method, an Android-based smart student attendance system [4], which has been projected as an online mobile solution for recording attendance quicker, cheaper and with systematic attendance reports. Another RFID application that integrates face detection has been developed to track approved students and count them when they enter and leave the classrooms. The above

application is very efficient, considering the present trends in which Android systems are implemented progressively [5]. The author proposed another type of Android system, which avoids long lines in registering earlier automated attendance procedures [6].

Several face detection techniques have been initiated, but many must be downloaded and deployed initially to the user's system. Therefore, to reduce the burden of customers like this, experts suggested that face detection systems can be accessed straightly without downloading or installing fresh applications [7] – [10]. We aim to construct online applications on web servers that are easily accessible from a terminal through a web browser. As for the facial mask detection function, a current system is the mask recognition system, which was structured based on the feature extractive vector expression classifier model (FEVECM) concept. This model is very similar to the use of face masks required at times of epidemic to avoid the spread of the virus-like Covid-19. The study considers the requirement to detect facial masks. It uses a similar face detection procedure, but the data processing improves slightly in terms of face recognition and detection of masks and optimizing time to record participation.

Based on the challenges mentioned above and some of the objectives we want to accomplish, the complete concentration of this research is to develop an online application for attendance records based on facial detection and facial mask recognition. The facial detection procedure known as the feature extractive vector expression classifier model (FEVECM) is necessary to recognize the student's ID to record the presence of students and facial mask recognition to detect the student's security compliance. Combining these functions into a system allows the application to identify a person's identity, whether they have exposed their face entirely or wear a mask. This proposed network-based application will enable users to easily record their activity through a web browser from any terminal without downloading or installing special applications.

RELATED WORKS

Several experts have tried initiating the most favourable facial emotion recognition (FER) system. Commonly, the principal techniques were facial recognition only

through machine learning (ML) or deep learning (DL). Major studies concentrate on machine learning techniques because DL is a modern approach not available in ancient times [11]. The deep learning approach poses challenges like increased calculation time and requires high speed and storage, whereas machine learning techniques only need some of these requisites. The probable associations are infinite because face recognition, feature identification, and categorization have all changed. Some studies have changed the methods for identifying features while keeping recognition and classification unchanged. Author Shan et al. initiated facial emotion recognition systems that recognize facial expressions using enhanced versions of the local binary pattern (LBP) and categorized them using a support vector machine (SVM). Shih et al. scientist Khan used linear discriminatory analysis (LDA) and SVM techniques and developed an LBP-pyramid integrated with support vector machine classification [12]. Jaffar executed a local binary pattern associated with the Gabor filter. All the methods mentioned above are constructed with a machine learning approach, where the entire face is recognized, and then, gradually, all the other novel models are implemented in facial recognition. Few researchers aim to split the facial images instead of taking them as a whole and modifying their extraction model. The author employed facial classification to divide the mouth and eyes of the face earlier to the application of histogram-oriented gradient (HOG) characteristics and categorizing the image with a support vector machine. Patch-based Gabor filter is used by the author Chen et al. following the segmentation of the face into various parts.

Several other experts have associated various extraction techniques with enhancing the speed and reducing the computation time. To extract the features of the face, local binary pattern and Histogram oriented gradients are integrated [13]; then, to reduce the computational time and to increase the speed, a Principal component analysis (PCA) is applied, and finally, a support vector machine is employed for classification purpose. Some experts suggested deploying deep learning models instead of a machine learning approach. Mollahosseini et al. applied deep neural network (DNN) application. As mentioned above, there are various combinations of

facial recognition systems; however, their exactness is quite competitive. This enables many experts to change the different pre-processing methods, such as histogram equalization, resolution enhancements, spatial direction, colour conversion, etc. The pre-processing of the facial image before the feature extraction and the categorization phases are the main focuses of the technique used in this study. The categorization is divided into three distinct stages, consisting of binary comparisons based on the situation and the requirement. In the earlier research [14], the authors used histograms of gradients for the feature extraction procedure. 3-dimensional facial emotional recognition was evaluated in some other studies. A dictionary-based method for facial emotion recognition was utilized in the study. Learning vector quantization and Gabor filter wavelets are applied in the research. In another study, facial emotion recognition integrated with contourlet transform is employed. Shape deformation information is used in the work. SVM was associated with FER. A convolutional neural network (CNN) was utilized in the research [15]. The authors of the study reported a pair-wise feature selection process for classification. Another research uses multiple CNNs. A prototype model for facial emotional evaluation was applied. It is also employed with curvelet transform. Line-based caricatures are emphasized in FER. Extended local binary patterns are used with FER based on covariance matrix transform. The distance between the features present in the three-dimensional facial images is used. Systematic facial detection with significant facial patches was introduced in the study. Analysis of fisher discriminant was implemented. Some other studies employ segmented facial regions in FER.

METHODOLOGY

Cropping

The upper border was the only one that remained unchanged. Here, the choices were to edit and crop the facial image with the face's forehead included or crop it without it. Testing was required to make this decision because the forehead was confused, and it was unclear if it added anything to the emotion or was just excessive. Once along with the forehead and again after removing the forehead from the face, the system was tested. Two types of datasets are applied for testing: JAFFE and

CK+. The analysis shows that the forehead is necessary for recognizing facial emotion and should be included in the face to identify the exact emotion, as shown in Table 1. Emotions like depression and irritation are determined using the face recognized along with the forehead.

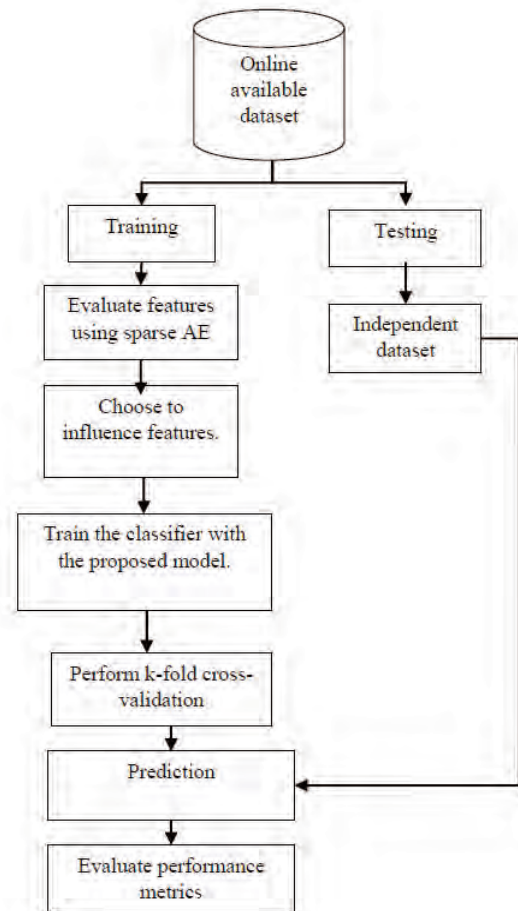


Fig. 1 Flow of prediction model

Prediction

The overall framework of the proposed technique is given in Fig 1. The dataset images are split into two blocks, one for testing and the other for training. The image count in each dataset changes based on the various authentication approaches implemented. Each dataset image undergoes a few pre-processing steps before being subjected to feature extraction and facial detection. Support vector machine classification is then used to classify the features. The dataset to be tested passes through the same procedure as the trained dataset

once the method is taught; in the end, the outcome is determined by comparing the features taken from the image with the FEVECM classifiers.

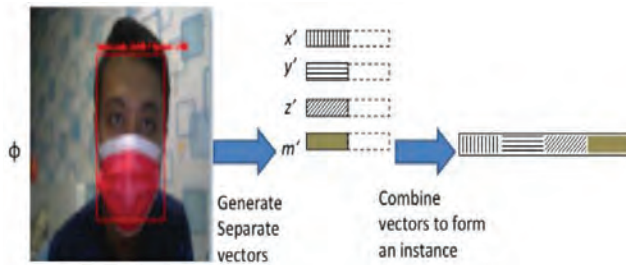


Fig. 2 Proposed classifier model

Fig2 describes the feature extractive vector expression classifier model (FEVECM), which has two parts constructed in three stages. Every step serves a distinct purpose in achieving the desired outcome. Twenty-one support vector machines are included in the first phase of the network. Each of the seven primary expressions is compared to another, creating a distinct binary support vector machine. Equation 1 displays the number of probable combinations that can result from the binary comparison, where all possible binary outcomes can be found by choosing two emotions from the total expressions. Each emotion has a counter that estimates the occurrences of the expression by analyzing the FEVECM results. There are twenty-one various outcomes from the support vector machines displayed above. After calculating the occurrences, the results are compared between the counters and one of the following conditions is met.

$$X_2^8 = \frac{8!}{2!8!} \quad (1)$$

If the output contains one of the emotions many times, then the resulting outcome contains this emotion. If two emotions occur equally in the final result, these expressions are sent into the next stage (Stage 2). Stage 2 comprises a single support vector machine trained with the above two equally happened expressions. These two expressions are compared again, and the final result is produced. Three expressions move on to the next step 3, Stage 3, if they appear equally at the outputs. Like in stage 2, all possible combinations between the three emotions are represented by three support vector machines in stage 3. The occurrences are counted using

the same methodology as the FEVECMs. The output of this step is then used to determine the outcome in the end.

NUMERICAL RESULTS AND DISCUSSION

This discussion section will outline how the study was implemented as a server application, along with the findings and an analysis of those findings. The accuracy equation is utilized to compute the exactness of facial detection, as in [2].

$$X_2^8 = \frac{8!}{2!8!} \quad (2)$$

The sensitivity equation is applied to compute the sensitivity of facial identification as in [2].

$$X_2^8 = \frac{8!}{2!8!} \quad (3)$$

The precision equation calculates the facial identification precision as in [3].

$$X_2^8 = \frac{8!}{2!8!} \quad (4)$$

Where TP indicates true positives, FN represents false negatives, FP indicates false positives, and TN represents true negatives. The accuracy of the mask recognition procedure was determined from the twenty-four synthetic dataset samples of face mask recognition samples that were gathered, as indicated in Table 1, using Eq. (2) to Eq. (4).

Table 1 Accuracy comparison

Approaches	Accuracy	Precision	Recall	F1-score
HOG	92	93	94	95
SVM	94	95	96	96.2
LDA	95	96	97	96.9
SVM	79	80	82	85
LBP	91	92	94	95
PCA	92	93	95	96.2
FEVECM	98	98.5	99	99.2

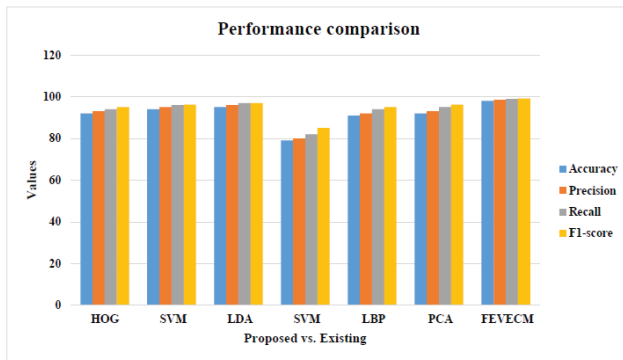


Fig. 3 Performance comparison

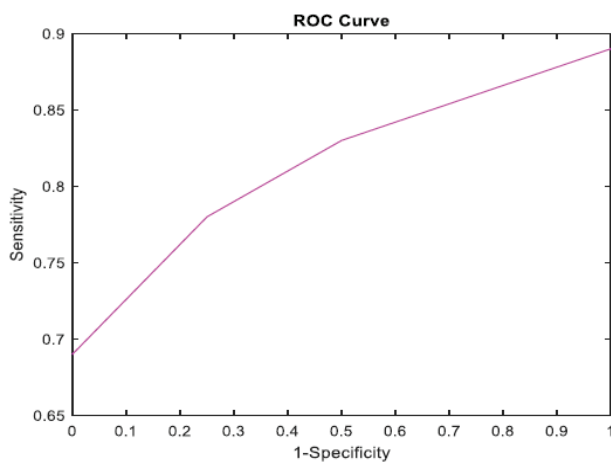


Fig. 4 ROC comparison

Table 2 K-fold validation comparison

Approaches	10-fold	5-fold	3-fold	2-fold
HOG	92.5	94	94.5	95.1
SVM	94.8	95.5	96.7	97
LDA	96	96.2	97.8	97
SVM	81	81	82.5	86
LBP	92	93	94.5	96
PCA	93	94	96	97
FEVECM	98.5	98.6	99.1	99.5

Based on testing and analysis, the system's accuracy is computed to be 98% for face detection and 80% for face mask identification, which is also the sensitivity value for face mask recognition. With the previous computation, the precision score for face mask recognition is 100%, a respectable degree of accuracy. More data, including synthetic data, might be needed to feed it to increase the recognizer's sensitivity, accuracy,

and precision and enable more accurate face and mask recognition. The primary goal of this system is to use a webcam to recognize faces and record a user's presence or attendance online via a browser. A data repository was created for this record maintenance to accumulate all the captured information. This comprises the customer's username, the time of the submitted image, and whether or not the user is wearing a mask. The repository interface was created rapidly because this is just an early prototype.

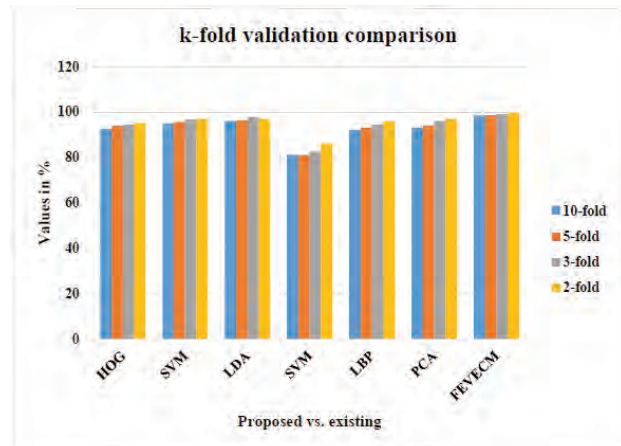


Fig. 5 K-fold validation comparison

CONCLUSION

The project has accomplished its intended goals. To begin with, a working prototype application for online attendance tracking was created. This system uses facial biometrics to identify users. Because this system is web-based, users can access its interface from any browser on any terminal. As a result, the user is relieved of needing to install specific applications. Making it possible for users to be recognized whether or not they are wearing masks is one of the goals of this system. Because of this, the sample datasets used to train the FEVECM face recognition model included both the synthetic images for the essential face mask function and the actual images of the user's face. For testing and analysis, nearly 200 data points of the user's face were successfully collected. It has been determined that this system has certain limitations. For instance, the accuracy of facial recognition and face mask identification processes will be lowered when the sample size of user face information is inadequate. As a result, additional user-face data samples are required

to obtain higher accuracy. In summary, the research effectively generated an application that facilitated the process of taking attendance more rapidly and efficiently. Additionally, it monitored public safety by implementing mask recognition to halt the spread of the Covid-19 virus.

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Deep Learning Approach of Speech Emotion Detection

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ABSTRACT

For detecting emotions from human speech in contact centres, automated translation systems, innovative healthcare, driving, and human-machine interface, Speech emotion recognition (SER) systems are employed. Discriminative acoustic feature extraction, which affects classifier performance and shortens processing times, is the most significant and essential stage in the standard SER technique. SER systems designed for real-time deployment are limited by the accuracy and capabilities of the manual acoustic features currently in use. In an attempt to address the shortcomings of handcrafted features, several deep learning (DL) algorithms have been developed and applied for automatic feature extraction in emotion prediction from speech emotion in recent years. A review study has yet to be carried out that assesses and enumerates the benefits of diverse DL techniques for SER. This study targets to offer a thorough overview of DL approaches, together with information on their advantages, specializations, and limits for SER. Performance measurements, speech processing methods, and publicly accessible emotional speech databases are all included in this review study.

KEYWORDS: *Deep learning, Emotion, Detection, Signal processing, Feature.*

INTRODUCTION

A speaker's gender, emotions, language, accent, and other distinctive qualities can all be learned from speech signals, which are helpful tools for communication. Thanks to these unique features, researchers can infer speakers' emotions over the phone, even when they are not physically present [1]. These traits enable robots to learn the emotional expressions of speakers like what humans are capable of. Because of this, many researchers are concentrating on speech SER or the technique of utilizing speech signals to predict people's emotional states. Research on SER is crucial for several uses, including voice-activated innovative healthcare that recommends treatments according to the patient's emotional state. Because the in-car SER

system can detect the driver's emotional state and apply the necessary safety precautions, SER is also beneficial when operating a vehicle [2]. It is also used in various contexts involving human-machine contact, call centres, and automatic translation systems. Several machine learning (ML) classification techniques are used in these fields of study to identify emotions, including sadness, happiness, and rage [3].

Previous SER research can be categorized according to several data types that predict human emotions. These consist of speech signals, facial detection, and live streaming of videos or conference calls. A video-based method for identifying emotions uses a stream of captured video, picks out frames linked to specific emotions, and then uniformly samples these frames to

recognize emotions [4]. In daily life, computer programs are needed to carry out the capability of determining a person's emotion from their facial expression [5]. To identify human emotions from facial expressions, discriminative features from image datasets must be extracted, a master feature vector must be created, and an ML algorithm must be trained. However, light variability can impact human emotion recognition from streaming video, resulting in poor results because of visual disturbance of emotion-associated frames [6]. Furthermore, capturing the appropriate mood while creating an image or video database takes a lot of time. Conversely, audio-based methods offer greater advantages for SER systems in real-time. Additionally, SER systems are affordable and independent of language [7] – [8]. The several stages ML classification systems go through to identify emotions from audio data.

1. The input signals is an essential component of developing a trustworthy and efficient speech recognition system. Pre-processing of the signal consists of filtering through filter to restrict the speech signal's range, pre-emphasis, noise reduction, and silence removal in addition to using N samples to frame the speech signal. Computational time is also decreased when the silent portion of emotional speech signals is eliminated.
2. Employing numerical data for model training, we construct a feature vector from segmented data and extract the traditional handcrafted acoustic properties.
3. Choosing properties for the feature vector which will be used to train the DL classifiers a step in the feature selection process. Furthermore, feature selection techniques are frequently used to optimize the characteristics collected from step 3 to the most essential features for SER. Efficiency is increased and classification mistakes are decreased.

The work is organized as: section 2 gives wider analysis of prevailing approaches. The methodology is elaborated in section 3. The numerical outcomes are provided in section 4 and summary in section 5.

RELATED WORKS

The area of deep learning (DL) has gained importance in machine learning (ML) as it is a subfield that retrieves

significant features from input data. Deep is the process of learning properties hierarchically across multiple layers of artificial neural networks [9]. It has grown to be a significant study area for natural language processing, object identification, image classification, human gait recognition, and human activity recognition for video surveillance. Recently, SER has seen the application of numerous DL techniques. These techniques include recurrent neural networks (RNN), deep auto-encoders (AE), convolutional neural networks (CNN) and restricted Boltzmann machines (RBM) [10] – [12]. By layering several DL approaches, models with enhanced resilience, flexibility, and improved classification performance can be built without depending on conventional expert-driven features.

Research in the developing domains of signal processing and DL has been underway for many years. Since patterns in speech signals can distinguish between different languages, image-related features for language classification were proposed by [13]. Next, CNN was fed features generated from images to classify Malayalam, Telugu, Tamil, and Kannada languages. ADL framework was created by [14] to identify movement and breathing-associated sleep problems using electrocardiography (ECG) and electromyography (EMG) signals. A study on speech-based features, machine-learning-based classification techniques, and databases was given by [15]. The authors of the surveys and extractor toolkits highlight the SER system. Still, they did not discuss DL methodologies, their modifications, features, advantages, and disadvantages, or the optimization, evaluation, and training of DL models or implementation frameworks. The advantages and disadvantages of using acoustic speech features were also disregarded. The previous section highlights the need for an in-depth analysis that summarizes the body of research on SER through DL methodologies. This work aims to analyze SER systems that used DL approaches for feature learning. In addition to the training process, features of SER benchmark databases, performance evaluation metrics to assess DL technique performance, and widely used frameworks for DL application, the current paper provides a taxonomy of recent research on DL-based SER [15], a thorough overview of DL methodologies, and an analysis of the benefits and drawbacks of these approaches. Based on the examined studies, this study

also addressed observations, unanswered inquiries, and areas for future research that need further investigation and development.

METHODOLOGY

Dataset

42 non-professional people from 14 countries (32 men and 8 women) make up the eNTERFACE'05 Database. Every emotive word that was said was spoken in English. Six short stories in a row, each evoking a different feeling (fear, anger, sadness, joy, surprise, and disgust), were required of all participants. Technically speaking, the speech utterances were recorded using a premium microphone designed explicitly for voice recordings. The subject's mouth was around 30 centimetres below the microphone. Furthermore, the emotional outbursts are 48 kHz sample-rate stereo uncompressed 16-bit recorded.

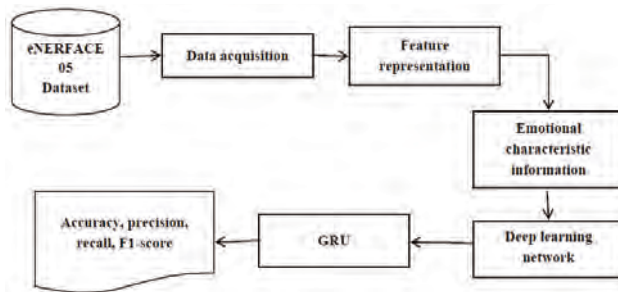


Fig. 1 Flow diagram of the anticipated model

Prediction

The limbic system in humans can perceive implicit emotional characteristic information. A part's ability to perceive emotions indicates that the implicit attribute information associated with those feelings is also present. Simultaneously, the fact that different sections perceive the same feeling implies that these parts share some structural similarities. This information is used for the development of an implicit emotion attribute classifier, which simulates how the human brain perceives emotions. As a result, Table 1 shows how an implicit attribute binary classifier was developed based on whether or not certain regions' perceptions of particular emotions are related. For instance, it is thought that while some feelings, like neutrality and sadness, lack an implicit quality, strong emotions such as happiness and fury do. The human frontal brain

senses these emotions. Consequently, the classification label for joy and anger specifies 1 in the binary classifier for attribute whereas the label for other emotions is set to 0. This work defines four implicit features together with the corresponding classifiers and introduces four distinct parts.

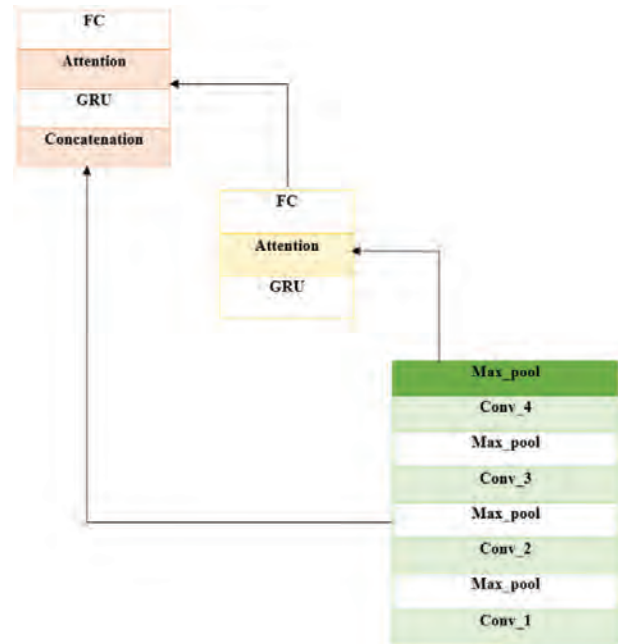


Fig. 2 Network layers

Table 1 Dataset attributes

Attributes	Regions	Label 1	Label 0
A	1	Happy	Neutral, anger and sad
B	2	Angry and sad	Neutral and Happy
C	3	Sad	Neutral, angry and happy
D	4	Angry and happy	Neutral and sad

This study simultaneously trains speech emotion classifiers and four implicit attribute classifiers using a multi-task learning approach. The implicit emotion attribute binary classifier job's failure is why the model has a preset weight's total loss. Moreover, this paper adds implicit emotion attribute information to the network, enhancing the network's capacity to differentiate between different emotions. This is accomplished using the human brain's organized network properties

for emotion recognition. Fig [] depicts the network's specific structure. The network comprises four implicit emotional attribute categories, four CNN layers, an attention layer, and a gated recurrent unit (GRU). The obtained features are then fed into successive CNN layers. Finally, an emotion attribute classification network comprises the attention layer, and GRU provides input to the network. The binary classification network's attention layer and the final CNN output are combined to form the final emotion classification network's input. The emotion that the model predicted is acquired after categorization. Utilizing the cross entropy loss function, the network training is optimized. The network's attention layer allows it to extract implicit emotional attribute information, simulate how different brain regions are sensitive to other emotions, and reflect how the limbic system's internal structures differ.

NUMERICAL RESULTS AND DISCUSSION

The most often utilized evaluation metrics are the confusion matrix, ROC curve, recall, accuracy, and precision. Thus, the emotion can be classed as True Positive (TP), True Negative (TN), False Negative (FN), or False Positive (FP) based on how well the classifier predicts it. The sources of further evaluation measures include TP, TN, FP, and FN. The following is a discussion of these metrics:

Accuracy: This performance metric is highly favoured because it can supply all properly anticipated instances from feature vector. The computation involves dividing the total number of accurately predicted cases by the total number of cases. Eq. (1) presents the accuracy formula.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

However, if the database contains different utterances in each class, the classifier's accuracy may need to be more accurate due to either over-fitting or under-fitting. To overcome this problem, confusion matrices are therefore utilized to illustrate intra-class performance and depict each class's performance. Confusion matrix: It gives the total misclassifications for every class in SER. Table 2 shows how the performance metrics

represents actual classes as rows and expected classes as columns created by classifiers. Here, FP denotes the proportion of similarly classified emotions wrongly classified and classed as "B." In contrast, TP denotes the proportion of correctly diagnosed emotions in the "A" class that are classified as "A." Comparably, FN denotes the proportion of incorrectly predicted emotions in the same class that is classified as "A". In contrast, TN is the proportion of correctly anticipated emotions in the "B" class categorized as "B".

Table 2 Metrics comparison

Approaches	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
DNN	95	89	90	89.8
CNN	96.1	90	91	90.2
KELM	93	92	92.4	91
Data augmentation	94	89	89.8	90
MobileNet	94	77	77.5	78
VGG16	97	75	75.9	76
ResNet	98	65	66	65
Proposed	99	98	97.8	97

The precision can be defined as the ratio of projected negative instances to positive instances. Usually, the precision measure is used to calculate exactness. The FP rate decreases as accuracy values increase. Furthermore, specificity is another name for precision. The performance of correctly categorized cases as positive examples is calculated by recall, sometimes called sensitivity. The mathematical depictions of recall and precision are shown in Eqs. (2) and (3), respectively.

$$Precision = \frac{TP}{TP + FP} \quad (2)$$

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

To assess how well DL techniques perform, employing a performance metric that considers how accurate and comprehensive the methods are can be helpful. Thus, researchers have used the F1 score metric to accomplish this purpose.

$$F1 - score = 2 * \frac{precision * recall}{precision + recall} \quad (4)$$

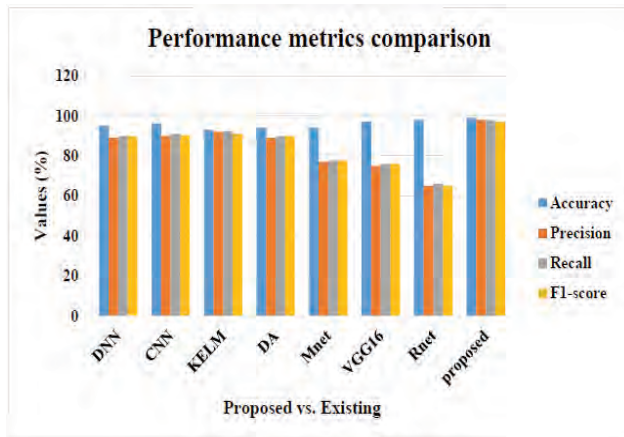


Fig. 3 Performance comparison

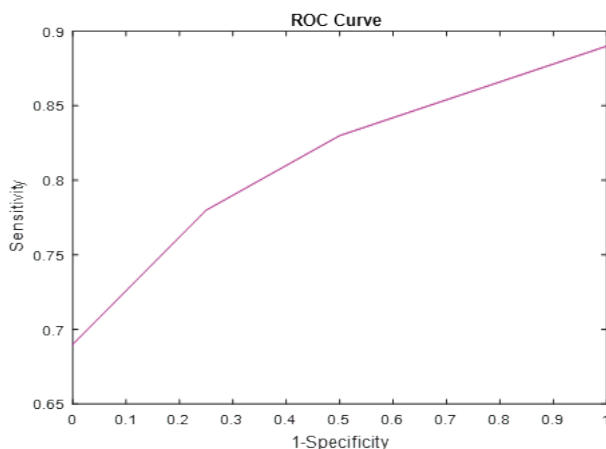


Fig. 4 ROC comparison

The precision and recall yields the F1 score, primarily used with unbalanced databases. Equation (20) presents the equation for the F1-score. By plotting the recall, sensitivity against the false positive rate (FPR) and computing the AUC, one can utilize the ROC curve to assess how well a DL technique performed. A way to evaluate how well DL approaches perform for each class is to look at the ROC measure. The mathematical formula is given, and the FPR can be found. AUC values below 0.5 indicate poor performance; if the AUC value is close to 1, the classifier operates appropriately. This measure, however, might not be suitable for an imbalanced database, which is a frequent SER that uses DL techniques.

CONCLUSION

The use of DL methods for SER is growing in popularity. The complexity of massive speech emotion databases is beyond the capabilities of ML, and advances in computation technology have led to this situation. This review study assessed speech processing, DL methods, and traditional features for automatic prediction of SER. Pre- and post-processing speech signals are essential in designing and developing a robust and effective speech recognition system. It is best to use continuous auditory signals including pitch and fundamental frequency to distinguish speech emotions from excitement. Furthermore, integrating information can enhance the task's classification accuracy. Lastly, there are numerous avenues in which further research can be pursued. The importance of context in speech emotion research, how DL integrates the SER system with smart applications and the usage of the SER system in combination with automatic speaker recognition are a few examples. In a broader sense, the insights obtained from examining diverse DL methodologies are offered in this piece. They may prove beneficial for future advancements in DL and SER systems architecture. We want to use DL techniques in the future to conduct meta-analyses on the research published on SER.

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Human Resources Super Visualization System for Salary Automation

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ABSTRACT

A manufacturing organization must confirm that new hires' service work is accurate. Research is regarded as lacking in effective approaches for automatically evaluating a newly hired employee's performance. The principal objective is to create an advanced learning model that can be utilized for the automatic assessment of an individual worker's job. To provide a solution that allows for the evaluation of the activities of solo workers, the proposed approach employs multiple linear regression with Bayesian tree model (MLR-BTM) together with a product from a particular company which is used as an own-created dataset. Without using any scripts or guides, data were gathered from a manufacturing cell that was in operation. The findings show that the created model can accurately assess whether the work process is correct. The model outperforms the prevailing techniques currently used for identifying work activities in manufacturing in terms of accuracy. The suggested two-stage method produces 96% and 97% recognition accuracy by removing the object from the reference frames using MLR-BTM after first utilizing regression to identify the proper graphic instruction for a certain employee's behavior.

KEYWORDS: Salary, Automation, Human resources, Visualization, Prediction.

INTRODUCTION

Managers nowadays must use more automated work support and training technology to boost product quality and worker productivity in manufacturing organizations for worker-performed operational responsibilities. Furthermore, the ongoing turnover of workers especially specialists is a challenge that production companies face [1]. For this reason, it is essential to provide new hires with specialized training and potential verification. Employees with experience must constantly participate in the training process, which takes time. The motive behind this research project is to create an efficient tool that manufacturing organizations may utilize to streamline the initial

training while reducing expenses and labor hours [2]. This is a significant issue when doing specialized maintenance work at a certain location. The search for an automatically built scenario that teaches new work activities based on available specialized knowledge was therefore defined as the research challenge. This scenario would teach workers to do a particular activity without expert involvement [3]. Automated activity tracking and assessment are crucial for accurate and timely diagnosis of high-quality work, especially during the early training phase. Even with a video system, it is almost hard to locate and gather evidence of incorrect actions [4]. The recognition of human activity (HAR) has been developed through several research studies

that use classifiers, which include principal component analysis (PCA), K-nearest neighbors, linear discriminant analysis (LDA), deep learning techniques, support vector machines (SVM), random forests, and the hidden Markov model [5] – [6]; The findings of these studies are encouraging; for a more comprehensive summary [7]. Object and video identification using deep learning has also been successfully achieved [8]. Deep learning can learn from unlabeled, raw sensor data. Video analysis, viewed as a series of separate images, is intimately associated with image recognition and analysis processes. The features taken from each frame are used to calculate the probability of a class [9]. Convolutional neural networks (CNNs) are remarkably effective at a wide range of tasks, including the recognition of images and videos [10]. A series of linked processing units, or neurons, comprise the CNN network's architecture. The output data from one neuron is used as the input data for the next neuron in the chain where $n \in N$ represents each neuron's weight and $X = (x_1, x_2, \dots, x_n)$ represents the same threshold or bias, respectively, $W = (w_1, w_2, \dots, w_n)$. Sub-layers like convolutional layers, are created by combining processing units into layers. This type of network depends on an image's intrinsic, stationary properties, such as the ability to apply data taken from one segment to other parts and the consistency of statistics across all areas of the image.

As previously mentioned, our method combines four novel algorithms regions with multiple linear regression with Bayesian treemodel to automatically verify the job being done by a new employee at a company. In the first stage of our system, motion data from the workplace was collected using video cameras. In addition, a reference film from the workplace is being used to generate a repository of graphic instructions for this workplace. After identifying the object and frame references, multiple linear regression with Bayesian treemodel will be utilized to extract the attributes of these frames from the reference video footage. The next step is to generate the dataset and compute the reference frames depending on the later stages of the task. Next, regression model was used to compare the work that a new employee had finished (the tested video sequence) with the reference frames that had been previously supplied. The traits and components found in the test material frames were then compared to those found in the previously created work

database. Inconsistencies in duties completed at work are quickly identified, and the instructions are removed based on the comparison findings.

The works plan is provided in a way that the existing researcher's predictions are discussed. The proposed regression model is explained in section 3 with the related outcomes in section 4. The work summary is drafted in section 5.

RELATED WORKS

This study assesses the work behavior of a unique single-worker manufacturing cell using deep learning and autonomously generated instructions. Utilizing created HAR solutions is one highlighted research niche for ambient assisted living, sports injury detection, rehabilitation, smart home environments, and elderly care. These investigations can be carried out as a system component that permits a manufacturing organization to continuously monitor employee activities. There are two forms of HAR: sensor-based and video-based. Video-based HAR examines images or videos, whereas sensor-based HAR examines data from a gyroscope, an accelerometer, mobile sensors or Bluetooth [11]. As part of our approach, we capture work at a particular workspace and use the footage as a reference for our videos. Each service activity carried out by a new employee must be evaluated by retrieving the reference feature and object from the data or the reference video sequence. The objective is to compare the objects and features of the tested video sequence or test material frames [12]. Because of this, our method needed to incorporate classifiers in addition to CNN. Several research initiatives have attempted to provide dependable and practical features by combining CNN with classifiers.

Disease diagnosis, image recognition, auto component diagnostics, target detection, image classification, facial recognition, car color recognition, stock market predictions, and animal species identification are among the applications for CNN and SVM. Since monitoring gathered time series data is a challenging task, data processing can use symbolic aggregate approximation (SAX). Time series data are separated using SAX. Classifying time series according to distance measurement compression may also be utilized to identify anomalies, examine set differences, and

display bitmaps. Furthermore, SAX may be applied to 2D form matching, time series rule discovery, arbitrary length motivation discovery, space-time linkage creation in trajectories and pattern recognition in robot sensors. For use in various data mining methods, SAX effectively reduces high-dimensional time series data [13]. However, feature extraction activities are beyond the capabilities of SAX. An approach for identifying temporal data that combines compressed learning (CL) and dynamic time warping (DTW) was proposed by [14]. DTW is applied as a network convolution layer data filter and distance measure to generate more effective CNN feature extractors. Human motion animation, speech recognition, time series, and categorization of human activity are some of its uses [15]. To anticipate the remaining useful life, the method additionally uses artificial neural networks and DTW. The computation needed by DTW to determine the optimal time alignment path is usually very large, which restricts its use in real-time monitoring systems.

The short-term, long-term memory (LSTM) is employed in many different applications, such as binarization, image labeling, video sequence analysis, texture analysis, time series processing, speech recognition and traffic forecasting. Network traffic anomaly detection is another application. LSTM can also be used to analyze images and their objects. This architecture is used in the literature to simulate pedestrians and analyze specific body parts. LSTM also shows major potential for object detection and image classification by simulating spatial dependencies and analyzing contextual data. Our method is comparable to the related model; however, employing classifiers (CNN + R-CNN and NNC + SVM) in place of just CNN, we monitor the activities of individual workers in manufacturing using video. We believe that [15] integrates diverse, unsupervised feature learning approaches, a deep learning algorithm, and expert knowledge in areas that require further research. To assess and oversee a new hire's performance, we utilize CNN, SVM, and R-CNN in conjunction with pre-recorded video content and workstation instructions. A framework for categorizing image areas and object detection is R-CNN [16]. The deep learning approach that is being described entails both support for the control process and the gathering and formalization of specialized information unique to

the organization. Since the tasks in this research were taken from a specific organization—the maintenance of a solid-fuel boiler—and were seen on camera in an actual workplace, we think the results presented in this study are exceptional.

METHODOLOGY

Dataset

Aspects used to estimate salaries fall into three categories: incumbent traits, occupational characteristics, and organizational aspects. The type of economic activity is the main distinguishing characteristic of organizational aspects. The International Standard Industrial Classification of All Economic Activity, Revision 4 (ISIC4) provides a simple and thorough list of all economic activity kinds. It is used to record the characteristics of each firm in an economy for a prediction model. Similarly, the International Standard Classification of Jobs (ISCO-08) is used to build a comprehensive list of all jobs within an economy. Lastly, the experience and educational background of the incumbents round up their qualifications. Nonetheless, it has been established that other variables, like gender and immigration status, affect salary levels. We prioritized occupational variables over incumbent traits to minimize feature duplication in the prediction model. For example, advanced labor necessitates a greater level of education or expertise. On the other hand, an educated worker does not receive the highly skilled labor wage from basic employment, which requires low-skilled labor.

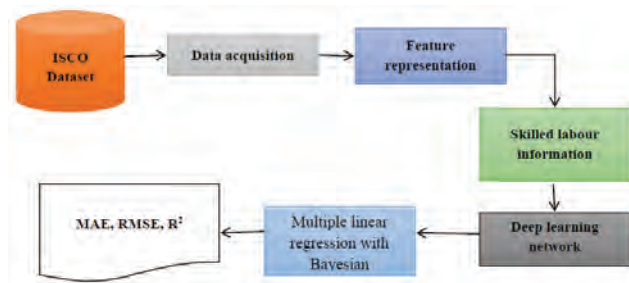


Fig. 1 Flow diagram of the anticipated model

Prediction

Our research aims to estimate average earnings across all economic activity and occupational categories. Because of this, our objective is to map compensation

levels across industries and firms rather than to predict future salary changes. Consequently, we used statistical machine learning to assess regression models for multiple linear regression with Bayesian treemodel. In the following two sections, the effectiveness of each regression model is evaluated using R-squared (R^2), mean absolute error (MAE) and root-mean-square error (RMSE). Let n represent the total number of observations in the training set, v the number of confounding factors predicting Y , and X the number of confounding variables affecting Y 's level. If Y is the average yearly wage for a certain occupation across all economic sectors then:

$$Y = f(X_{ij}) + \epsilon \quad (1)$$

Where, the v^{th} confounding variable is denoted by $j = \{1, 2, 3, \dots, v\}$ and the i^{th} observation is denoted by $i = \{1, 2, 3, \dots, n\}$. Consider that ϵ represents random mistakes which cannot be decreased by raising $f(X_{ij})$. A matrix X has dimensions of $n \times v$. The wage design used real salary data, is outlined. The mapping function that reads the data to prepare for ML-supervised training is shown in the following column. The survey data requires two mapping functions. The first step is to map current job names to unit-level occupational classifications. This is made easier by an index that links occupational groupings to names often used in job markets, as found in the ILO's ISCO-08 document. The second stage is to match organizational features to a category in the economic activity classification of ISIC4. Furthermore, based on the number of employees, the organization's size is separated into three categories: small, medium, and large. The mean or median salary for a certain sector in a given year, or even for all sectors in the same year, is a continuous variable from which the total yearly wage for the incumbent data is generated. The various sizes of the training data sets provide the chance to investigate the performance of the five machine learning regression models utilized in this study. Do certain models perform better with larger training datasets? What happens to performance when there's not as much info available? Furthermore, 15% of each data set was randomly chosen to serve as test data for the two models and to be excluded from the training set. The purpose is to evaluate the models using previously unknown data from the training approaches.

This makes it possible to confirm that test and validation data perform consistently.

NUMERICAL RESULTS AND DISCUSSION

Several regression models based on statistical ML were used to determine the average annual wage across all economic activities. Table 1 presents the findings demonstrating that MLR-BTM is a considerably better approach than MLR. To adjust the hyper-parameters of each regression model, experiments were conducted with the number of layers and nodes in the ANN, the amount and size of leaves in the TBR, and the types of kernel functions in the bayesian regressions. Table 1 show only the best-performing models and their individual model hyper-parameters. Top-performing Up to 98% of the response variable's variability can be explained by factors related to economic activity (R^2 for Bayesian ML). Gaussian process regression had the lowest RMSE and MAE. Fig [] shows the expected and actual response variables. The values are generally consistent except for a few data points where the true and projected values differ significantly. Additionally, with a few significant exceptions, the bandwidth for residual values in the residuals plot is largely constant. All regression models experience the same model improvements since the test data's performance in Table 1 is either better or equal to that of the validation data.

Table 1 Prediction models evaluation

Model	Validation			Test		
	R^2	RMSE	MAE	R^2	RMSE	MAE
MLP	0.55	8700	4000	0.60	8700	4300
ANN	0.96	1900	630	0.89	1300	560
Bayesian	0.96	2100	580	0.87	2080	570
SVM	0.95	3200	640	0.89	1400	530
MLR-BTM	0.98	1880	480	0.99	1490	520

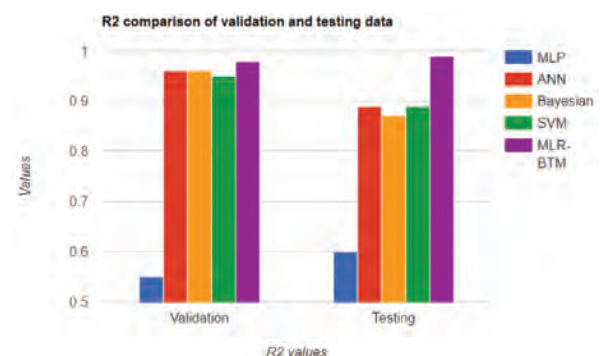


Fig. 2 R^2 comparison

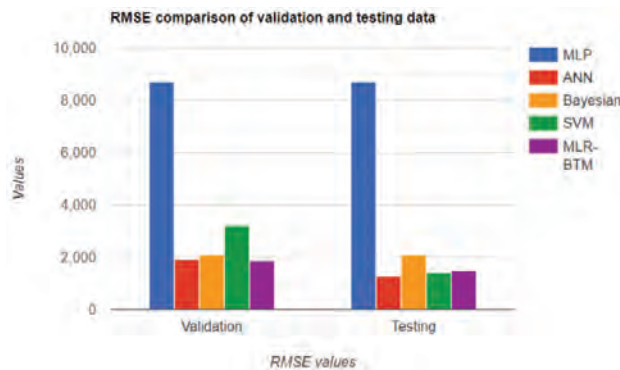


Fig. 3 RMSE comparison

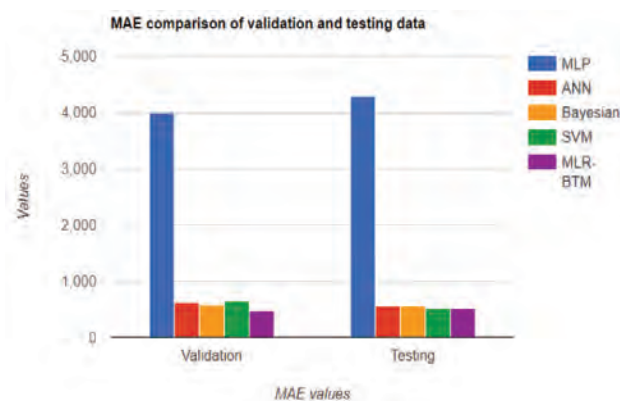


Fig. 4 MAE comparison

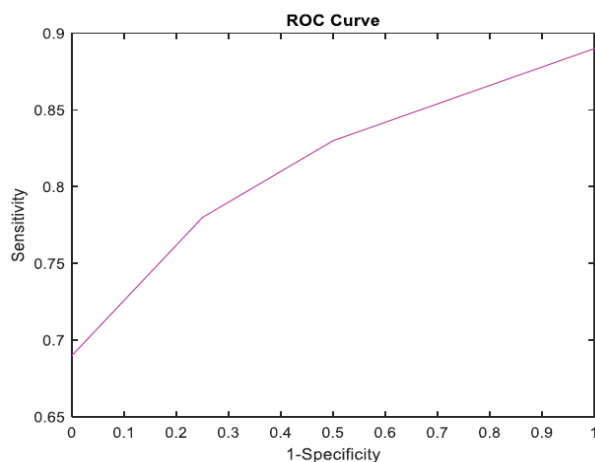


Fig. 5 Actual value vs. predicted value

Table 1 indicates that among the major occupational groupings, ANN had the highest predictive accuracy of mean annual pay with R^2 of 99%. However, the ANN model was less successful on the test data than Bayesian ML utilizing the Gaussian process regression. Fig [] shows the top-performing ANN model's actual

and anticipated compensation values. Nonetheless, the performance of the regression across economic activities is not as important as the differences in the nonlinear regression models. Table 1 illustrates how badly SVM and ANN performed using the smaller training set. There are also significant variations in the goodness-of-fit for ANN between the test and validation sets with R^2 dropping from 0.45 to a low of 0.15. This would imply that models require greater training data sets. Moreover, Fig 2 to Fig 5 residuals plot of the ANN model shows a practically constant deviation. In this case, the results demonstrate good prediction model accuracy when employing the Bayesian or ANN-based model, even with a small training data set.

CONCLUSION

The study results on enhancing the procedures for confirming salary automation in manufacturing firms are presented in this paper. It lowers the amount of work allotted to the newly hired employee by comparing the video input with the tasks completed with the reference material. The connection between MLR-BTM and freshly created algorithms makes this feasible. The two-phase verification procedure and comparison between the obtained information and the reference material is the main advantage of the methodology provided. This verifies the correctness of the new model and guarantees that errors in the tasks the employees accomplished are accurately identified. Developing a model to enable us to confirm the correctness of a new hire's work activities was our main objective, especially when it came to repairing a solid-fuel boiler. By registering video footage that provides expert examples of how a specialist should carry out a certain task, we think that overseeing and controlling this activity can be accomplished automatically.

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Design of A Novel Transformer for Analyzing Lossy Image Compression to Investigate Image Error Rate

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ABSTRACT

Lossy compression is commonly employed for transferring, sharing, and storing captured images due to the potential increase in their number and size. While lossy compression offers efficient compression, it generates distortions that must be managed. The coder utilized a variety of properties, each with its compression value, impacting the distortions of images. Once the image quality matches the requirements of a specific purpose, the compression parameter needs to be adjusted individually for each image. This is typically a task that must be completed immediately. Repeated methods are often required; quick and accurate strategies are needed to reach the desired level of quality. This work uses the discrete cosine transform technique for both encoders in the research. This technique calculates the root MSE for specified quantization step by analyzing the image's complexity. We examine the characteristic distortion generated by 2D-DCT-based encoders and the quantization phase and local content play crucial roles. Extending the data to grayscale test image sets and quantization step (QS) values makes it easy to estimate MSE. Tests using traditional optical and remote sensing images indicate that these forecasts are precise for appropriate quantization. This technique is suitable for compressing grayscale images with loss and partially compressing multi-channel data.

KEYWORDS: *Lossy image compression, Image, Transformer, Encoder, Loss.*

INTRODUCTION

Today, a multitude of photos are gathered from different origins. Many users capture multiple colour images and share them online [1]. Satellites and space-based remote sensing (RS) technology capture millions of pictures daily. Medical diagnostic complexes offer doctors diverse visual information, and advertising images are utilized by Internet retailers and other services [2]. The subsequent techniques yield varying-quality images, yet they all exhibit similar patterns. Their population, for instance, is experiencing a rapid increase [6, 7]. Next, the average image dimensions

grow larger. With improved digital cameras, capturing a more significant number of colourful images is achievable. Enhancements in spatial resolution and utilization of multi-channel imaging modes result in remote sensing images growing larger; medical images are also experiencing size increases. Data compression is necessary for transmitting, storing, and distributing these images. Lossless compression algorithms typically fail to reach the intended compression ratio (CR) [3]. Additionally, lossy image compression techniques can be adjusted using the compression control parameter (PCC) to produce significantly larger CRs [4]. This

could involve BPP in JPEG2000, Q in BPG, QF in JPEG, QS in DCT-based encoders, and more. Higher Compression Ratio (CR), which is correlated with lower Bit Per Pixel (BPP) or higher Quantization Factor (QF) or Quality Scale (QS), typically results in more degradation and lower quality in both visual and traditional assessments across most images [5]. The following step involves finding the best balance between distortion and CR required by the application and photo compression. Speed/distortion curves and the relationship between image quality parameters and PCC or CR are commonly used to assess image compression techniques' efficiency [6]. To achieve accurate outcomes, it is necessary to conduct this analysis on a substantial quantity of photos featuring a diverse range of CR (PCC) image quality. Many studies on compression algorithms [7] indicate that lossless compression methods yield promising outcomes, such as DCT utilizing orthogonal transformations [8]. Some DCT-based encoders significantly improve over the JPEG [9]. It is DCT-based and it is incorporated into prevailing hardware and software image-processing devices like embedded systems and remotely sensed image compression devices. Thus, the study aims to determine the mean square error (MSE) for AGU [10] and ADCT (advanced DCT) encoders with the possibility of extending the method to 2D-DCT-based packaging approaches.

The work is organized as follows: Section 2 extensively analyses existing models related to lossy image compression. Section 3 drafts the 2D-DCT-based methodology, with numerical outcomes in section 4. The conclusion is given in section 5.

RELATED WORDS

One possible initial approach is to employ an iterative method, which consists of compressing and decompressing multiple images while refining PCC and estimating quality measures (such as MSE) during each iteration. This method ensures precise delivery of a specific measurement value, such as achieving a PSNR accuracy under 0.2 DB (with an MSE relative error of less than 6%) [11]. The maximum packet time criteria may only sometimes be fulfilled due to the unpredictable number of iterations. Additionally, since the method involves more significant calculation

requirements compared to the other two methods, it is deemed less favourable in terms of green technology, according to correlation publications. Employing a step-by-step procedure involving the compression and decompression of numerous images, along with PCC refinement and the estimation of quality measures (e.g. MSE) in every iteration, may serve as an initial move [12]. The maximum packet time criteria may only sometimes be satisfied because total iterations is known. Additionally, this approach involves more computations than the other two methods, it is considered less favourable in terms of environmentally friendly technology and correlation publications.

Employing a step-by-step approach involving the compression and decompression of numerous images with PCC refinement and assessing quality measures like MSE in every iteration could be an initial move. This method ensures precise delivery of the intended value for a particular measurement, such as achieving a PSNR accuracy of under 0.2 DB [13]. The uncertain number of iterations can lead to the maximum packet time criteria not always fulfilled. Because the method involves more calculations than the other two, green technology is deemed less favourable. Two-step procedures, also called second methods are relatively recent. The average distortion rate for a specific encoder (MSE/PSNR) is determined using past offline acquisitions. This curve defines the initial QS, the base for decompression, image compression and metric calculation. After that, the last compression takes place, and the ultimate quality score is determined using the slope of the average curve. This approach is frequently much quicker than iterative methods. Nevertheless, its precision is lower compared to the iterative method, and for specific scenarios [13], it is not be appropriate for real-world use. Moreover, every scenario necessitates compression and decompression stage. If the packing and unpacking process is quick enough, it will be okay, but if it is slow, there will be a problem.

Next, several predictive techniques are introduced [14]. The primary benefit is that the PCC (QS) is determined using the anticipated metric value. Hence, the initial packing and unpacking in the two-step method are no longer required. Consequently, PCC can be resolved quickly. Additionally, the approach outlined in the

reference can forecast the spatial arrangement of distortions triggered by lossy compression, a crucial factor for various upcoming image processing applications. Nevertheless, thorough research has yet to be carried out, and the anticipated precision is typically inferior to that of two-step and iterative approaches. Hence, the purpose of this study is to develop the method suggested in our prior publication [29] further. This article is composed of two fresh sections. The initial analysis focuses on the spatial patterns of array distortions. Next, the MSE forecasts are examined for various grayscale test images, including some not included in the prediction curves. Multiple research studies have examined lossless compression techniques to enhance compression ratios while upholding high image quality (approximately 40 dB PSNR). Different standard colour space conversions, like Y-CgCo [15] and Y-U-V, are employed before the discrete cosine transform (DCT) to enhance compression efficiency by partially correlating the colour components. In their study, the authors suggested the Y-E-F transform as a more optimal colour space transform that focuses the energy on the Y channel while enhancing the colour components (CSTDCC), specifically for analyzing WCE images. Some of the conversions mentioned earlier may be flawed. Our team presented the Y-D1-D2-E colour space transform based on the Karhunen-Loève transform theory, which is an optimal model statistically. Nevertheless, it was discovered that the KLT-based transformation may not be suitable for all images or image sets (such as a series of endoscopic images of a single patient), although it is statistically optimal. To reduce energy usage, additional studies aim to incorporate simple image compression into the capsule [15]. An example is a quantization table composed of multiples of two following an integer DCT.

METHODOLOGY

Dataset

JPEG is a popular and widely utilized encoder based on DCT. Its benefits and drawbacks are commonly acknowledged. The primary disadvantages include the blockage effect and the restricted usage of blocks, which constrains the compact options available. These constraints have encouraged studies on maximizing

the benefits of DCT and image compression tasks. An example of an extension is the AGU encoder, which utilizes 2D-DCT in image pixel blocks. Additionally, following the decompression of the image, AGU implements a straightforward coding method to encode the DCT coefficients and subsequent quantization efficiently. The AGU encoder surpasses JPEG2000, SPIHT, JPEG and numerous other compression methods because of the mentioned enhancements.

Block transform with DCT

Fig 1 displays 4×4 data block from a lossy image. The R-G2-G1-B data intensities often exhibit a distinct pattern: $R > G1 \approx G2 > B$. The 2D coordinate is created by placing the R-G2-G1-B blocks one on top of the other in the Xplane and matching the X-O-Y plane with R block plane as illustrated. By applying 2D-DCT in X-Y direction, every colours frequency spectra-based block level are obtained. At point (x,y) in the block plane, there is a DC component in the frequency spectrum when $x = y = 0$ as shown. As x and y increase, the frequency changes from low to high. Utilizing 1D DCTs on the XY axis can effectively decrease the relationships between R,G1,G2,andB, as illustrated. Therefore, in this scenario, formula (1) demonstrates the utilization of 4×4 DCT with $F(j,i)$ denoting the frequency level coefficients related to (j,i) and $f(n1,n2)$ representing the input image pixel at (n1,n2).

$$F(i,j) = \sqrt{\frac{1}{8} C_i C_j} \sum_{n_1=0}^3 \sum_{n_2=0}^3 f(n_1, n_2) A_{n_1,i} A_{n_2,j} \quad (1)$$

$$C_i = \begin{cases} \frac{1}{\sqrt{2}}, & i = 0 \\ 1, & i = 1, 2, 3 \end{cases} \quad A_{p,q} = \cos \frac{(2p+1)q\pi}{8} \quad \text{else} \quad (2)$$

Here, 4×4 DCT can be transformed into a 4th point DCT in X and Y dimensions. In this scenario, correlations in colour components are removed with X-and Y-direction DCTs and correlations between them are removed with XY-direction DCT. Our group developed a concept that involves reducing the computational cost of the 2D-DCT is based on one multiplication by $\sqrt{2}$. As DCT compaction is performed in real-time, the amount of multiplication needed is reduced even more. We substitute multiplication with four additions and shifts,

ensuring a precision loss under 1.5×10^{-4} following the equation $\sqrt{2} \cong 1+2^{-1} - 2^{-4} - 2^{-5} + 2^{-7}$.

NUMERICAL RESULTS

The estimated value σ_{dist} for an 8×8 pixel block in an image can be determined by predicting the value σ_{im} using Eq. (3) for DCT encoders. Each block and quantitative step (QS) have corresponding estimates from the encoders.

$$\sigma_{dist} \cong \left(\frac{QS}{12^{0.5}} \right) \cdot f(\sigma_{im}/QS) \quad (3)$$

The estimated MSE of the entire image can be calculated based on the estimates $\sigma_{dist}(k)$, where $k = 1, \dots, K$ with K representing the total blocks (for block placement and a number tied to future problems discussed).

$$MSE \cong \sum_{k=1}^K \sigma_{dist}^2(k)/K \quad (4)$$

$$MSE \cong \sum_{k=1}^K \frac{QS^2}{12} \cdot f^2(\sigma_{im}(k)/QS)/K \quad (5)$$

The RMSE value determined for the k^{th} block of Eq. () is represented as $\sigma_{im}(k)$. All values of $\sigma_{im}(k)$ where k ranges from 1 to K can be easily calculated beforehand as long as the block configurations are predetermined. Now, we analyze how accurate the predictions are when using MSE with extra distortions. Data from the 4 test images used to create the scatterplots for the encoder is displayed in Table 1. The current MSE values closely resemble the predicted values known as MSE_{pred} ; in real-life scenarios, the difference is deemed unimportant as it is below 10%. Information from four identical image DCT encoders is displayed. Their research also indicates a strong correlation between the actual and forecasted values. The PSNR has a maximum discrepancy of 8% or 0.3 dB.

Table 1 Comparative analysis of various metrics

Image	QS	MSE	MSE_pred
1	5	2.0	1.8
2	5	1.9	1.8
3	10	2.0	1.9
4	10	1.9	1.7

5	20	6.9	6.9
6	20	6.9	6.8
7	20	7.2	7.1

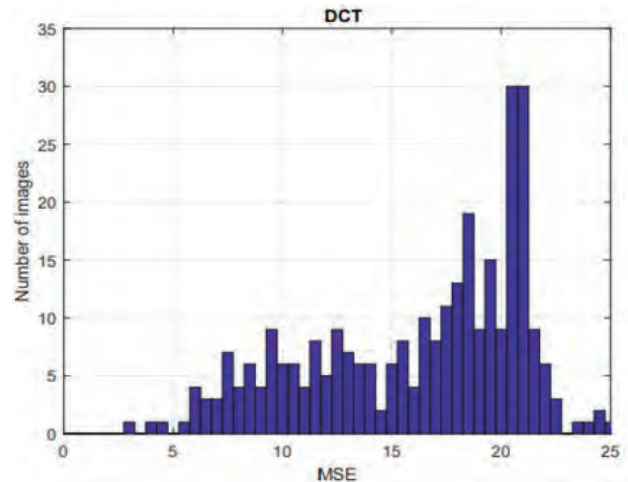


Fig. 2 Number of Images vs. MSE

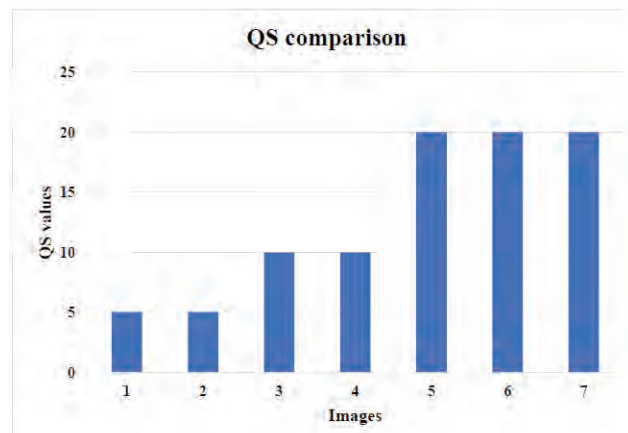


Fig. 3 QS comparison

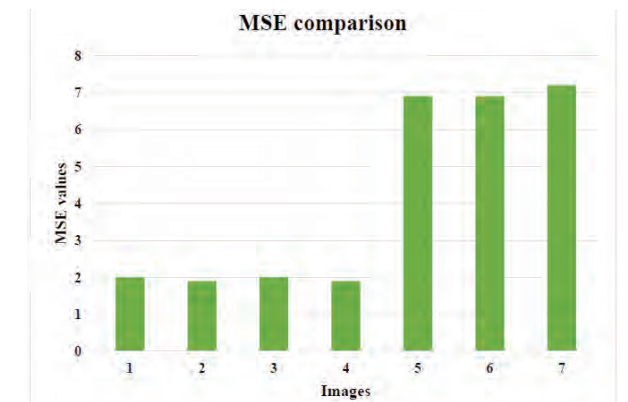


Fig. 4 MSE comparison

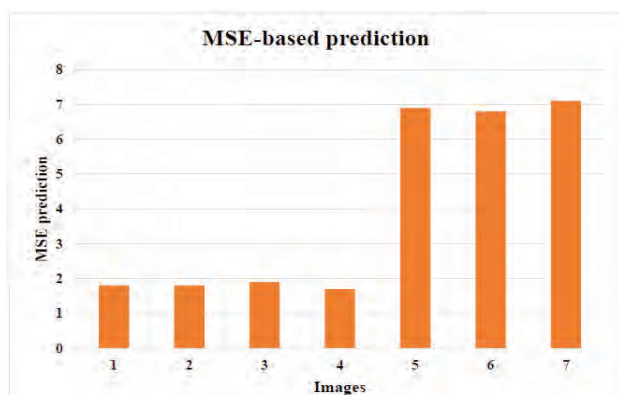


Fig. 5 MSE-based prediction comparison

CONCLUSION

This work shows a 2D-dimensional study of the distortion caused by 2-DCT encoders. Some distortion situations are negligible, and the image is optically lossless, which has been studied. It is shown that there is no spatial relationship between the local propagation of the distortions and the local performance of the image. Distortion propagation under locally passive conditions is significantly lower than $QS^2/12$. As a result, a method to measure MSE was proposed and extensively tested on images from different sources. The two DCT-based encoders are shown to have perfect prediction accuracy. The speed with which this forecast can be predicted is another advantage.

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Design of A Deep Convolutional Network Model for Blood Group Prediction with Fingerprints

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ABSTRACT

The beginning of any digital term is regarded as the foot impression or fingerprint in the modern digital world. Still, the human fingerprint was the most reliable form of identification in the past since it was unchangeable over time, even after an individual passed away. The fingerprint proof is undoubtedly the most reliable and recognized evidence available in court. Every human has a unique fingerprint design, and the probability of two people having the same fingerprints is extremely rare, roughly one in 64 million. Additionally, the minute details of the fingerprints of identical twins are distinct, and the point pattern on each fingerprint is constant from death to birth. Research on biometric trademarks, pattern recognition, and anthropometry has fueled the idea that blood groups can be predicted by reading a fingerprint map. Dermatoglyphics has been used as a diagnostic tool since ancient times. It is currently widely accepted as a means of screening for unusual abnormalities and various diseases with a vital genetic component. Dermatoglyphics is utilized in forensic medicine for physical anthropology, person identification, medical diagnostics, human genetics, and other applications. On the other hand, it would be an uncommon research project to use deep learning techniques known as Convolutional Neural Networks with seven and nine successive layers to fingerprint miniature patterns that are trained by other NNs for blood group recognition and different arrangements of prevalent scientific disorders that occur with ageing based on lifestyle.

KEYWORDS: Blood group, Fingerprint, Image processing, Dermatoglyphics, Biometric.

INTRODUCTION

Traditionally, fingerprint patterns have been used to identify a person. Although Dr. Harold Cummins first presented the research of fingerprint patterns, the practice dates back several centuries. Recently, fingerprint verification has been used by all organizations, including many government institutions in India [1], to verify everyone's identity. It is also employed in the biometric modality for age and gender identification. Because each person is unique, biometrics have gained popularity as a secure substitute for more conventional

identification techniques like passwords or tokens. The 16th century saw the beginning of fingerprint-matching techniques as we know them today. Henry Fauld was the first person to experimentally propose the singularity and uniqueness of fingerprints [2]. Herschel contributed to the development of modern foot impressions. The author supervised extensive research and categorized several fingerprint types based on fundamental examples such as whorls, loops, and arches during the 1800s. The term "Dermatoglyphics to dermal edge on the palms was coined by Cummins.

Cummins also showed that edge is partially handled by of natural impact that produces strain and pressure on fetal life development. The fingerprint design accounts for around 30% of the total and might be roundabout, spiral, oval, or loop. Arches are the most prevalent type, roughly 5% [3]. The edges of the fingerprint pattern cross over to the other side of the impression without reversing. When an example falls into more than one of the categories above, it is referred to as a composite [4]. To date, analysts or researchers have typically employed fingerprint as viewpoints to highlight an individual's distinctiveness. The ridge patterns can be broadly categorized into five types: arch, tented arch, whorl, radial loop and ulnar. Any type can exist in person's fingers [5].

All in all, the majority of fingerprints observed in the population review consist of loops, with 70 % of prints being loops, 25 % of prints being whorls, and just 5 to 10 % of prints being tented arch patterns or designs or arch [6] – [7]. According to specific twin tests, but non-distinguishable, comparable occurrences of monozygotic or indistinguishable twins have been observed. Dermatoglyphics has been used as a diagnostic tool since ancient times. It is currently widely accepted as a means of screening for abnormal defects and various diseases with a vital genetic component [8]. Genetic and environmental factors work together to determine the uniqueness of each fingerprint's minute ridge patterns. Fingerprint algorithms for person identification are highly advanced and are being used globally for authentication and security purposes [9]. The impression is also used to categorize people's gender and age. Still, little manual research has been done to investigate the connections between clinical disorders and blood type, including type 2 diabetes, arthritis hypertension, and fingerprint patterns [10]. In addition to helping crime investigators reduce the suspect pool by using Convolutional Neural Networks(CNN)with seven layers and nine layers to predict blood types, anthropologists will find it helpful to use fingerprints extracted utilizing Deep Learning to classify certain diseases and provide an early warning system against ageing-related common clinical diseases.

The work is organized as follows: Section 2 provides an extensive analysis of existing models related to blood group prediction. Section 3 drafts the CNN-based

methodology, with numerical outcomes in section 4. The conclusion is given in section 5.

RELATED WORKS

The arch and ulnar radial loop tented arch whorl are the common forms of fingerprints. Fig. 2 illustrates the various whorl patterns seen in fingerprint designs. Two deltas and one focal roundabout centre represent a whorl. There might be several examples at the centre. It could resemble the state of a peacock quill's eye spiralling, concentric circles, or compacted vertical circles. The edges rise from one end, pause in the centre, and descend toward the other. Current innovative developmental biology and genetics studies have confirmed that different mental projections correspond physiologically to varying fingers on both hands [11]. The fingers of the right hand are identified with the cerebral side of equator and vice versa, indicating practical coordination. Thus, the right hand's fingers are linked to the focused left half of the mind. The thumb is made possible by the unparalleled frontal projection. The index finger is linked to the mediocre frontal fap, the middle finger is linked to parietal projection, the ring finger is linked to the feeling projection, and the little finger is linked to the occipital fap, which is located in the back of the cerebrum. Similarly, comparable cerebrum faps are linked to the left side of the brain [12].

A piece of the other impression of the encompassing is the responsibility of each projection zone. A straight vertical edge in the middle of a simple arch design represents a tent arch pattern. The loops are typically the recent highlights on an individual fingerprint, similar to the arbitrary situation space of a few fingerprints. They are identified by edges that begin to trickle out of the fingertip crosswise circle about the finger cushion's focal point and then return to their original path. The thumb can be used to initiate these loops. Any loop that opens infinitely from the thumb is any loop, and the ulnar loop that opens close to the thumb is a radial loop due to specific areas of the arm bones called the Ulna and radius. Round designs formed as a middle at the core or centre are called spiral whorls [3]. There are two deltas in this design at the two corners. The circular rings of edge designs display the concentric whorl form.

The investigation circle is developing smaller programmed devices for use in clinical settings. An

illustration of this work is the development of a flexible, simplified, programmable framework of low-effort for blood type in alternative situations, taking into account a spectrophotometric method and taking agglutination (the surface of red blood cells cooperating with specific reagents) into consideration. The construction of an electronically programmed framework is empowered, and blood typing is made possible through a simple and fast exploratory convention [4]. This framework will assist in removing some of the barriers that the existing frameworks and methods for blood typing have. A few variations that make up a programmed framework more willingly can affect the results. These include the trial basis used for spectrophotometric valuations, the quality of agglutination, which influences the differences between control and test samples; the amount of time spent getting ready for the test because it's crucial to weaken the reagents and blood and performing spectra estimation [5] as fast as time allows because the agglutinated cells will generally settle in the base of the cuvette.

METHODOLOGY

This section presents the suggested methods for blood group categorization utilizing an image of a finger mark from another class. The first step is to define the dataset used in the study. The feature extraction technique uses deep learning theory in the next section. Lastly, the training procedures and the categorization strategies used should be outlined.

Dataset

The ten fingerprints of 392 subjects, 268 male and 124 female, between 18 and 58, will be collected in real-time from Mumbai-based college through the use of the 500 DPI DX HFDU06 fingerprint Scanner. Depending on the sensor resolution and finger positioning, a good fingerprint takes 25 to 80 minutes to process. The ridges break in false details because the finger is positioned incorrectly on the scanner sensor. Fingerprints taken from very dry fingers or fingertips with extensive scars or scrapes are challenging to retrieve details from. In this stage, the obtained minute characteristics are used to define the fingerprint to create a feature vector with 3920 images for later matching. There were 1.21 males for every female in this study. In this study, blood types B and O accounted for the majority of individuals

(34%), followed by AB (14%), O (26%), and B (28%). Of all instances, 87.2 percent are Rh-positive. There was a notable influence on all finger patterns, with whorl recording the highest frequency at 53%; loop came in second (39%), but there were also substantial effects on left (26) and right (14%) loops as well as arches (9%).

Prediction

Here, two distinct CNN-based models (7 layers and nine layers) were used in our study, and the outcomes designs on the chosen dataset were compared. CNN-based architecture and several deep neural architectures wherewith several deep neural to their exceptional performance and precise outcomes in computer vision issues and image classification. CNN-based models provide advantages over traditional feed-forward neural network models, such as faster training and fewer parameters and connections. CNN model with five layers with Rectifier Linear Unit (RLU) activation, first input CNN layer with third input channels. This model consists of four hidden CNN layers and five CNN layers overall. The max pool layer received the output from the fourth, fifth, first, and second CNN layers, with a filter size 2×2 . The image's dimensions are 3×3 . This is the kernel size that was applied. Stride and padding requirements are set to another. Three fully connected layers with RLU began receiving features from the flattened 2D-CNN layers' outcome. The log-softmax probability was computed and utilized in subsequent calculations. To prevent overfitting, a dropout with a probability of 0.4 was employed.

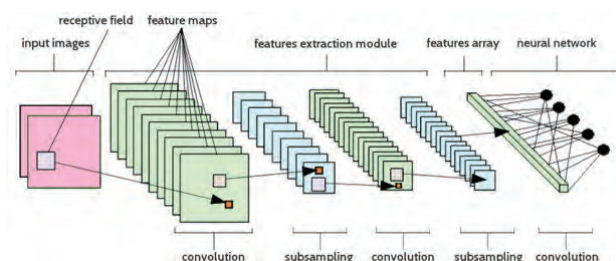


Fig. 1a CNN with seven successive layers

Every image is transformed into a vector by the first layer, which also serves as the input layer. The convolutional layers haul out both spatial and temporal data using several filter kernels across the entire image. These filters go across the picture, multiplying the filter weights element by element using the image's pixel values. The

updated activation or feature map that results from adding these values for every footstep is subsequently fed into the buried CNN layers. Subsequently, the hidden CNN layers modify the feature extraction and improve the activation maps depth. The output is provided to ReLU to initiate non-linearity for superior performance. The max pool pooling layer receives the production to diminish feature map's dimensionality. The last layer consists of fully linked dense NN which classify the data using the created characteristics. The prediction error is calculated using the log-soft max probability final output, which is obtained by applying the NLL criterion and back-propagating the error via network for gradient weight tuning and layers with Adam optimizer with 0.001 learning rate. An early halting strategy and the dropout regularisation technique are used in our model to prevent the results from being overfitting. Table 1 displays the initialization parameters of the CNN. The model is trained across fifteen epochs with a batch size of 84. Every epoch has 8 80 steps for 13,440 steps in the training set. To compute model's presentation, the validation dataset was used to validate the current step model parameters successive step in the training process for forecast. Subsequently, arithmetic analysis was performed on the observed results, and the testing dataset was assessed with fully trained models.

Table 1 Parameter initialization

Parameter	Values
Weight initialization	Random
Input	128*128
Loss	NLL
Optimizer	Adam
Learning rate	0.001
Batch size	85
Output	Softmax

NUMERICAL RESULTS

The suggested system employs several methods to predict a person's blood group. All gathered picture examples are labelled with the blood group as part of the image-based CNN technique. The earlier techniques described in the literature required real blood samples for blood group identification or manual techniques such as using ink and paper to collect fingerprint

samples. On the other hand, the classifier's accuracy refers to how many facts from our model it utilizes to decide whether or not the model is valid. Recall is the capacity of a model to identify every concentration point in a dataset or its capacity to locate every tolerable instance in a dataset. They were added together to create an F1 score for the performance to obtain the optimal balance between accuracy and recall. The concordant mean of recall and accuracy is the F1, considering both measures. The following equations are used to calculate these values:

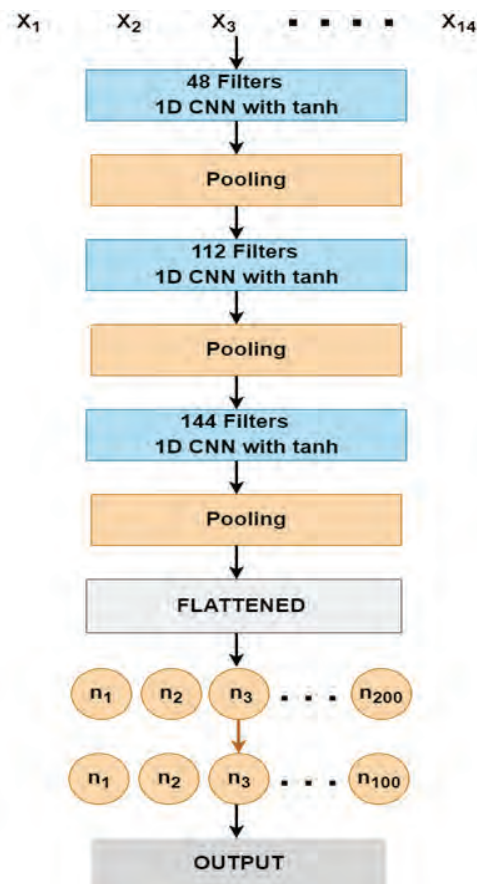


Fig. 1b CNN with nine successive layers

$$precision = \frac{TP}{TP + FP} \quad (1)$$

$$recall = \frac{TP}{TP + FN} \quad (2)$$

$$F1 = 2 * \frac{precision * recall}{precision + recall} \quad (3)$$

All of these CNNs were trained using the stochastic gradient descent technique. Table 6 compares the projected CNN against various CNN models using performance criteria, including F1-Score, Precision, and Recall. The F1score, precision, and recall are calculated for both yes and no classes. The suggested model has a more significant 90% precision rate for a given class. Fig 2 displays the feature maps and visualized filters of the proposed architecture. The maps that demonstrate how the model internally converts an input at a specific point in the model may be produced by filters applied to input images and feature maps produced by previous layers. The study's training and validation graphs demonstrate how altered architectures outperform other designs in terms of representations. To evaluate a model's generalization performance, it must be subjected to metrics that gauge its capacity for generalization. Accuracy, confusion matrix, Recall, Precision, and F1Score are also employed as evaluation measures to assess the effectiveness of this suggested approach. Here, false negative (FN), false positive (FP), true negative (TN) and true positive (TP) values are taken from the confusion matrix to calculate the prediction accuracy for each blood group separately. 95.27% is the average accuracy calculated with the confusion matrix. With 33.67% of samples, blood group A yields 95.01% accuracy; comparable blood types O, AB, and B yield 9.22%, and 93.55%, 94.50% accuracy with 13.26%, 25.51%, and 27.55% of total samples respectively. Table 8 summarises the relative performance for each blood type based on recall, precision, and F1 score. With 92% accuracy, blood group O has a better level of precision. Blood group AB came next, with a lower 88% precision.

Statistical analysis

The study shows that the female-to-male ratio is more than 1.2:1, and the number of men is more than twice that of females. Table 2 displays the distribution of samples by sex and age. Most cases (33.77%) were of blood type A. Blood groups O, B, and AB were the next most prevalent, with percentages of 28.17%, 24.72%, and 13.38%, respectively. Chi-square tests revealed that the correlation between blood group and sex is statistically significant at $p < 0.05$. Based on the study's findings, Table 3 displays the distribution of samples by RHand ABO blood types. Of the patients, 33.67 had

blood group A and 91% were Rh + ve. Blood groups AB, B, and O comprise 27.55, 13.26%, and 27.51% per cent of the total. Blood group A accounted for 4.08% of Rh-positive patients. When taking into account chi-square, the distribution of cases based on Rh blood and ABO types is statistically critical at $p < 0.001$. The feature vector dataset is statistically analyzed using a similar statistical method during the first examination. The work establishes a connection between fingerprint and blood group-based identification using merely patterns, such as wholes and loops.

Table 2 Performance comparison

Class	Accuracy	Precision	Recall	F1-score
A	98	90	95	94
B	97.5	91	90	92
AB	98.2	92	95	93
O	98.1	93	95	98

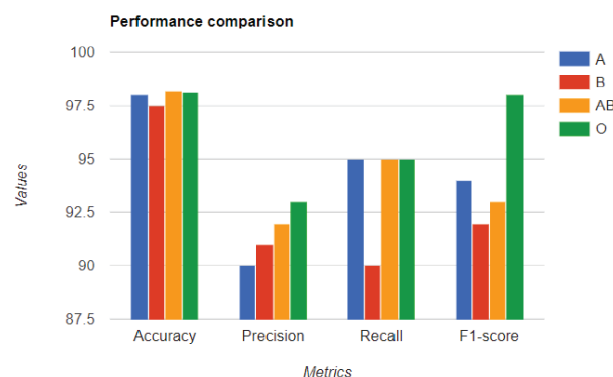


Fig. 2 Performance metrics comparison



Fig 3. Finger print patterns with blood group prediction

CONCLUSION

Due to their great potential, fingerprints are a reliable method of identification. An innovative deep-learning-based Convolutional Neural Network with successive layers for blood group identification is suggested. Furthermore, because each person's fingertip patterns

contain a variety of minutia, it is quite possible to extract the maximum amount from a fingerprint if a digital device is needed to capture it. Due to recent developments in image processing and fingerprint detection technologies and improvements in the speed and accuracy of contemporary algorithms for identifying approaches with 98% accuracy, blood group identification seems more exciting—moreover, comparable research aids in the early diagnosis of specific disorders. The examination and categorization of populations based on factors such as blood type, age, lifestyle disorders, and fingerprint patterns can help mitigate the risk of pandemics, which will afflict those with lifestyle-related illnesses, including type 2 diabetes and hypertension.

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Enhancing Coastal Sustainability: Design and Implementation of an Automatic Beach Cleaning Vehicle

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ABSTRACT

In order to ensure the long-term viability of both biodiversity and tourism, it is essential to preserve unspoiled coastal habitats. Maintaining clean beaches is essential for the survival of these ecosystems and the enjoyment of beachgoers. An automated beach cleaning vehicle that aims to improve operating efficiency and reduce environmental effect is explored in this abstract. To clean beaches without human intervention, the Automatic Beach Cleaning Vehicle (ABC-V) uses cutting-edge robotics and sensor technology. It finds trash, including plastic, seaweed, and other contaminants, and gathers it using algorithms powered by artificial intelligence. Solar panels power the car throughout the day, while battery storage allows it to continue running effectively at night. Robust cleaning processes remove trash thoroughly without harming natural habitats, and its small size and lightweight materials reduce its environmental impact. Important parts include a network of sensors for navigating and detecting obstacles, as well as adaptive decision-making systems based on machine learning. Thanks to its modular design, the vehicle can be easily upgraded or maintained, which improves its performance over time and cuts down on downtime. Trials on several beach settings have shown that the ABC-V is successful, with far faster cleaning times and higher trash collection rates than the old ways. Coastal towns and environmental groups are among the stakeholders who are interested in using these vehicles to improve beach maintenance and cut down on labour expenses. Finally, a revolutionary strategy for coastal sustainability is the Automatic Beach Cleaning Vehicle. This scalable approach uses autonomous technology to reduce marine pollution and keep beaches clean and appealing. Improvements to AI in the future may allow for the analysis of data in real-time and the incorporation of smart city frameworks into operational management.

KEYWORDS: *Autonomous beach cleaning vehicle, Robotics, Sensor technologies, AI algorithms, Environmental sustainability, Marine pollution, Biodiversity conservation, Tourism, Coastal management,*

INTRODUCTION

The background and significance of the development

The sand beach serves as a representation of coastal cities, and their preservation is an act of stewardship over their natural resources. Similarly, lawns, as the

foundation of urban greening, are indicators of a city's level of development and civilization. They also play an important role in controlling the microclimate and improving the city's aesthetics. A growing number of individuals are concerned about trash pollution on beaches and lawns, which is an issue that 65.3%

of people prefer, according to the Holiday Travel Arrangements study. A 2017 report from the Hainan Marine Environment Bulletin found that there is an average of 142,500 pieces of beach litter per square kilometre. This amount of trash makes coastal ecosystems even more vulnerable, which in turn speeds up erosion and deterioration [1]. Lawns in parks, playgrounds, and other public spaces collect a lot of trash and deciduous leaves, which poses a threat to the lawn's health, impacts public play, and detracts from the city's aesthetic value (Figure 1).

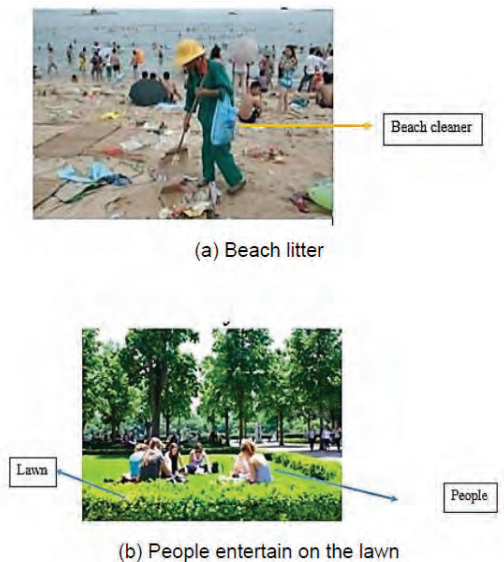


Fig. 1. (a) Beach litter(b) People entertain on the lawn

LITERATURE REVIEW STATUS OF BEACHES AND LAWNS

The 19th National Congress of the Communist Party of China highlighted the significance of promoting the construction of an ecological civilization and increasing green space, refusing to reduce the number of beaches, and centred to enhance the quality of the beach ecological environment in response to the declining beach ecosystem and lawn surroundings. China has used a range of machines and technologies to clear up the daily trash, enhance cleanliness, and manage the beach and lawn in an effort to halt the beach's degradation and preserve the lawn's ecological environment.

Currently, most of the upkeep and cleaning of sandy beaches and lawns is done by hand [2]. However, certain beaches do make use of huge beach waste

cleaning trucks on a regular basis. During the grass season and deciduous season, mechanical aid is used to clean the lawns [4]. The sanitation machinery sector in China isn't very strong since mechanical cleaning equipment didn't emerge until much later than in other countries, and manual maintenance is labor-intensive, slow, and takes a long time [5]. Garbage sweepers are time-consuming and inefficient, large beach cleaners are costly and hardly used, and most lawn mowers don't have a scum cleaning function, so it'll have to clean them more often [6]. To some degree, the comfort of visitors is affected by the existing machinery and equipment that operate with significant dust, noise, and non-clean energy consumption, as well as by the usage of closed or semi-open spaces [7].

With this background in mind, the project develops a tiny beach-lawn cleaning vehicle to supplement human cleaners, increase the efficiency of manual cleaning, decrease the intensity of labour, and lengthen the work cycle of deep maintenance, among other uses [8]. They may minimise the rate of beach deterioration, keep lawns in good shape, and safeguard beach and lawn ecosystems to their fullest potential by meeting their daily clean-up obligations without interfering with routine beach and lawn usage [9].

Plan

In order to alleviate the current heavy workload and inefficiency associated with beach and lawn cleaning, this study primarily aims to develop and test a compact beach-lawn cleaning vehicle that can be used as an auxiliary tool by beach and lawn cleaners [10]. Figure 2 shows the basic components of a small sandy beach lawn cleaner, which include cleaning, sieve, and trash collecting modules [11]. The trash collection module is located at the bottom of the box and uses a removable design to store and transfer garbage. The cleaning module uses a disc brush to expand the cleaning range and a rolling brush to sweep the collection to the shovel board. The vibration sieve module uses a vibration screen to separate the garbage from sand grains and delivers the separated garbage to the collection box [12]. Two modes of operation, manual operation and automatic cleaning, were integrated into the gadget to make it more adaptable to diverse terrains and to suit a range of cleaning demands. The G5N-20K DC motor, which drives the clean-up vehicle in a compact

manner with rear-wheel drive and front-wheel steering, uses clean energy and powers the vehicle [13]. When in manual mode, the driver can use the buttons on the armrest to start and stop the vehicle, as well as control the steering and vibration screen. The GPS module will then correct the direction and steer the vehicle based on the predetermined path, thanks to the BFS algorithm. The gyroscope makes the ride easier and less taxing on the operator[14].



Fig. 2: The unit's schematic

Design of the cleaning module

Roller brushes, detachable disc brushes, and adjustable shovel plates make up the bulk of the cleaning module [15]. To clear up beach trash, the equipment advances, dips its shovel tip into the sand at the right angle, and then transfers the collected sand and trash to the back sieve, where it can be easily sorted. Grass waste may be easily collected by adjusting the shovel angle to a specific distance from the ground, using a combination of a detachable disc brush, plate brush, and roller brush. Simply load the grass waste into the back shovel board. Adjusting the shovel plate's tilt angle allows it to get the greatest possible beach cleaning effect, while also ensuring that the sand filter is adequately sturdy and protecting the grass from damage. If it want to maximise efficiency and minimise wear on the shovel plates, it should examine the data and calculations based on the amount of shovel sand and the depth of the shovel sand to determine an angle range of 23 to 34 degrees. The roller brush height may be adjusted from 0 to 65 m/min to minimise the cleaning blind spot, which is necessary for lawns and sandy beaches with pits.

Structure design of the vibration sieve module

The sand grains are separated from the trash by means of vibration filtering, which is accomplished by the vibration sieve module. A vibrating screen and a

crank swing rod mechanism are the basic components of the vibration screen module. The screen moves in a repetitive, straight line along the rails as the motor rotates to drive the crank swing mechanism. The gadget utilises the crank swing mechanism's quick return to provide the vibration effect on the sieve plate, and the crank's rotating motion may be transformed into the guide rod's reciprocating swing.

Shock screen with a mesh

In order to filter sand grains, the Zhen sieve mesh is constructed as a step-by-step bevel mesh. It is operated by a crank swing lever that transfers rubbish up the mesh. The cleaning needs informed the design of the vibration screen, which is a detachable structure that allows for easy cleaning of leftover waste and makes it more convenient and user-friendly to filter different specifications of beach debris.

There is a lot of plastic, cigarette butts, melon shells, and wood items among the beach trash. The results demonstrate that a 4" "mm vibration screen with a fine mesh can completely filter the sand, leaving most of the trash on the screen. In order to determine the screening inclination, three sets of sieve inclination parameters were set to 12.5 degrees, 22.5 degrees, and 32.5 degrees. After analysing the sieve experiment to obtain the separation of sand particles and garbage on the sieve surface, as shown in Table 1, it was decided to use a sieve tilt of 22.5 degrees. The movement law of the sand grain in the sieve surface is affected by this parameter.

Table 1. A comparison of the three screening inclinations' experimental outcomes

Sieve the inclination	Scree imapce	Duration
10 Degree	difference	long
15 Degree	Good	Shorter
25 Degree	Average	Longer

Mechanism for crank swing

The vibration screen is driven along a predetermined trajectory of repeated straight-line vibrations by means of a crank swing mechanism, a rail system at either end of the screen for linear motion, and a slider that rides on the rails for directional control. A complete upward transfer of garbage occurs when the vibration screen

is in a reciprocating motion; the fast return nature of the crank swing bar speeds up the screen's upward movement, which in turn generates a backward force on its garbage. The screen then returns to its original position, with the garbage falling onto the upper ladder.

Module design for garbage collecting

To collect the screened trash, the unit has a rubbish bin that is situated below the vibratory sieve module. There is a push-pull design on the bottom of the box, and the bin is attached to the frame. Pull out the bin's base, dump the rubbish inside, and then gather and bundle it all up when it's full.

Module for driving

The device can reach speeds of around 55" "m/min, and the maximum RPM that the motor can handle is around 90RPM. The rear-wheel drive is established by frictional resistance and is dependent on the tyre radius. It is powered by two 80" "W motors with an approximate rated current of 8.3" "A" and is supplied by a 12" "V lithium battery. To match the motor's current voltage needs, drive it using an industrial-grade 10A, 3-36V two-way DC high-power H-bridge motor drive module. It has a driving rated current of 10A and a peak current of 60A. The signal control pins DIR1 and DIR2 allow for two-way control, and the PWM1 and PWM2 controls the speed, which may range from zero to one hundred percent. Due to the increased torque needed for differential steering—which is a realistic consideration given that this work's rear wheels are driven by a twin motor—the front rudder guide is utilised to direct the steering in conjunction with the differential speed of the rear wheel motor. A 180" "kg.cm rudder controls the front wheel's direction machine; a connection links the rudder's output shaft to the machine; and a left-to-right rotation of the rudder causes the front wheel to spin in the desired direction, so altering the device's steering.

Operating Mode

Two modes of operation, manual operation and automatic cleaning, are available to operators via a mode switching switch, allowing the device to be better suited to various working situations. A power button and a mode button are located on the device. When it connect in the device and push the power button, it'll see a mode switch with three settings: stop, manual,

and automatic. It may use these to change the gadget's operational state. The manual setting With more visitors and the site's complicated landscape, manual operating mode is the way to go. In manual operation mode, the procedure is as follows: the worker must first determine the working conditions, then set the shovel board to the suitable angle, then turn on the device by pressing the power switch opener and the mode switch. Here, the employee may navigate to their job station by adjusting the control device's steering to match the site's real circumstances. The adaptability and versatility of this work mode allow it to lessen the burden of manual labour while simultaneously increasing productivity (Figure 3).

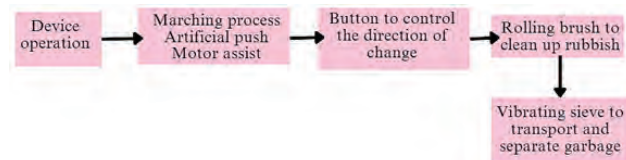


Fig. 3 Flowchart of the manually assisted work mode

The Auto Clean feature

When there are fewer people around and the landscape is flat, it can use the automatic clean-up option. When set to this mode, the unit will walk autonomously in accordance with the walking trajectory and the BFS algorithm. A combination of the unit's gyroscopes for steering and directional correction and its GPS modules for location and range allow it to automatically turn around after a certain distance. The operator has the option to pre-set the walking distance and cleaning range. When the machine changes to automated cleaning mode, it measures the starting placement and angle.

Within this mode, the unit is able to utilise sensors to identify walking distance and corner angle. This information is then used in conjunction with GPS module placement and path planning to enable the unit to autonomously clean up defined areas. The general functioning of the body is comparable to the manual auxiliary mode (Figure 4).

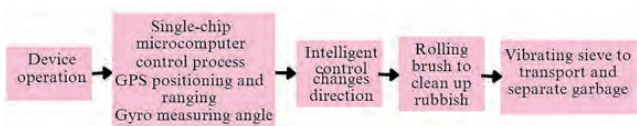


Fig. 4: Flowchart for the automatic cleaning of the work pattern

GATHER DATA FROM RESEARCH ON EFFECTS

Verification of the cleanup impact on beach trash

Wuhan Tianxingzhou Beach is the location of the experiment.

Samples of melon shells and sand containing cigarette butts were used as experimental subjects.

Procedure for conducting an experiment: The study's findings indicate that it should be distributed uniformly around the experimental location and limited to a waste specimen for the experiment. The amount of trash in the trash can and the amount of trash in the experimental sand were both measured manually. Tabulated in Table 2 are the outcomes of the experiment:

Table 2 Data records of the installation's sand waste cleanup operation

garbage sample	garbage	area	time	efficiency
2 kg	0.4 kg	14 m ²	5 min	80%

The data clearly shows that the gadget can make manual cleaning more efficient, and it gets the job done well.

Verify the effect of lawn waste clean-up

Wuhan Shahu Park is the location of the testing. Participants in the experiment included samples of plastic bags, grass with deciduous leaves, and toilet paper.

Experimental procedure: Following the experiment, measure the amount of waste in the experimental grassland and the weight of the rubbish bin. Then, use the automated cleaning mode to clean up. Table 3 displays the documented experimental results.

Table 3. Information for the system that will remove grass clippings

Junk style	Lightening the Load	clean space	duration	efficiency
10 kg	15.2 kg	500 m ²	20 min	82.40%

The results demonstrate that the gadget is capable of performing its intended task of collecting grass debris and that it does so effectively.

EVALUATION OF BENEFITS

Analysing the advantages of energy savings and reduced emissions

Beach

The 2017 Hainan Marine Environment Bulletin reports that there are an average of 142,500 beach litters per

square kilometre, with a density of 3992.5" kg/km². Not only will the beach ecosystem suffer if trash isn't picked up soon, but the ocean will carry the trash back into the water, further damaging the natural environment. Connections to preexisting components.

Current heavy trucks emit a great deal of carbon dioxide gas due to their diesel fuel consumption (15 litres per hour) and four-wheel drive operation. With a carbon footprint per litre of diesel fuel, the device employs renewable energy to prolong the life of big beach trash trucks, cutting the number of uses per month in half. 1.56×10^{-6} " " L Using this device to lower carbon emissions:

$$\text{CO}_2 \text{ "Reduction" } = 1.58 \times 10^6 \times (2-1) \times 4 \times 15 = 9.48 \times 10^7 \text{ " " L} \#(1))$$

The deployment of beach trash collecting trucks would effectively reduce trash pollution to the sea and beach, in accordance with the applicable national rules.

Greenery

A healthy lawn can serve as the "lungs" of the city, absorbing carbon dioxide and other pollutants; however, it will suffer stunted growth if left unattended and covered in trash and deciduous leaves, which reduces its oxygen production and carbon dioxide absorption. For instance, Wuhan's park green space area reached 8355.86 hectares at the end of 2017. Grasslands in Wuhan city emit 1671172 kg of oxygen per day and absorb 2088965" kg of carbon dioxide per day, resulting in a 20.72% decrease in the city's daily consumption of oxygen gas and a 21.29% increase in carbon dioxide generation if the growth condition is not suitable.

The quantity (Q_ "Oxygen reduction " = $(0.03 - 0.01) \times 8355.86 \times 10000 = 1671172$ (" " kg)#(2)) The equation @Q_ "co2cut back " = $(0.04 - 0.015) \times 8355.86 \times 10000 = 2088965$ (" " kg)#(3)) is not directly applicable.

Inadequate grassland growth will not improve the city's air purification, will increase the greenhouse effect, and will put people's health at risk; in contrast, park green space can successfully decrease urban carbon dioxide emissions, harmful gas pollution, ecological environmental degradation, and protection of the urban environment.

Analysis of economic advantages

Analysis of costs

The small beach-lawn cleaning vehicle that this project proposes is structurally straightforward; it runs on clean energy electric power; its motor drive device moves; and the modules work together in a fixed mode to give the device its fundamental structural strength and stability. The device, once assembled, can be used on a variety of terrains; it has a high cleaning efficiency; and it saves both human and material resources. Considering the aforementioned expenditures and costs associated with mass production, the following table displays the cost analysis:

It is simpler to sell this device to sanitation or associated entities responsible for the beach environment because of its low cost and low yearly maintenance expenses, as can be seen from the data in the table.

Evaluation of labour expenses.

One example is the Nanshan Bay Sea Baths in Shantou City, which employs ten full-time cleaners and needs ten more during the holidays to keep the beach clean. The cleaning personnel is currently paid 3000 yuan per month and works 12 months a year. They utilise huge garbage trucks roughly twice a month, which consume 40 litres of diesel fuel every time. The yearly cleaning cost is broken down into ten fixed salaries for cleaning personnel, ten salaries for new workers on holidays, and a big automobile usage fee. The formula for this fee, which is based on the February holiday season, is $Q_{old} = 10 \times 3000 \times 12 + 10 \times 3000 \times 2 + 12 \times 2 \times 7 \times 40 = 4.2672 \times 10.5$ “yuan” (number four)

Using the device, it can cut down on the number of employees and the frequency of vehicle cleanings by half. It'll only need to hire five cleaners instead of deploying extra staff on holidays. A large cleaning car will only be needed once a month. The yearly cleaning cost of five cleaners and a large car is two parts. Following the initial usage of unit Q new, the following cleaning cost will be applied annually:

The “new” Q_{yuan} #5 is equal to 1.80336×10^5 multiplied by $5 \times 3000 \times 12 + 12 \times 1 \times 7 \times 40$. If it utilise this equipment, it may cut down on cleaning expenses, intrinsic costs, and losses.

Analysis of the Economic Impact of Tourism

The beach must be closed while heavy vehicles are on the road; decreasing the number of these vehicles can lessen the financial burden of this closure. For instance, Sanya City generated 54 million in income from 126.6 million day excursions. Consider the following: if it employ a big cleanup truck every day and block the beach for one day at a time, the economic loss from beach maintenance in one year (Q_1) and the drop in traffic (W_1) would be: In a nutshell, this technology may lessen losses, boost urban population movement, and substantially enhance tourist earnings.

Evaluating the societal advantages

The city's reputation, tourism, and economic growth may all benefit from the restoration and preservation of its beaches and lawns. The national plan for the construction of “beautiful cities” calls for “ecological beauty,” “governance beauty,” and “development beauty” in its development, and appropriately protecting, planning, and constructing beaches and lawns are inherent requirements and inevitable choices for conserving natural resources and growing the economy.

HIGHLIGHTS OF INNOVATION

Improvements in labour efficiency, a waste cleanup procedure, and a number of other institutional combinations are all examples of combination innovations. Introducing a new functional innovation: a combination of manual operation and automated cleaning to suit various cleaning demands; The goal of this innovative application is to automate the cleaning process by filling the gaps left by smaller sanitation machines.

PRIMITIVE APP

Small in stature, easy to operate, inexpensive, and suitable for daily beach and lawn cleaning, this work effectively removes daily trash, enhances tourist comfort, has positive social impacts, and can compensate for the drawbacks of large-scale cleaning machines, prolong their use cycle, and lessen economic losses caused by the shutdown of such machines. As a result, the equipment is quite versatile and may be utilised for cleaning purposes on sandy beaches and

various grass areas. With this device's auxiliary manual operation, it can clean beach baths and park lawns all day long. It will drastically improve cleaning efficiency, alleviate the weariness of manual labour, and cut down on labour costs. It's also useful for picking up common trash, like leaves on the road, from different locations. The device's brush attachment is removable and replaceable, making it suitable for usage in a variety of settings, including playgrounds, golf courses, roads, and other cleanup tasks. In conclusion, this work has several potential uses.

CONCLUSION

A big step forward in coastal sustainability has been the creation of the Automatic Beach Cleaning Vehicle (ABC-V). Using state-of-the-art technology including sensor arrays, artificial intelligence algorithms, and robotics, this vehicle provides a thorough answer to the problems associated with beach waste management. Its superior cleaning efficiency and reduced environmental effect compared to conventional approaches have been shown in field experiments. Using solar power and lightweight materials, the ABC-V is designed to operate autonomously and is ecologically benign. Its dedication to sustainability is evident in its operations. Its modular design makes it easy to modify and update in the future to suit changing environmental requirements, and it also makes maintenance a breeze. The revolutionary potential of autonomous beach cleaning trucks is becoming more and more acknowledged by stakeholders, such as coastal municipalities and environmental organisations. These vehicles help with more than just trash pickup; they also keep coastal habitats beautiful and help keep biodiversity high, which is great for ecotourism.

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Alumina Friction Plate Design and Analysis for Single-Plate Clutch Systems: A Thorough Investigation

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ABSTRACT

The friction plate is a critical component in single plate clutches, influencing their performance and longevity. This study focuses on the design and analysis of friction plates using alumina, evaluating its suitability and performance enhancement compared to traditional materials. Alumina, known for its high thermal conductivity and mechanical strength, offers potential benefits in terms of durability and heat dissipation in clutch applications. The study incorporates finite element analysis (FEA) to simulate the mechanical behavior and thermal response of the friction plate under varying operational conditions. Key parameters such as contact pressure distribution, temperature distribution, and wear characteristics are analyzed to optimize the design for maximum efficiency and longevity. The CREO 2.0 programme is used to model and develop a single plate clutch. The ANSYS 15.0 software was used to conduct both static and dynamic analyses. Experimental validation complements the FEA results, providing insights into the real-world performance of alumina-based friction plates in single plate clutches. The study explores manufacturing processes suitable for alumina, considering factors such as material properties, cost-effectiveness, and environmental impact.

KEYWORDS: Friction plate, Single plate clutch, Alumina, Finite element analysis, Thermal conductivity, Mechanical strength, Wear characteristics, Clutch performance, Material optimization, Manufacturing processes.

INTRODUCTION

Clutches are mechanical devices that link one mechanism to another, transferring the driving power from one mechanism to another. A brake, which restricts movement, is its polar opposite. Devices with two revolving shafts benefit from clutches. The driving component of such a device is often a motor or other power unit, while the driven member is the part of the device that really does the work. For example, a drill has two shafts: one that turns a motor and the other that turns the drill bit.

A clutch is a mechanical device that enables the engagement or disengagement of two shafts, allowing them to rotate at the same speed or at different rates. It allows the driving shaft to be started or stopped independently of the driven shaft. Thus, a clutch connects two shafts that are in motion and may be interrupted. A minimal amount of power can be used to state a large inertia load using clutches.

Friction clutch plates can be made from a variety of materials, including grey cast iron, E Glass Epoxy, Kevlar 49, silicon carbide, aluminium alloy A360,

and En-Gjs-400 - 15Steel. There are two main types of clutches: a single-plate clutch for smaller automobiles and a multi-plate clutch with a steel component for bigger vehicles.

An investigation was carried up by May Thin Gyan, Hla Min Htun, and HtayHtay Win [1] on the structural stability of a single clutch plate, and several materials were suggested as potential options for the plate. Static and dynamic analyses of single plate clutches, as well as comparisons of various materials utilised in their manufacture, have been the primary foci of B. Sreevani and M. Murali Mohan [2]. Researchers Vishal J. Deshbhratar and Nagnath U. Kakde found no evidence of harm from using a single-plate friction clutch in their investigation [3]. This is due to the fact that the material does not undergo any stress levels that exceed the maximum allowable under these circumstances while being loaded. Consequently, the item won't work as intended. An extensive analysis of the different clutch plate materials was carried out by G. Kannan, K. Krishnamoorthy, and K. Loheswaran [4]. The use of static structural analysis to handle the complexity of clutches with many plates and varying frictional forces was proven by Anil Jadhav, Gauri Salvi, Santosh Ukamnal, and Prof. P. Baskar [5]. The materials have been subjected to pressure or forces that have been dispersed.

The clutch plate was improved by Abhijit Devaraj [6] to make it last longer and work better. A. Krishna Reddy, Sesha Talpa Sai, and Mangeelal [7] need to have explicitly included stresses and deformations while describing the single plate friction clutch. Researchers Sagar Olekar, Kiran Chaudhary, Anil Jadhav, and P. Baskar [8] used ANSYS to study the deformation of the clutch plate for different materials in order to determine the optimum material to line a multi-plate clutch and to assess its structural behaviour. A static examination was conducted using finite element analysis to establish the stress distribution, maximum shear stress, and total deformation of a Friction clutch. The results were presented by Ganesh Raut, Anil Manjare, and P. Bhaskar [9]. Both the structural stress and thermal analysis temperature values for positive multiple friction plates were computed by Shaik Mohammad Ali and N.

An investigation on the various friction clutch plate

materials was carried out by Amaranageswara [10]. Alloy steel is now being used to make the friction disc for this project. Both static and dynamic analyses were performed on the single-plate clutch using ANSYS 15.0 after its design in CREO 2.0. Aluminium Alloy A360, E Glass Epoxy, Grey cast iron, Kevlar 49, Silicon Carbide, and En-Gjs-400 - 15Steel were the materials used for friction. The optimal material for the friction clutch plate was then determined by comparing the stresses, strains, and total deformation [11–13].

DEFINING TERMS AND MATERIALS

Materials Selection

Graphite is a component of the microstructure of grey iron, sometimes called grey cast iron. The term “graphite” comes from the fact that the resulting cracks are grey in color. Considering its light weight, cast iron is the most popular and often used material for casting. According to [15], the clutch disc is often made of grey cast iron. When compared to other materials such as Al-MMC (aluminum-metal matrix composite), carbon composites, and ceramic-based composites, grey cast iron is the material of choice for clutch discs because of its low manufacturing cost, excellent wear resistance, and high thermal conductivity (Terhech et al. 1995; Jang et al. 2003). A material's ability to quickly disperse heat is one benefit of its thermal conductivity or diffusivity [14]. For this project's commercial clutch disc, either ASTM G2500 grade grey cast iron or BS200 grade is used.

Steel - En-Gjs-400 mm

Cast iron of this quality is ubiquitous, both in China and across the world. Compared to grey cast iron, it has superior tensile strength, ductility, and toughness, and its mechanical characteristics are comparable to those of cast steel. Having said that, its drawbacks are also apparent. It is easy to produce shrinkage faults because of its significant shrinkage rate. Raw pig iron has more needs and a more involved casting process than other types of cast iron. Not to mention the extremely high and stringent technical standards that apply throughout the whole manufacturing process. SG iron grades EN-GJS-400-15 include Spheroidal Graphite, which can be seen as nodules or spheres. Cast iron's ductility and fracture resistance are both enhanced by the addition of

rounded graphite nodules, according to the International Journal of Emerging Technologies in Engineering Research (IJETER). SG iron outperforms grey iron in terms of fatigue and impact resistance.

E (Epoxy) Glass

Fibres such as carbon, glass, etc., are widely utilised. Glass fibres' primary benefit is their inexpensive price. Besides being very insulating, it is also quite strong and resistant to chemicals. Spring size and weight are increased due to high density, poor adherence to polymer, low fatigue strength, and low modulus of elasticity. Crystalline, semi-transparent, and extra-transparent glass fibres are available. In all current systems, the E-glass fibre serves as the standard reinforcing fibre, thanks to its excellent quality and ability to meet mechanical property requirements. Which is why E-glass fibre was deemed suitable for this purpose. Figure 1 displays a laminate made of epoxy glass cloth.

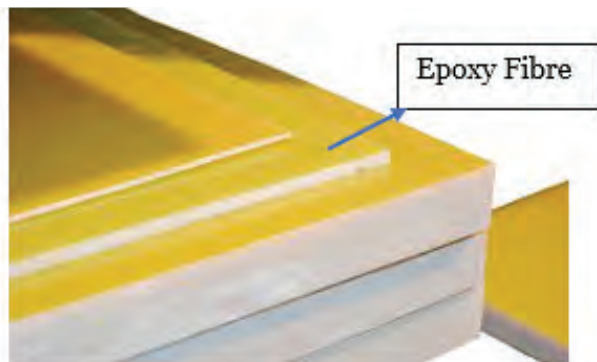


Fig. 1. Epoxy Glass Cloth Laminate

A360 Aluminio

Of all the aluminium shed components made for automobiles, 85–90% are Al-Si alloys, which are the most malleable of the bunch. The three main types of Al-Si alloy systems are hypoeutectic (<12%Si), hypereutectic (14-25% Si), and eutectic (12-13% Si), which are determined by the Si focus in weight percent (wt. %). Despite this, the majority of Al-Si alloys aren't cut out for usage in extreme heat applications due to their lower-than-desired tensile and fatigue strengths within the 500–700 F temperature range. Due to increased combustion pressures and piston temperatures, piston materials have been significantly

affected by the performance-enhancing effects of high-specific-power diesel and direct-fuel injection petrol engine developments in recent years. These alloys' wear resistance is due to the high volume proportion of hard primary silicon particles in their microstructure, even though surface hardness is often associated with wear resistance as a result of matrix characteristics. These alloys' already rapid rise in popularity has only quickened in the last several years. Casting and machining hypereutectic aluminum-silicon alloys are more challenging than other types of alloys. Enhanced wear resistance is another benefit of matrix-hardening alloys.

Dimethyl Siloxane

Carbon and silicon, having the molecular formula SiC. Since its first usage as a course material in 1893, silicon carbide powder has been mass-produced. Applications needing strong staying power, such as ceramic dishes in bulletproof jackets, cutting tools, grinding wheels, automobile brakes, and clutches, are frequently made of very hard ceramics that are bound together by sintering of silicon carbide grains. Today, SiC is extensively utilised in high-temperature/high-voltage semiconductor electronics; its electronic uses date back to 1907 when it was first utilised in light-emitting diodes (LEDs) and early radio detectors. The Lely process may be used to generate silicon carbide single crystals, which can then be carved into jewelry-quality gems called artificial moissanite. Plant materials containing SiO₂ can be used to make silicon carbide with a large surface area. Figure 2 illustrates the chemical compound Dimethyl Siloxane.



Fig. 2 Dimethyl Siloxane

Composites can benefit from the addition of SiC particles in the form of reinforcement, whiskers, or fibres. Composite SiC's overall strength, deterioration resistance, and wear resistance are all enhanced when

encased in a metal matrix. Aluminium metal matrix composites (MMCs) reinforced with silicon carbide. When compared to the identical unreinforced alloy, the addition of (SiC) particles results in a 20% improvement in lowered coefficient of thermal expansion, yield strength, and modulus of elasticity. The remarkable hardness of sic-based composites makes them very desirable in a wide range of applications, including but not limited to: cutting tools, jewelry, structural materials, electrical circuits, automotive components, nuclear fuel particles, and countless more. There are many other places you could find it; brake discs, airplanes, cars, and bicycle frames are just a few examples.

A-47 Kevlar

The name Kevlar was first used in the 1970s by DuPont. Because of its high modulus and tensile strength, it was the first organic fibre to find a home in high-tech composites. Although Kevlar was initially created to substitute steel in radial tyres, it has now found several other uses. A paraaramid synthetic fibre, similar to Nomex and Technora, with the registered brand Kevlar 49. This high-strength material was initially utilised commercially in the early 70s as a replacement for steel in racing tyres. It was developed by Stephanie K. Wolek at DuPont in 1965. It is also used to line newer drums since it can endure a lot of impact. As a woven material, it works well for mooring lines, has underwater uses, and might be utilised as lining material in the future.

Table 1 friction plate's material properties

Materials	Youngs modulus (GPa)	Density Kg/m ³	Poisson's
Ratio			
Gray Cast Iron	110	6100	0.21
En-Gjs-15Steel	120	5800	0.3
E GlassEpoxy	256	1100	0.12
Aluminium AlloyA360	41	1200	0.14
SiliconCarbide	450	1500	0.15
Kevlar 49	100	1452.6	0.65

CALCULATING MATHEMATICALLY

Requirements

At 4700 rpm, the power is 73HP.

The torque is 202.5 N-m at 2800 rpm.

The pressed asbestos material has a μ value of 0.3.

Maximum working temperature . $C=150-(250-1)^{\circ}C$

$P=300 \text{ kN/m}^2$ is the maximum pressure.

The frictional surfaces' outer and inner radii

the number of contact surfaces, $n=2$, $r_0=0.1145$ “ mm, $r_i=0.0802$ “ mm

R = average friction surface radius

For consistent pressure:

The equation $R=2/3[(r_0^3-r_i^3)/(r_0^2-r_i^2)]$ may be rewritten as $2/3[(0.3145)^3-(0.0802)^3]/(0.3145)^2-(0.0802)^2$.

The value for “m” for uniform wear is 0.09836. The equation $(R = (r_0+r_i)/2\#(2)@=(0.1145+0.0802)/2\#(2)@=0.09735$ “ m#(2)) can be used in this context.

DIFFERENTIAL EQUATION

A. When thinking about Uniform Pressure

When pressure is evenly distributed across the whole friction face,

$$p = \frac{\text{load}}{\text{contacting surface area}} = \frac{W}{\pi(R_1^2 - R_2^2)} \quad (3)$$

Where,

W =” Axial thrust with friction surface “

Frictional torque acting on the friction surfaces is included by

$$T=n*\mu* w*R \quad (4)$$

Where,

n = no of contact surfaces

μ = Coefficient of friction

R = mean radius of friction

$T=135\text{N-m}$

$$= 202.5 / (2 * 0.3 * 0.09735)$$

$$W = 3466.8721 \text{ N}$$

For Considering Uniform Axial wear

Axial force is required to engage the clutch

$$W = 2 * C * \pi * (r_o - r_i) \quad (7)$$

$$C = P * r \quad [C = \text{Constant}]$$

The Maximum intensity pressure occurs at inner radius of friction surfaces

$$C = P_{\max} * r_i \quad (8)$$

$$C = W / \{2\pi * (r_o - r_i)\} \quad (9)$$

$$= 3466.8721 / \{2\pi(0.1145 - 0.0802)\} \quad (9)$$

$$C = 16086.584 \text{ N/m} \quad (9)$$

$$P_{\max} = C / r_i \quad (9)$$

$$= 16086.584 / 0.0802 \quad (9)$$

$$= 200.5808 \times 10^3 \text{ N/m}^2 \quad (9)$$

The minimum intensity pressure occurs at outer radius of friction surface

$$P_{\min} = C / r_o$$

$$= 16086.584 / 0.1145$$

$$= 140.4942 \times 10^3 \text{ N/m}^2$$

On average, the friction surface's pressure

Total force acting on the friction surface divided by the area of the friction surface's cross-section is P_{avg} .

$$P_{\text{avg}} = 165.2448 \times 10^3 \text{ N/m}^2 = W / \{\pi(r_o^2 - r_i^2)\}$$

$$P_{\text{avg}} = 3466.872 / \{\pi(0.1145^2 - [0.0802]^2)\}$$

The friction plate's maximum operating pressure.

The formula $P = 200.2249 \times 10^3 \text{ N/m}^2$ is acceptable.

The friction plate works by using the material's characteristics.

A REVIEW AND DESIGN OF A SINGLE-PLATE CLUTCH

Four windows in the clutch design can hold springs that damper smash, making it easier to use and reducing the force on the gear box when engaged. There are six rivet holes and a hole in the middle for the hub to go through in the design.

Analyzer

Ansys Workbench, an analysis programme, was subsequently used to import the 3D part model. The

geometry was given the material characteristics shown in table 1. Following this, the model was fine-meshed, or split, into a limited number of elements, as seen in the Figure 3.

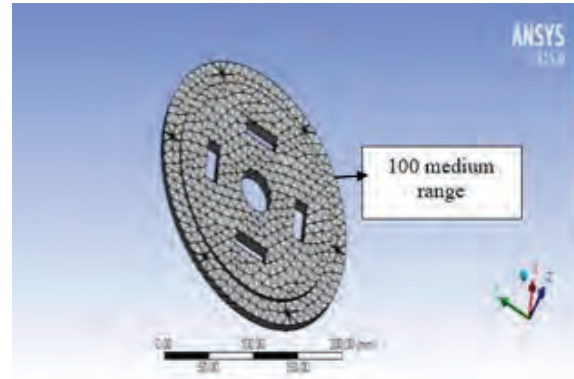


Fig. 3 The single plate clutch in a mesh perspective

It can't engage or disengage the clutch disc without a pressure plate. The clutch is fastened to the pressure plate using rivets. Before the diaphragm spring, there is a clutch release bearing. The mounting of the pressure disc is flexible enough to allow the pressure plate to disengage when the release bearing is pressed inward, and for the clutch to come into contact with the plate again when the release bearing is released. The geometrical boundary conditions were derived from this reasoning.

ANALYSIS AND DECLARATION

An investigation was conducted to examine the performance of materials in a single plate clutch by analysing design characteristics generated from the study, including VonMises stress, VonMises strain, and total deformation. Furthermore, the investigation obtained a maximum strain of 0.00055353 and a total deformation of 0.22113 mm, both of which are far below the material's deformation threshold of 1mm. The material should not be bent beyond a safe limit so that the engine can transmit the maximum torque to the gearbox. The results show that the maximum stress occurs at the rated torque for all materials.

CONCLUSION

Finally, alumina friction plate design and analysis has great potential for improving the efficiency and longevity of single plate clutches. Crucial for preserving operating

efficiency under changing loads and temperatures, alumina's use into friction plate structure provides substantial enhancements in mechanical strength and thermal conductivity. Results from finite element analysis (FEA) show that friction plates made of alumina are more thermally stable and have better mechanical behaviour than other materials. This discovery highlights how alumina may reduce heat degradation and wear, which means clutch components last longer and maintenance costs go down. Experimental results corroborate the feasibility of using alumina in actual clutch applications, as predicted by FEA. To achieve robust performance and cost-effectiveness in friction plate design, the study stresses the need of optimising material attributes and manufacturing methods..

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Findings from an Experimental Examination of the Energy Consumption of R513A in a Miniature Refrigeration System in Place of R134a

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ABSTRACT

It is critical to investigate eco-friendly refrigeration system alternatives to high-global warming potential (GWP) hydrofluorocarbons (HFCs) since their phase-out is approaching quickly. In order to determine whether or not R513A, which is a mixture of 41HFO and HFC, is a viable alternative to R134a in a refrigeration system with a modest capacity, an exergy analysis is carried out in this research. Evaporating temperatures range from -15 degrees Celsius to 5 degrees Celsius, while condensing temperatures are at a constant 30 degrees Celsius and 35 degrees Celsius throughout the experiment. Exergy destruction rates reveal the highest inefficiencies at the compressor and evaporator, while the condenser and expansion device exhibit superior exergy efficiencies. Comparing R513A to R134a, the average global exergy efficiency shows a modest 0.4% increase with R513A, indicating acceptable performance per the second law of thermodynamics. Despite slight efficiency reductions in the condenser with R513A, the overall exergy analysis supports its feasibility in practical refrigeration applications

KEYWORDS: *Exergy analysis, Refrigeration system, R513A, R134a replacement, Global warming potential, Thermodynamic efficiency.*

INTRODUCTION

To mitigate the projected rise in the average surface temperature of the Earth, the phase-down of hydrofluorocarbons (HFCs) must be a top concern. Two other important pieces of legislation that have played a role in implementing this method so far are the Kigali Amendment to the 102 Montreal Protocol [1] and the Regulation (EU) No 517/2014 [2]. The Kigali Amendment sets a deadline for the global implementation of a severe decrease in HFCs. In 2015, the European Union (EU) began a regulation that would eventually restrict the use of HFCs in the most

extensive commercial and residential refrigeration and air conditioning systems, as well as those with a high Global Warming Potential (GWP). In Europe, R134a—one of the longest-lived refrigerants with a GWP of 1300—will soon no longer be used in applications including home freezers and refrigerators, supermarket multipack systems, and portable air conditioners [3]. In addition, R134a is becoming more expensive as a result of regulations limiting the consumption of HFCs or, in certain countries, taxes on fluorine fluids.

In response to the harmful effects of climate change, there has been a flurry of research into potential

replacements for hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), with a focus on R134a, as well as other synthetic and natural refrigerants [4,5]. Synthetic low GWP refrigerants R1234yf [6] and R1234ze(E) [7] were the first to be developed as a replacement for R134a. With GWP values < 1 [8] and minimal flammability [9–11], these two fluids are hydrofluoroolefines (HFOs). The following fluids' operating benefits and drawbacks were established after several theoretical and experimental investigations: R1234ze(E) necessitates substantial alterations or new design methods to achieve the refrigeration system's cooling capacity [12], and There is no evidence that R1234yf improves the energy efficiency of HVAC systems [6,7].

A number of hybrids combining HFCs and HFOs have been developed and marketed as a solution to the issues associated with pure HFOs, as well as a lower GWP value than R134a, the standard operating procedure fluid. To make R450A and R513A, respectively, it combines R134a with R1234ze(E) and R1234yf. Their low toxicity, non-flammability, and lowered GWP values make them ideal for usage in air conditioning and refrigeration (547 for R513A and 562 for R450A, respectively). Few studies have investigated the energy efficiency of refrigeration systems and their parts [13–14]. This is likely due to the novelty of these refrigerants. In contrast, there has been a great deal of study on pure HFOs.

R513A AND R134A PROPERTIES 2

You may find the main details about the refrigerants that were studied in this study in Table 1. The qualities of refrigerants exhibit obvious similarities in terms of the following aspects: In addition to the ASHRAE safety classification, the critical temperature and pressure, the usual boiling point, and the density of the liquid. In addition, the R513A GWP value is lower than that of R134a, and the fact that it has almost no temperature glide makes it an azeotropic refrigerant. It may get more details on other R134a refrigerants in [3].

Table 1. R513A and R134a most important features.

	R513A	R134a
ASHRAE safety class	A1	A1
Critical pressure [Mpa]	4.85	3.12

Critical temperature	85.2	98.1
Glide at 0.1 Mpa [K]	0.1	0
GWP	658	1100
Liquid density at 0 Degree [Kg m^{-3}]	1221.9	1294.8
Molecular Weight	102.5	100
Normal boiling point	-29.6	-26.1
ODP	1	1
Vapor density at 25 degree [Kg m^{-3}]	37.63	32.35

APPROACH

Experimental Design

The exergy performance of the vapor compression system may be accurately represented by employing a tiny chilled test bench. This system uses low GWP mixes, notably R513A, as an alternative to R134a. Figure 1 serves as a test bench and displays the primary components of this system.

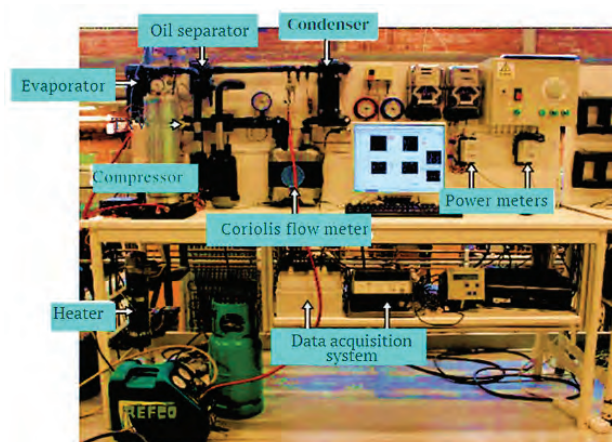


Fig. 1 Experimental setup and its essential components schematically

The 550” “ W nominal port and 15.4” “ cm³ swept volume compressor is of the hermetic rotary type. In the next step, plate heat exchangers with a channel volume of 0.062 dm³ are utilised for the condenser and evaporator, respectively. These heat exchangers have an exchange area of 0.248 m² and 0.558 m², and ten and twenty plates, respectively, are utilised. The circuit's flow is controlled by the R134a-specific thermostatic expansion valve (TXV). For more accurate readings, it is important to separate heat exchangers,

secondary components, and circuit pipes. Water is used in the open loop of the condenser secondary circuit and a solution containing 43 itight percent ethylene glycol is used in the closed loop of the evaporator secondary circuit. The goal condensing pressure is maintained by adjusting a water regulating valve, and the quantity of heat transmitted in the evaporator is determined by three phase poitr resistances submerged in an isolated tank (2İ810” “W fixed and 1×970” “W adjustable, nominal values).

According to the data in Table 2, it measure the following: temperature, pressure, mass flow rate, poitr, and heater poitr consumption. These readings are taken by a data collecting system, which then sends them to a computer, where they are shown and saved every ten seconds. The remaining steady-state output parameters are derived from the REFPROP v9.1 database’s provided attributes [28].

Results from the experimental refrigeration arrangement, as shown in Table 2.

Table 2 Measurements collected in the experimental refrigeration setup.

Measurement	Sensor	Range
Temperature	T type thermocouple	[-60-100]
Discharge pressure	Pressure sensor	[0-2.1] Mpa
Suction pressure	transducer	[0-1.1] Mpa
Evaporator pressure drop	Differential	
	Pressure sensor	
Refrigerant mass flow rate	Coriolis type	[0-20]gs
	flowmeter	
Electric poitr use of the		[0-750]W
motor-compressor se	Configurable multi	[0-3000]W
Electric poitr use of the	transducer	
heaters		

Experiment methodology

The duration of the steady-state test is approximately 30 minutes. To take into account the steady-state condition in a test, the pressures need to be within ± 2.5

kPa and the temperatures need to be within ± 0.5 ” K. After attaining a steady state, the parameters that are mentioned in Table 2 are measured sixty times, and the data that is utilized to describe the ideal operating condition is averaged over the course of the ten minutes that are the most stable. The purpose of the tests is to simulate the conditions under which a refrigeration system with a limited capacity would operate at the typical medium evaporation temperature, which is somewhere between -15 degrees Celsius and 5 degrees Celsius. The maximum permissible variation was ± 0.2 ” K, and the condensing temperatures that were selected are 30 and 35 degrees Celsius Fahrenheit.

Analysis of exergy

When a system reaches an equilibrium state under given external parameters, its exergy is the greatest theoretical work that was gained during that process. Based on the second rule of thermodynamics, the exergy method analysis helps designers pinpoint where, what’s causing, and how much heat is being lost in thermal systems. In order to assess the efficiency of a refrigeration system, one may utilise the exergy analysis to find out how big and where the irreversibility is.

An application of the first and second laws of thermodynamics yields Eq. (1) [29], which shows the generic formulation of exergy balance in any control volume.

$$\dot{E}_d = \sum \left(1 - \frac{T_0}{T}\right) \dot{Q} - \dot{W}_{in} + \sum_{in} \dot{m}e - \sum_{out} \dot{m}e \quad (1)$$

A actual drop in energy quality that cannot be identified using an energy balance is represented by the exergy destruction rate, which is denoted by the symbol $\dot{E}_d$ in this particular exergy balance. Equation (2) demonstrates that the total rate at which exergy is lost in the compact refrigeration system being studied may be determined by adding together the rates at which exergy is lost in each individual component.

$$\dot{E}_{d,system} = \dot{E}_{d,comp} + \dot{E}_{d,cond} + \dot{E}_{d,TXV} + \dot{E}_{d,evap} \quad (2)$$

It doesn’t take into account how kinetic and potential energy affect the particular exergy of the refrigerant’s working fluid. To continue, the individual exergy is defined by Eq. (3). The dead state conditions of 101.3

kPa and 298.15° K are used in the equation to determine the enthalpy (h_0) and entropy (s_0).

$$e = (h - h_0) - T_0(s - s_0) \quad (3)$$

Equation (4) is used to get the global exergy efficiency, which is equal to the ratio of the exergy expenditure to the least power that is needed by a reversible system. This efficiency is used to quantify the relative losses that occur across the refrigeration system as a whole

$$\eta_{ex} = 1 - \frac{\dot{E}_{d, \text{component}}}{\text{exergy expenditure}} \quad (4)$$

The actual power provided to the compressor, as shown in Eq. (5), represents the exergy expenditure for the whole vapour compression system.

$$\eta_{ex} = 1 - \frac{\dot{E}_{d, \text{system}}}{\dot{W}_{\text{comp}}} \quad (5)$$

Heat transfer accounts for the exergy dissipated into the environment as part of the compressor's exergy balance. Wall temperature, T_{wall} , "here refers to the boundary temperature situated on the compressor's compression shell wall. The average value of 77 degrees Celsius was determined by analysing experimental data. The exergy expenditure, as it pertains to heat exchanger exergy efficiency (refer to Eq. 4), is the sum of the exergy of the refrigerant that flows into and out of the heat exchanger. Due to its diminutive size, the expansion valve's heat transmission to the environment was disregarded.

FINDINGS AND ANALYSIS

The exergy performance was projected based on the previously described physical principles and empirical data. The estimate of thermophysical properties was conducted using MatLab, which was connected to REFPROP [27]. The exergy research reveals the primary findings for the R134a and R513A refrigerants under certain working settings. These results refer to the temperature range of -15 degrees Celsius to 5 degrees Celsius for evaporation, with two unique condensing temperature conditions of 30 degrees Celsius and 35 degrees Celsius, respectively.

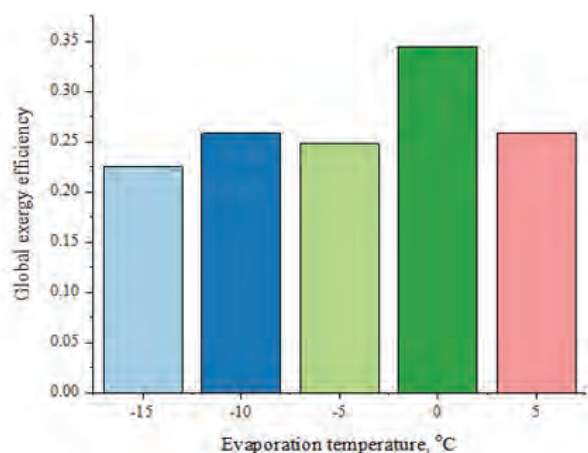
Following the presentation of the global exergy parameters, the article moves on to conduct an analysis of the data on the exergy destruction rate and the exergy

efficiency for the compressor, condenser, expansion device, and evaporator. The refrigeration system is comprised of these four components, which are the most important portions. In Appendix A, you will find the estimated uncertainty [30] of the exergy destruction rate and the exergy efficiency for the four primary components that make up the global refrigeration system. The purpose of providing this information is to make it easier to conduct a more in-depth study of the results that are shown in Figures 1 and 2. The dimensions of global exergy Point two and a half

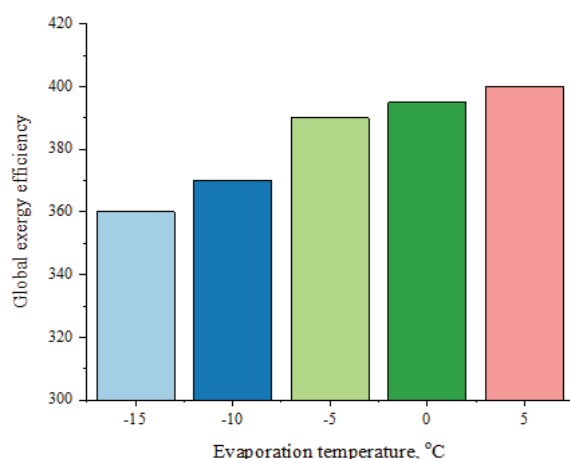
The rate at which exergy is being lost is shown in Figure 2, along with the overall efficiency of the refrigeration system in terms of the amount of global exergy this system consumes. Figure 2a indicates that the global exergy efficiency steadily decreases after reaching its maximum point (between -15 degrees Celsius and -7 degrees Celsius) when the evaporation temperature is higher than -7 degrees Celsius by a significant amount. This is seen in Figure 2b, which shows that the global rate of exergy degradation rises when the temperature of evaporation approaches greater levels. As can be seen in Figure 2, the temperature at which condensation occurs has a major influence on the exergy performance of the refrigeration system.. The worldwide exergy efficiency rating declined with increasing condensation temperature. Raising the condensing temperature for both refrigerants leads to an increase in the rate of exergy destruction due to a greater temperature difference between the component and the surrounding air.

Through the application of the second rule of energy balance to the whole cycle, it becomes apparent that the exergy of the system is controlled by both the pressure that is supplied to the compressor and the cooling capacity of the evaporator. Therefore, this contribution may be broken down into three different variables: the rate at which exergy is lost, the amount of exergy that is lost to water in the condenser, and the amount of exergy that is lost to the environment as a result of heat dissipation in the compressor shell. Evaporation temperature has a negligible effect on the amount of electricity used and the amount of cooling capacity available. The temperature at which water is condensing will stay constant, often falling somewhere between 30 and 35 degrees Celsius, and there will be very little change in the amount of heat that is

transferred to water. This conceptual study reveals that R513A exhibits behavior that is equivalent to that of R134a, with a higher evaporation temperature resulting in a larger cooling capacity and exergy destruction rate. Multiplying the mass flow rate by the difference in enthalpy of the refrigerant at the evaporator, which is often referred to as the refrigerating effect, is one method that may be used to ascertain the cooling capacity of a system. In accordance with the technique described in Section 3.1, the necessary quantity of heat is supplied.



a) Efficient use of energy



b) Loss of energy

Fig. 2 Relationship between evaporation temperature and global exergy performance

At temperatures of 30 degrees Celsius and 35 degrees Celsius, respectively, the maximum exergy efficiencies for R134a are around 0.265 and 0.236, as shown in Figure 2a. On the other hand, the values for R513A

are 0.264 and 0.245. The evaporation temperatures for R134a are -10 degrees Celsius and -5 degrees Celsius, respectively, whereas for R513A, the temperatures are -10 degrees Celsius and 7.5 degrees Celsius, respectively. As a result, the previous work on first law analysis demonstrated promising energy performance results, suggesting that R513A may attain the same or even greater global exergy efficiency in this R134a-designed test bench [14].

PARAMETERS OF COMPONENT EXERGY

This section presents and discusses the behaviours of the key components of the refrigeration system in order to expand the knowledge on its exergy performance.

Boiler

Figure 4 illustrates the exergy performance of the compressor at two constant condensing temperatures (-30°C and 35°C) and an evaporation temperature range of -15°C to +5°C under the conditions described in the previous sentence. Increasing the temperature at which the evaporation occurs results in an increase in the exergy efficiency of the compressor, as shown in Figure 4a. Under a variety of refrigeration system operating conditions, the behavior of the compressor's exergy efficiency while it is working with R513A is slightly greater than that of R134a. The compressor's exergy efficiency is much higher while using R513A, even though it was designed for R134a. The R513A has a 3.4% higher exergy efficiency than the R134a at 30°C and a 6.7% higher exergy efficiency at 35°C, respectively.

This expansion is achieved even though the earlier work reported a larger usage of electrical power [14]. Compression of this novel combination results in less entropy due to its thermodynamic characteristics. With lower compression ratios, the compressor's exergy efficiency should improve. Based on several studies in the literature, it is known that hermetic rotary compressors with limited capacities have low exergy efficiency owing to the compressor's moveable elements [21,22]. Consequently, this component is the most important one to consider.

The rate of exergy degradation due to the compressor is also shown in Figure 4b.

With a rise in evaporation temperature, the exergy destruction rate decreases. The rate of exergy degradation and the global exergy efficiency are both impacted considerably by the compressor. Raising the compression ratio reduces the efficiency of the compressor and, therefore, the efficiency of the global exergy system. Additionally, the viscosity causes a higher loss of energy, and the temperature inside the compression chamber increases in tandem with an increase in the compression ratio.

Refrigerant

The link between the exergy destruction rate, the temperature at which evaporation and condensation occur, and the exergy efficiency of the condenser is shown in Figure 5. Depending on the refrigerant, the temperature of the secondary fluid, often known as drain water, may range anywhere from 17 to 22 degrees Celsius. This component, which already has a high exergy efficiency, is capable of achieving optimal performance at a low condensing temperature of 30 degrees Celsius (Figure 5a). At low condensing temperatures, the behavior of the condenser in terms of exergy is not significantly affected by changes in the temperature of the evaporation process. One of the reasons why the component has such a high insulation level is because it has a great exergy efficiency in adiabatic circumstances. Condensing temperatures that are extraordinarily close to the temperature of the surrounding environment are another factor that contributes to the high exergy efficiency under equilibrium conditions.

Valve for expansion

The TXV exergy destruction rate and efficiency are displayed in Figure 6. The literature study typically shows that the TXV has the greatest exergy efficiency values of any refrigeration circuit component, and that throttling has no discernible effect on the exergy destruction rate. An improvement in this component's exergy efficiency is a direct result of the fact that raising the evaporation temperature slows the rate of entropy creation and, by extension, exergy degradation. The design of the R134a thermostatic expansion valve is likewise suitable for R513A because there are no noticeable changes between the two refrigerants.

Vaporizer

This is the exergy behavior of the evaporator, as seen in Figure 7. When subjected to the operational conditions represented in Figure 7a, both refrigerants display behaviours that are quite similar with regard to the rate of exergy degradation and efficiency. Considering that the exergy efficiency of the evaporator is comparable to that of a compressor at higher evaporation temperatures, this sizing is ideal for loitr operating temperatures (the loitr difference between the temperatures of the secondary fluid and the refrigerant in the evaporator, as well as the mass flow rate), with the exception of condensing conditions. In light of this, the conditions in which it ought to be used are not those described above.

Regardless of the temperature at which condensation occurs in the evaporator, the rate of exergy destruction remains unaltered. Even though the evaporator was designed to operate only with R134a, it is important to note that there are no discernable patterns or numerical differences in the exergy destruction rate between the two refrigerants. This is something that should be taken into consideration.

CONCLUSION

In this research, the exergy behavior of R513A was compared to that of R134a. The analysis took into account the global system's exergy efficiency and destruction, in addition to the four primary components of the system. The investigation was based on data obtained from a compact vapour compression system that had a rotary compressor that was hermetically sealed in its whole. Condensation occurs at temperatures ranging from 30 to 35 degrees Celsius, whereas evaporation occurs at temperatures on the lower end of the temperature spectrum, between -15 and 5 degrees Celsius. It is possible that the following findings may emerge from this investigation: Despite the fact that it had a greater exergy destruction rate, R513A had a global exergy efficiency that was slightly higher than that of R134a. After peaking at a specific evaporation temperature, the worldwide efficiency began to decline. Specifically for the novel R513A combination, loitr condensing (cooling water) temperatures improved this parameter. Because of its rotational components and losses to the surrounding environment, the compressor was the experimental system component that reduced exergy efficiency and increased irreversibility. The parts

that demonstrated the greatest exergy efficiency in the expansion valve and condenser, while the evaporator exhibited intermediate values. Because of the insulation and the plate heat exchanger's compact design, which leads to improved heat transfer rates, the water-cooled condenser's exergy destruction rate was lowered. Since all of the components had exergy efficiencies that were either equal to or greater than R134a, the second-law analysis proved that R513A may be utilized in R134a refrigeration systems without undergoing any modification. If it were our refrigeration system to operate better in the end, it would need to find a replacement for the rotary compressor that can handle smaller cooling capacity just as it is.

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Development of QRob: A Compact Autonomous Fire Fighting Robot for Enhanced Safety and Efficiency

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ABSTRACT

Fire incidents pose significant threats to human life, property, and the environment, often resulting in tragic consequences such as injuries, fatalities, and psychological trauma. Firefighters, tasked with extinguishing fires, face substantial risks, particularly in hazardous environments like nuclear facilities, refineries, and confined spaces where fires can be difficult to reach and extinguish. Technological advancements offer promising solutions to enhance firefighting capabilities and minimize risks to personnel. This paper introduces QRob, an innovative firefighting robot developed to mitigate these challenges. Unlike traditional firefighting methods that rely heavily on human intervention, QRob is designed to operate autonomously, thereby reducing the exposure of firefighters to hazardous conditions. The robot's compact size enables it to access narrow and confined spaces, where fires often occur and are difficult to extinguish using conventional methods. QRob integrates advanced sensors for enhanced functionality: an ultrasonic sensor ensures obstacle avoidance, enhancing maneuverability in complex environments, while a flame sensor detects fire presence and location accurately. These features enable QRob to autonomously navigate through obstacles, locate fire origins, and extinguish flames effectively. Operational control of QRob is facilitated remotely via smartphone or other devices, allowing firefighters to monitor and direct firefighting operations from a safe distance. The robot is programmed to approach fires within a maximum distance of 40 cm, ensuring efficient and controlled fire suppression without endangering human life.

KEYWORDS: *Firefighting robot, Autonomous system, Fire detection, Obstacle avoidance, Remote operation, Safety enhancement.*

INTRODUCTION

Robots are automated devices that carry out tasks that are often done by humans or other equipment. These tasks can be either flexible or repetitive. Several studies have demonstrated the usefulness of robots in several fields, including healthcare [1], rehabilitation [2], rescue operations, and industrial [3]. Robots have been used in many different fields over the years. Industrial robots may carry out a wide range of

activities by using a variety of programming motions and specialised materials, divisions, gadgets, or equipment [10]. A unified system capable of controlling, communicating with, and integrating various types of robots is in high demand, in keeping with the Fourth Industrial Revolution (4IR). While machine learning is certainly a driving force behind some of the most recent advancements in robotics, it is by no means the only one. Machine learning algorithms have been used into recent

robotic development projects [4] in an effort to enhance robot intelligence. Over time, this will boost industrial output while decreasing expenses and electrical waste.

Researchers are actively studying how to deploy humanoid robots to increase productivity, safety, efficiency, and work quality while decreasing the number of injuries and fatalities suffered by firefighters [5]. There are several subsets of robots, including tele-robots, telepresence robots, mobile robots, autonomous robots, and android robots. While tele-robots and telepresence robots are conceptually similar, the key distinction is that the latter may receive input in the form of video, audio, and other data. As a result, telepresence robots are finding frequent application in a variety of industries that need constant supervision, including daycares, schools, and the enhancement of social and everyday activities for the elderly [6]. With the help of humans, mobile robots can move about and do jobs. In contrast to android robots, which are designed to imitate humans, autonomous robots are capable of carrying out the work autonomously and drawing power from their surroundings.

An autonomous firefighting robot is suggested in this article. Designed to hunt for and put out fires, this robot's primary role is to serve as an unmanned support vehicle. There are a variety of vehicles available for use in domestic firefighting and in putting out wildfires [7]. It is our hope that our suggested robot would have the capability to operate autonomously or under remote control. Firefighters can avoid hazardous situations and increase safety during fire identification and rescue operations by utilising these robots. What this means is that firemen won't have to put themselves in harm's way as often thanks to robots. When a fire breaks out in a tunnel or a nuclear power plant, for example, the robot's tiny size and ability to operate autonomously make it an ideal tool for the job [8].

Two well-established firefighting robots on the market today are FireRob and Thermite. Hoit and Hoit Technologies Inc.'s Thermite is a 400" "m-range, remote-controlled firefighting robot [11]. With a maximum pressure of 150 psi, it can produce 1200 gallons per minute of water flow. The dimensions of this mechanical marvel are 187.96" "cm x 88.9" "cm x 139.7 cm. With its diesel engine, this robot can reach

a maximum power of 25 horsepower (18.64 kilowatts). The heart of this robot's design is its multi-directional nozzle, which is supported by a 600gpm (2271.25l/min) pump. Places like nuclear power facilities, processing factories, processing planes, and chemical plants are ideal for this robot's usage [9].

The FireRob, made by the Croatian company DOKING, is a remote-controlled fire engine that only requires one operator. With a hydraulic arm that can pump water up to 55" "m distant, it puts out fires without the need for firefighters. It has two onboard tanks that can hold 1800 litres of water and 600 litres of foam. The coating that FireRob has enables it to endure temperatures of 250°C and radiation levels of 23 kW/m for 30 minutes [12].

This research led to the development of a tiny firefighting robot. The acronym "QRob" stands for "Rescue Robot," which is the name of this robot. Not only can this robot search for objects, but it can also put out fires. On top of that, this robot can improve the task's quality, efficiency, safety, and production. Compared to FireRob and Thermite, QRob is smaller and more versatile. A further perk of QRob is that it can go through spaces with limited openings or widths [10].

METHODS

Three sections make up the approach. After a brief overview of the hardware, the next section delves into the mechanical schematics, and lastly covers the programming design. A series of experiments were conducted to ascertain the ideal distance of QRob to put out the fire once all the components had been installed. Section A. Mechanical Framework The 2D and 3D schematic diagrams were created using AutoCad and Google SketchUp, respectively.

In terms of its primary structure, QRob has two wheels on the back and two wheels on the front, allowing it to achieve the desired speed and mobility. The robot can spin in a full circle and stay upright thanks to its wheels. To keep the electronic circuit safe, the robot's body is constructed from an acrylic plate. Heat up to 200 degrees Celsius can't damage the acrylic sheet. This grants the capability to operate and utilise (drill and cut). Acrylic chassis have perforations all over the body that facilitate the attachment of many different kinds of sensors and mechanical parts.

To help the robot avoid obstructions and detect fires, an ultrasonic sensor and a flame detector are mounted on its front end, respectively. A small camera, which is connected to the smartphone, was also mounted on the robot's front side to record the surroundings and the robot's progress. In Figures 1, it can see the framework of the robot that can detect fires.

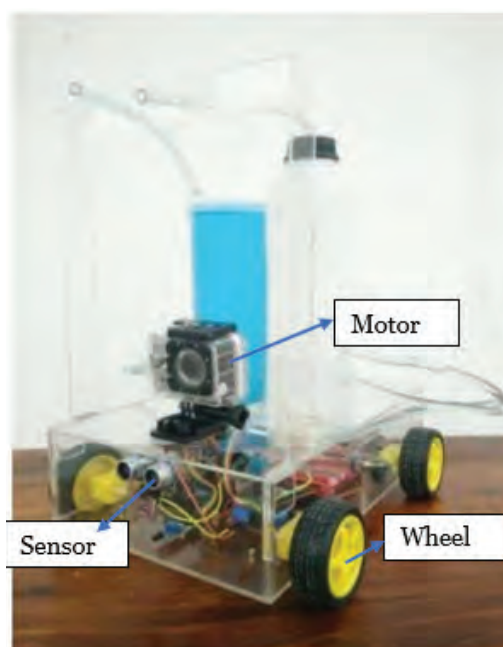


Fig. 1. Firefighting Robot (QRob)

SETTING UP HARDWARE

An integral aspect of QRob's development is the electrical component. Some of the components include a water pump, a transmitter, a remote control, a variety of sensors, a microcontroller, and a DC motor with wheels [13]. Inputs to the QRob system include flame and ultrasonic sensors, as shown in the block diagram of the system's operation in Figure 2. A microcontroller that can be linked to additional parts is the Arduino Uno [14]. In order to get the system's output, it needs a motor driver (L298N) and a transmitter/remote control. The operator controlled the flow of water and the fire extinguisher. Conversely, a camera (Go Pro) attached to a smartphone allows the operator to track the robot's movements. Smoke detector: As the "eyes" of the robot, fire sensors are crucial in locating the origins of fires in most firefighting robots [15]. Using the range of visible light from 760 nm to 1100 nm, it can detect fires. The

distance and detecting angle are 20" " cm (4.8" V) to 100" " cm (1 V) and 60 degrees, respectively. Two signal pins, one for digital output and one for analogue output, make up a flame sensor. DO pins can tell it if it's burning or not, but AO pins can identify the precise wavelength of light.

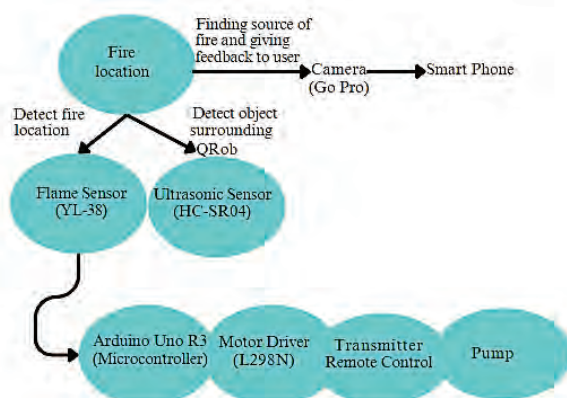


Fig. 2. Block Diagram of QRob

Ultrasonic sensor

An ultrasonic sensor is an essential component of any autonomous target detection robot's ability to avoid obstacles and barriers. In order to be used on a bigger scale, a sensor has to be small, inexpensive, and easy to manufacture. Additionally, it has to have sufficient sensing capabilities to enable robots to respond and navigate correctly. As of right now, only ultrasonic sensors meet all of these criteria. In this investigation, the HCSR04 ultrasonic sensor is used to measure distances between 2" " cm and 400" " cm at an angle of 15 degrees. In order to detect an item, this sensor sends out waves into space and then picks up reflected waves. The four output pins are a ground pin (GND), a digital output (DO), an analogue output (AO), and a reference voltage (VCC) that operates at about 5 V. Suitable materials for this project include DC geared motors with rubber wheels and DC motors with wheels. It may swap out its 2WD or 4WD chassis with this DC motor. A DC motor requires a voltage between 5 and 10 volts to operate. The gear ratio, however, is 48:1. This motor requires a current of 73.2 mA. Shipped to the scene of the fire by use of a DC motor. The water pump is a crucial component of this robot since it can pump soap or water to put out different types of fires. For this project, a small, lightweight water pump has been used.

On top of that, it uses very little power, is quite effective, and produces very little noise. For this water pump, 6" "V" is the ideal voltage. The voltage range for this water pump is from 4 to 12 volts, and the current it can handle is 0.8 amps. Section A: The Transmitter and the Control Unit: A four-mode wireless remote control transmitter and receiver will be utilised in this investigation. This receiver or remote control is a model S4C-AC110. This handset is equipped with a quartet of buttons. The relay can handle voltages between 110 and 240 volts or DC 0 to 28 volts, whereas the operational voltage for the remote control is 100 to 120 volts. This transmitter is a model C-4. There is a 100" "m, or 300ft, range for the remote control. These 12"-inch batteries will power this transmitter. The 315 MHz/433 MHz frequency is used for transmission. The operator may remain in a safe location when QRob enters a potentially hazardous fire zone; all they need is a transmitter and a remote control.

Control Instructions

The connection between the main surface plane and the QRob coordinate plane.

Initially, it is thought that QRob is at the centre position, with the current coordinate point being (0,0). The z-axis is rotated, a new coordinate is assigned to QRob, which is represented as (x,y) on the coordinate plane, representing the change in position from the initial to the final position. The figure's main surface coordinate plane is (X_m,Y_m), whereas the QRob coordinate plane is (X_r,Y_r).

In order to find the QRob's coordinates and angular position, it uses Equation (1). Here, x[^], y[^], and θ[^] are the coordinates with respect to the main surface plane (X_m,Y_m), and v and ω are the driving and turning velocities with respect to the QRob coordinate plane (X_r,Y_r). Next, replacing the obtained kinematic model of QRob with a differential-drive vehicle,

$$v = \frac{r(\omega_R + \omega_L)}{2}$$

$$\omega = \frac{r(\omega_R - \omega_L)}{d}$$

where the wheel's radius (r) and the distance (d) from the centre of rotation at any given moment are given.

Arduino keeps tabs on and controls all the sensor data. Figure 5 illustrates the Arduino programme that requires the declaration of all the input and output pins in the Arduino. To locate the source of the fire, QRob used forward and reverse code movement, as shown in Fig. 3. Using an ultrasonic and flame sensor, the Fire Fighting Robot (QRob) is depicted in Fig. 4 as a flow diagram. The movement of QRob may be programmed with these codes to locate the source of the fire.

```
#define RI 2
#define R2 3
#define ENR 9
#define L3 4
#define L4 5
#define ENL 10
#include <Ultrasonic.h>
#define TRIGGER_PIN 12
#define ECHO_PIN 11
#define btnC 8
#define sensorM A1
int btnInput;
int btnInputState = LOW;
int sensorMV
```

Fig. 3. Declaration Code

```
void forward()
{
  analogWrite(ENR, 200); analogWrite(ENR, 255);
  analogWrite(ENL, 180); analogWrite(ENL, 255);
  digitalWrite(R1, LOW); digitalWrite(R1, HIGH);
  digitalWrite(R2, HIGH); digitalWrite(R2, LOW)
  digitalWrite(L3, LOW)
  digitalWrite(L3, LOW); digitalWrite(L4, LOW);
  digitalWrite(L4, HIGH); delay(1000);
}
```

Fig. 4. Forward and Reverse Code Movement

RESULT

The purpose of the newly designed firefighting robot, QRob, is to locate and put out fires. By utilising flame and ultrasonic sensors, QRob is able to pinpoint the exact spot. The flame sensor can pinpoint the exact spot of a fire, while the ultrasonic sensor can identify any nearby objects. The Arduino Uno, which regulated the DC motor's motion, was linked to both sensors.

At 40” “cm from the fire, the DC motor will halt when the flame sensor detects a fire. From a distance, the operator will use a remote control to put out the fire. A smartphone-connected camera also allows the operator to keep an eye on the QRob.

A. It's Time to Put Out the Fire How Far Away Is the QRob from the Fire?

With the help of an operator, QRob is able to autonomously locate the source of fire and put it out. A camera linked to the operator's smartphone allows them to track the exact position of the fire. The image captured throughout the fire extinguishing process is shown in Fig. 5, and the time it takes to put out the fire is shown in Fig6. , which is dependent on the distance betitenQRob and the fire.

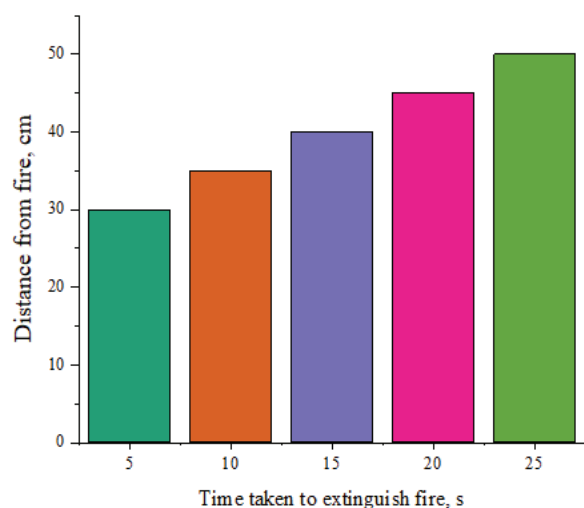


Fig. 5. The Time Required to Put Out a Fire When the QRob Is Far Away from the Flames

Extinguishing a fire takes more time as the distance betitenQRob and the fire increases, according to the trial data. Finding the sitet spot for the distance betitenQRob and fire is essential for future preparations. This ensures that QRob stays far away from the flames while efficiently putting it out.

B. QRob's Capability to Locate Fires at Varying Distances Route

An ultrasonic sensor allows QRob to navigate around obstructions. As seen in Figure 6, the maze has been meticulously constructed to evaluate the sensor's functionality and its ability to circumvent the obstacle.

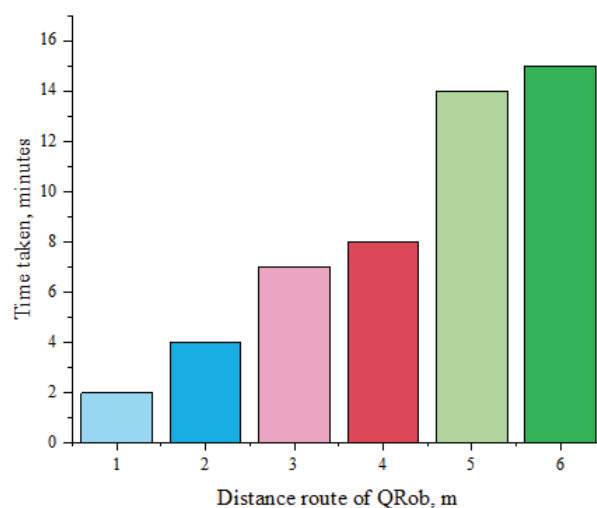


Fig. 6: The Route of QRob and How Long It Takes

According to Figure 6, the amount of time it takes for QRob to reach the scene of the fire is dependent on the distance it has to travel. Time required to reach the site of the fire is proportionate to the distance that QRob must travel, according to the findings of the experiments. Various fire locations itre used during the experiment.

CONCLUSION

When it comes to firefighting technology, QRob is a huge step forward in terms of safety and operational efficiency, especially in difficult circumstances. Because of their nature, fires pose a significant threat, especially when they break out in enclosed areas or in potentially dangerous places like nuclear poitr plants or industrial sites. Human intervention is crucial in traditional firefighting tactics, which puts firemen in a more precarious position. Because of its small size, QRob is able to enter hard-to-reach places where flames are located, therefore overcoming these obstacles. Using its high-tech sensors, which include ultrasonic and flame detecting capabilities, QRob can find and put out flames without human intervention. Not only does this capacity improve reaction time, but it also makes risky conditions safer by reducing the need for human intervention. Firefighters may keep themselves and others safer by controlling and monitoring QRob from a distance via smartphone connectivity, which allows for remote operation. Not only does incorporating these technology make fire suppression operations more effective, but it also makes firefighters' jobs

safer. Increasing QRob's extinguishing range or adding more sensors for better situational awareness are two possible areas for future research that might improve its firefighting capabilities. If it want to improve fire safety and response capacities in different urban and industrial areas, it need to keep researching and developing autonomous firefighting robots. To sum up, QRob is an encouraging development in the direction of more effective and safer firefighting methods, which use technical advancements to save lives and prevent property damage during fire crises.

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Design, Analysis, and Optimization of Composite Propeller Shafts for Automotive and Marine Applications

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ABSTRACT

Due to the inherent benefits that composite (CFRP) structures provide, the traditional metallic (SM45C) propeller drive shafts that are used in rear-wheel-drive autos with front-engine installation are rapidly being replaced with composite (CFRP) constructions. The engineering sector has been completely transformed by composite materials, which are famous for their high strength-to-weight ratio, resilience to corrosion, and adaptability. The purpose of this study is to investigate the full process of developing, evaluating, and improving composite propeller shafts. The research focuses on the use of these shafts in the boating and automobile industries in order to improve performance while simultaneously lowering weight. The first step in the design process is to define the specific requirements, which may include torque loads, rotating speeds, ambient conditions, and safety issues. Some of the most important choices that have a substantial impact on the performance and structural properties of a material are the selection of the fiber type, the resin matrix, and the orientation of the layup. Simulation of mechanical behaviors across a wide range of operating situations is accomplished via the use of sophisticated Finite Element Analysis (FEA) methods.

These approaches are used to detect stress distributions, deformations, and probable failure mechanisms. Utilizing the insights obtained from these simulations, iterative design improvements are carried out with the purpose of improving both performance and durability. During the analytical phase, comprehensive assessments of the stress distribution, torsional vibrations, and dynamic reactions of composite propeller shafts are carried out. A comprehensive analysis of the effects that different layup configurations and boundary conditions have on the structural integrity and dependability of the structure has been conducted. In order to guarantee both practical practicality and scalability, manufacturing issues are taken into account. These include fabrication processes, quality control standards, and cost-effectiveness. The objective of optimization efforts is to significantly reduce weight while simultaneously maintaining structural robustness and operational dependability. In order to strike a compromise between reducing weight and improving performance metrics, choices regarding ideal material combinations, layup sequences, and geometric factors are guided by the findings of optimization studies.

KEYWORDS: Composite propeller shafts, Finite Element Analysis (FEA), Material selection, Optimization, Automotive industry, Marine industry.

INTRODUCTION

A rear-wheel-drive vehicle's driveshaft must be flexible in order to accommodate variable angles with the gearbox and axle, as it is the central connection that transfers power from the engine to the differential gear. The long-lasting properties of premium building steel SM45C make it a popular choice. The bending natural frequency is inversely proportional to the square root of the specific modulus and directly proportional to the square of the beam length [3]. Steel driveshafts, which are frequently bifurcated, increase this frequency. On the other hand, the two-piece steel version adds a bracket, three universal joints, and a centre bearing, which makes the vehicle heavier in total. The automobile sector has shifted its focus to composite materials that offer greater specific stiffness and strength in an effort to reduce inertial mass and increase lightweight design. Driveshafts made of composite material are single-component designs that are both lightweight and strong and rigid, unlike driveshafts made of heavier materials like steel or aluminium [6]. Composites' increased strength-to-weight ratio is a major selling point, especially for systems that spin.

Helicopters, centrifugal separators, and cylindrical tubes in the marine and automotive sectors are among the many other potential uses [7]. Composites' malleability allows designers to exert control over critical speeds and other desired behaviours by manipulating ply orientation and amount. Light trucks, vans, and high-performance automobiles now use driveshaft tubes made of graphite, carbon, fibreglass, and aluminium, which the industry developed in an effort to improve performance and efficiency [9]. Enhanced grip on tyres, less wear on drivetrain components, better vibration dampening, and a more comfortable interior are all benefits of this innovation's weight reduction. One way the car industry is leading the way in technological advancement is by using composite materials in drive shaft construction. This allows for an ideal mix of strength, weight, and usefulness [12-15].

SHAFT DESIGN FOR PROPELLER

Issue recognised

Vehicles with a propeller shaft resonance frequency of 6,500 rpm or more and a torque transmitting capacity of

3,500 Nm or more are less likely to experience whirling vibration. There isn't enough room for a propeller shaft with an outer diameter more than 100 (table 1).

Table 1: Driveshaft Design Criteria and Details

S.. No	Parameters	Values
1	Outer Diameter	70
2	Inner Diameter	50
3	Length of the Shaft	1120
4	Thickness of the shaft	4
5	Ultimate Torque	2100
6	Max. Speed of shaft	4500

Aim and Objective

AIM

The goal of this project is to create, test, and model a propeller shaft with the best possible mass-to-strength and durability ratio.

Main Goal

In order to check the present setup of propeller shafts in automobiles. In order to investigate both traditional and composite shafts. Analysing propeller shafts made of conventional and composite materials using the Finite Element Method (FEM). So that it may evaluate the conventional shaft and the composite shaft using FEM. Compared to the steel shaft, the composite drive shaft should be lighter. In the end, make sure the propeller shaft is compatible and cost-effective by optimising its design.

Conceptual framework Part

How much the propeller shaft weighs.

The mass, denoted as 'm', of the hollow shaft is as follows:

$$m = \rho * A * L \text{ (or)} \rho * \frac{\pi}{2} (D_o^2 - D_i^2) * L \quad (1)$$

Shaft's Capacity to Transfer Torque

It can find out how much torque a hollow propeller shaft can transfer by following the formula below::

$$T = \frac{\pi}{16} * \tau * D_o^3 * (1 - K^4) \quad (2)$$

Where $K = \frac{D_i}{D_o}$

Bending Natural Frequency

An equation is used for the Bending natural frequency “fn”:

$$f_n = \frac{\pi}{2} * \sqrt{\frac{EI}{mL^4}} \quad (3)$$

Bending Natural Frequency

An equation is used for the Bending natural frequency “fn”:

A shaft’s mass, its length, its moment of inertia, and the Itng’s modulus are represented by E, I, m, and L, respectively.

Vital shaft velocities

The critical speed of the shaft is defined as::

$$N_{cr} = 60 * f_n \quad (4)$$

Bending Natural Frequency

An equation is used for the Bending natural frequency “fn”:

propeller shaft material characteristics (table 2)

Table 2 Product characteristics of SM45C, Carbon-Epoxy, and Glass-Epoxy Composites are shown .

Properties	Itng's modulus (x-direction)	Itng's modulus (y-direction)	Itng's modulus (z-direction)
Symbol	E_x	E_y	E_z
Unit	GPA	GPA	GPA
Steel (SM45C)	110	105	110
Carbon-Epoxy	104	25	55
Glass-Epoxy	35	10	10

METHODOLOGY

Computer-Aided Design

Precision in design and sizing is required when using Solid Works software to create a CAD model, especially when dealing with shafts that have certain

specifications. Here, the shaft measures up to 1200 mm in length, with an exterior diameter of 90 mm and an inner diameter of 80 mm (fig 1).

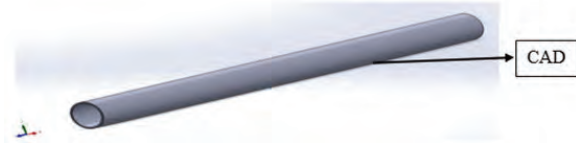


Fig. 1: Modelling

The creation of meshes

When it comes to numerical simulations, mesh generation is king. This process involves breaking down a geometric domain into basic forms like triangles, quadrilaterals, tetrahedra, and hexahedra. The generated mesh provides a good approximation of the investigated issue’s shape, which is necessary for reliable simulations. (table 3) The quality of this mesh determines the efficiency and accuracy of the simulation results, making its production a crucial step. Because mesh quality is so important, there must be constant innovation in mesh generation methods.

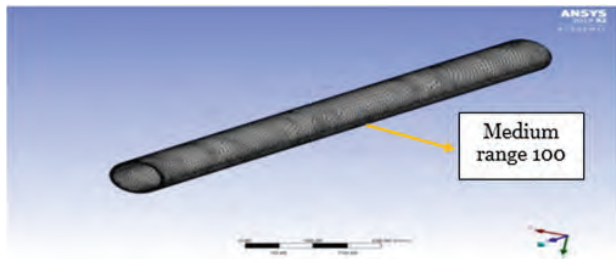
Improved simulation capabilities across many scientific and technical areas are impossible without these upgrades, which will allow for a more faithful portrayal of complicated real-world situations. The importance of mesh construction in improving simulation accuracy and effectiveness for many applications is shown by the ongoing quest of improvement in this area (fig .2).

Table 3: Parameters for Mesh Quality

Mesh Metric	Element Quality	Mesh Metric	Aspect Ratio	Mesh Metric	Skewness
Min	0.2154	Min	1.326	Min	2.1348
Max	0.32656	Max	1.5489		0.3265
Average	0.32654	Average	1.3265	Average	0.2154
Standard Deviation	0.2458	Standard deviation	0.24587	Standard Deviation	0.1485

Fig 3: (a) Element Quality (b) Aspect ratio (c) Skewness

Element size	10.0mm
Nodes	72759
Elements	36069

**Fig. 3: Mesh generation**

ANALYSIS WITH FINITE ELEMENTS

Computing phenomena including deflection, stress, vibration, and buckling behaviour is made possible by the use of Finite Element Analysis (FEA), a numerical approach based on computers, which is useful for evaluating the strength and behaviour of engineering structures. For this project, it used the ANSYS FEA programme to do static and modal calculations on the steel and composite driveshafts, taking into account the given measurements and material properties (fig 3).

The composite propeller shaft's plies and stacking sequences are created using the Ansys ACP pre-post tool, which is commonly used in the context of composite materials. To fully grasp the performance characteristics of composite structures, this tool allows for an exhaustive investigation of such structures. Optimisation of engineering components like driveshafts may be achieved through the application of finite element analysis (FEA), especially within the ANSYS framework. FEA's adaptability allows for significant insights to be gained in this process.

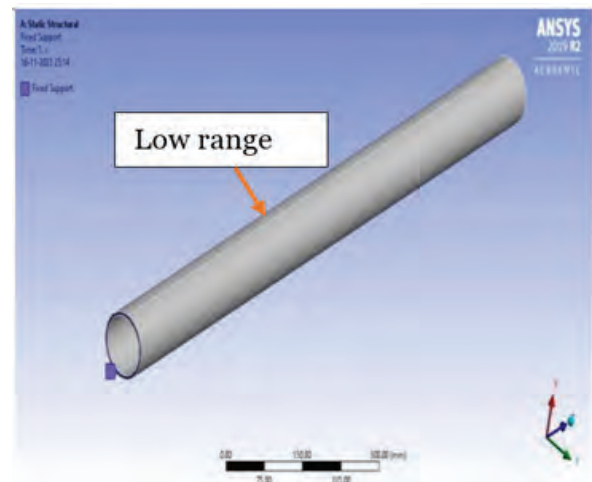
Analysis without data

To evaluate the mechanical behaviour of structures when subjected to static loading conditions, engineers rely on static structural analysis. Learning how buildings react to constant stresses or outside pressures is the main goal. This approach guarantees the system's structural integrity and allows engineers to optimise designs by analysing distributions of stresses, strains, and displacements inside the structure. One of the

most important tools for engineers is static structural analysis, which helps with making decisions about building strong and efficient buildings.

Shaft structural analysis using steel (SM45C)

A propeller shaft is completely Applied a 3500 N-m moment to the other end, which simulates real-world circumstances for static structural analysis, while the first end is constrained, limiting movement in either direction (fig. 4).

**Fig. 4: Fixed end**

Composite Shaft Structural Analysis

1. ACP Modelling:

Launch ANSYS Workbench. Then, in the project diagram, drag ACP (Pre).

Use the engineering data to determine which material is necessary.

To make the profile it want, go to the geometry menu and choose "thickness" as 0.

Launch the model cell, then choose the material, full mesh, and 1" "mm thickness.

Launch Setup and navigate to the Material Data menu to begin making a fabric.

After defining a rosette type as a parallel, create a new rosette and add it to the model.

Create a new set of orientated elements by combining the rosette with the necessary element sets.

Make a Ply Group consisting of orientated components and input an angle without using any layers.

Make a ply with the following angles:0,45,90,-45, and 0.

> Transform into a solid model and bring it up to date..

CONCLUSION

The development and integration of composite propeller shafts represent a significant advancement in the fields of automotive and marine engineering. By transitioning from conventional metallic shafts to lightweight composite alternatives, industries stand to benefit from improved performance, reduced fuel consumption, and enhanced durability. Throughout this study, the importance of meticulous design, thorough analysis, and strategic optimization of composite propeller shafts has been underscored. The design phase, driven by specific operational requirements and environmental conditions, lays the groundwork for material selection and initial structural configuration. Advanced Finite Element Analysis (FEA) simulations play a pivotal role in predicting mechanical behaviors, identifying stress concentrations, and refining design parameters iteratively.

The analysis phase further elucidates the dynamic responses, torsional vibrations, and stress distributions within composite propeller shafts under varied operational scenarios. Comprehensive evaluations of different layup configurations and boundary conditions provide critical insights into optimizing structural integrity and reliability. Manufacturing considerations are paramount to ensuring the practical feasibility of composite propeller shafts. Techniques for fabrication, stringent quality control measures, and cost-effective production methods must align with industry standards and economic feasibility. Optimization efforts focus on achieving the optimal balance between weight reduction and structural robustness. Insights gleaned from optimization studies guide decisions on material compositions, layup sequences, and geometric parameters to maximize performance efficiency.

In conclusion, the advancements detailed in this study contribute significantly to the evolution of composite

propeller shaft technology, offering engineers and industry stakeholders a roadmap for enhancing sustainability, competitiveness, and operational efficiency. By harnessing the benefits of composite materials effectively, the automotive and marine sectors can realize substantial improvements in performance metrics and overall system reliability.

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Building a Graphical User Interface Robot for Use in Military Video Surveillance and Monitoring

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ABSTRACT

The process of supervising a person, a location, or a situation via the use of video surveillance footage. The majority of the time, this takes place in a military setting, when the observation of boundary lines and area controlled by the adversary is crucial to the defense of a nation. The deployment of individuals in close proximity to sensitive places in order to continuously watch for changes is the method by which human surveillance is accomplished. On the other hand, people do have their limits, and it is not always viable to use them in locations that are inaccessible. This company has created a robot that can be used for video surveillance and monitoring, and it can be operated using a graphical user interface (GUI). The control mechanism is equipped with a capacity for the transmission of video pictures. When it comes to military operations, video surveillance is an extremely important tool since it allows for the monitoring of sensitive locations such as borderlines and enemy territory. Traditional techniques of human monitoring are often constrained in hostile areas due to accessibility and safety considerations. This study covers the construction of a robot that is built for video surveillance and monitoring, and it is operated via a Graphical User Interface (GUI). The goal of this invention is to solve the problems that have been presented. For the purpose of gathering real-time video footage, the robot is outfitted with a high-resolution camera. This film is then sent to a central server via a high-speed image transmission system. Through the use of the graphical user interface (GUI), remote operators are able to control the motions of the robot and monitor live video feeds from the surveillance area. When it comes to military situations when real-time monitoring is essential for decision-making, this technology improves both situational awareness and operational efficiency. Image transmission at a fast speed is the method that is used to realistically accomplish the video transmission. In the beginning, the robot will be outfitted with a camera that will take pictures of the surroundings and then send those pictures to a server where the user will be able to manage and see the live stream.

KEYWORDS: Video surveillance, GUI-controlled robot, military applications, high-speed image transmission, remote monitoring.

INTRODUCTION

I tare developing a robotic car-based web-based surveillance system. In addition to being a spy tool, this might be a practical and affordable security

measure. This robotic vehicle is part of our Internet of Things (IoT) project, and it was built using a Raspberry Pi, a camera, and two DC motors coupled with a robot chassis. On top of that, it has a camera that will provide

us with live video feed, and the best thing is that it can steer and operate this autonomous vehicle from any internet-connected webpage. It created an HTML website with four buttons—Left, Right, Forward, and Backward—that allow us to control the robot's movement in any direction. A self-contained house with an external security system is what this initiative is aiming to provide. Present day security systems are notoriously difficult to set up and necessitate a plethora of expensive parts. Spending a lot of effort and money on two fundamental sorts of systems is possible. The fact that it will always be a part of your house is another disadvantage. The security system is obligatory even if the owner relocates. The second kind of system is a wireless one, and its components are rather pricey as well. Additionally, certain areas may go unmonitored since the signal strength is insufficient to cover them all. Additionally, these systems' signals might be disrupted by inclement weather. The planned system's goal is to do away with the problems that come with both wired and wireless options. One unit will keep an eye on where all of the different II are in the planned system.

PURPOSE AND GOALS

The main idea behind the proposed concept is to create a self-contained gadget that can replace the traditional security system's monitoring capabilities. A user-friendly, dependable, and reasonably priced system is ideal. To run the system, sensors will take readings from the environment and transmit them to a microcontroller, which will then direct the actions of a robot.

The need for fresh approaches to monitoring has never been more than it is now, given the rate at which technology is developing. The use of a robotic car-based monitoring system is one such innovative solution. The innovative system combines state-of-the-art sensor technology with the mobility of a robotic vehicle to provide an effective and efficient security solution.

Envision a system whereby certain regions are patrolled autonomously by a small, nimble robotic vehicle that is fitted with cutting-edge sensors, cameras, and maybe AI capabilities. This feature allows for preemptive reaction to any security risks, real-time monitoring, and an expansion of the system's surveillance reach. An extensive and consequential list of possible uses

may be compiled by such a monitoring system. With its adaptability and efficacy, the robotic car-based system may improve security in residential neighbourhoods, industrial sites, and even during emergency circumstances by providing crucial monitoring. This introduction lays the groundwork for delving into the ways this cutting-edge surveillance technology may revolutionise security measures, enhance reaction times, and help create safer places in an ever-more-connected world. The importance of this technology in contemporary surveillance methods becomes quite evident when it explore its features, capabilities, and operational benefits in further detail.

The goal of this research is to create a model of a surveillance system that can provide more thorough monitoring with less setup time. It will outperform the majority of existing surveillance systems on the market in terms of comprehensiveness and ease of use. A pair of autonomous robots will be able to keep an eye on your house. This robot can keep an eye on things for at least eight hours and communicate with its operator through the transmission of text data and live video. Research Review

The article "Intelligent surveillance and security robot systems" was authored by Kyunghoon Kim, Soonil Bae, and Kwanghak Huh. It was presented at the 2010 IEEE Workshop on Advanced Robotics and its Social Impacts, which took place in Seoul, South Korea. Additionally, there is a significant cost connected with the purchase of this research. Furthermore, since the signal strength is not adequate to cover all of the places, there is a possibility that certain areas will not be monitored. It is also possible for the signals sent by these devices to be interrupted by adverse weather conditions. The method that has been offered will solve the deficiencies that are present in an innovative security solution that integrates vision, intelligent algorithms, and robot technology. In contrast to traditional security systems that depend on human operators to constantly monitor video feeds, the suggested system employs AI to account for human error and robotics to offer instantaneous retaliation. [1] "System and Software architecture for autonomous Surveillance robots in urban environments" was presented by Yungeun Choe and Myung Jin Chung at the 2012 9th International Conference on Ubiquitous

Robots and Ambient Intelligence (URAI) in Daejeon, South Korea (fig 1).

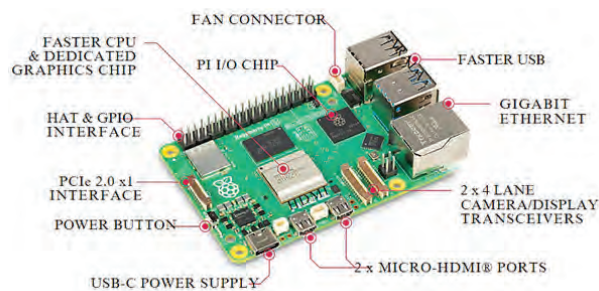


Fig. 1: Raspberry Pi

The authors of this work present a software architecture and system for a security robot. A robot capable of carrying out security duties will be created using the suggested system and software architecture. [2] In order to create a mobile order that can correct for the vehicle's motion when it encounters uneven terrain, this article uses a simulation-based design methodology. [3] A design of mobile robot based on Network Camera and sound source localization for intelligent surveillance system.

The speech was published on December 2, 2008. A system that augments vulnerability is suggested in this study. This article focuses on the tracking of intruders via the use of a mobile robot that is operating embedded Linux. The robot will make use of a sound source tracking module in addition to a network cable camera. The paper "Snitch: Design and development of a mobile robot for surveillance and reconnaissance" Embedded and Communication Systems (ICIECS) in Coimbatore, India, on August 13. An innovative robot called Snitch is introduced in this study. It can scale horizontal and vertical surfaces, climb walls, and regulate surface transitions automatically.

The controlling user may also monitor its whereabouts. The paper "Remote surveillance via web-controlled mobile robots" was given by T.M. Sobh, R. Sanyal, and Bei Wang at the 2004 World Automation Congress in Seville, Spain, on June 20. Online visual remote surveillance is the focus of this effort. The RISC lab produced a mobile robot that can be controlled online using photos captured by a network camera. Using the web-based visual interface that is updated in real-time, the user may specify the desired location. The robot

travels there on its own, avoiding obstacles along the way. Video control using smartphone and Raspberry pi. An Android-based app is suggested as a means of commanding a wireless robot for surveillance purposes in this article. Collective robot behaviour controller for a security system using open SW platform for a robotic services, In order to facilitate a recursive state estimation process in a guaranteed-connected multi-robot coalition team, the authors of this work propose a way to organise collective robot behaviours for a self-localization algorithm.

The paper Implementation of spy robot for a system using Internet protocol of Raspberry Pi, An important need for a robot that can identify intruders and notify the board security control unit in the vicinity is emphasised in this study. [9] Task allocation strategy of heterogeneous multi-robot for indoor surveillance.

The authors of this study offer a solution to the work allocation problem and discuss the necessity of doing more detailed studies of the mission of cooperatively increasing performance and fault-tolerance in multi-robot systems. The solution involves combining offline and online analyses. The article "A surveillance robot with hopping capabilities for home security, Design and implementation of Surveillance Robot for outdoor security" introduced to a contemporary method of outdoor security surveillance. [12]

WIRELESS CONTROLLED SURVEILLANCE ROBOT

The term "mobile robot" refers to a machine that is essentially installed or placed on a platform that is able to move about and may be controlled by following certain instructions. A great number of industries in the modern world make use of mobile robots. The basic mobile robots served as the platform for the development of many of the more complicated robots that we see today. The industry has seen a surge in the number of new applications thanks to this technology. [4] The combination of mobile devices and robotics is stimulating the development of novel concepts in a wide variety of domains. This is mostly due to the fact that mobile devices are portable and have a longer battery life in comparison to laptops. As a result, mobile devices are currently being employed in a plethora of

industrial applications. Additionally, they provide a data plan that is provided by a mobile phone carrier, which is a wonderful feature since it allows us to communicate with the mobile robot after the connection has been established. Teleportable Robots: There are a few distinct categories that may be applied to the mobile robots. It is the robot that moves about using tracks that is referred to as the track robot. But the construction of such robots is rather expensive. The flexibility of these robots is not as high as that of the wheeled robots. The term “wheeled robots” refers to robots that are able to move while using wheels. These robots are only able to move on surfaces that are smooth and flat. Legged robots, which are modeled after human bodies, make up the third category of robotics. Because they have legs, they are able to move around more easily. The creation of these robots is an extremely challenging endeavor.

PROBLEM DEFINITION

Comprehensive issue description

In this project, itare constructing a robotic car-mounted Raspberry Pi-based remote-controlled wireless surveillance monitoring system. With its various customisable settings, this security and surveillance gadget might be both practical and affordable. Itbuilt this robotic car with the help of a Raspberry Pi, a USB web camera, and two DC motors attached to a robot chassis as part of our internet of things (IoT) project.

Project Purpose

There will be far-reaching consequences for this technology in the future. When combined with home automation systems, this technology can accomplish much more. It has the potential to be enhanced to the point where it finds utility in banking, big warehouses, and similar settings. With the proliferation of criminal risks ranging from robbery and burglary to terrorism, surveillance has become an essential tool for protecting both public and private spaces. Airports, train stations, factories, hospitals, government buildings, and more may all benefit from its use in surveillance.

Project Description

Suggested Framework

An connected camera will allow the driver of this remote-controlled vehicle to see what’s around them.

A remote-controlled vehicle that can be operated from afar is the focus of this research. The graphic shows how a camera installed on the car may be used to remotely control the vehicle while observing its perspective [1]. The camera may be moved about by the car’s pan tilt motor, allowing the user to observe everything happening from their seat. At our university, where wifi was available everywhere, itwere able to successfully launch this project. Itcan now take the car anyplace it can establish a wireless connection. In all likelihood, it will be able to perform this project and operate the vehicle remotely from any location with an internet connection.

Raspberry Pi

The little Raspberry Pi computer, about the size of a credit card, has many uses, including in military applications, surveillance systems, and more. Wife module for the Raspberry Pi

With the addition of WiFi, your Internet of Things gadget becomes cable-free. A low-cost, highly-reliable wireless connection is one of its benefits. Cannon camera module for the Raspberry Pi

An excellent addition to the Raspberry Pi, the Camera Module lets users capture still images and full HD video. Drive Unit IC L293D Motor

The L293D is an IC that drives two H-bridge motors. As they transform a control signal with a low current into a greater current, motor drivers are essentially current amplifiers. In order to power the motors, this greater current signal is utilised. Powering two DC motors

Applicable Software The Flask Library in Python Android (Motion Library) on Raspbian OSCSS and HTML

METHODOLOGY

All of the interdependencies and fundamental model of the system’s relationships are shown in Figure [1]. An IC driver L293D receives power, which is then distributed to two dc motors. Robotic cars equipped with Raspberry Pis and camera modules are used for surveillance purposes.

Implementation

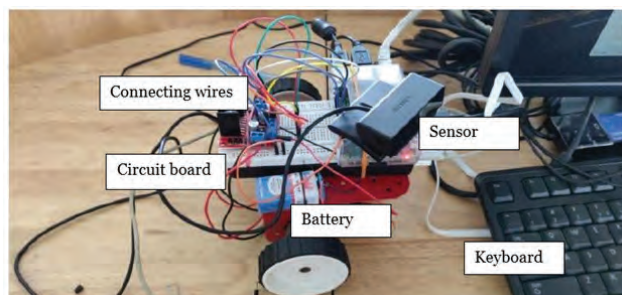


Fig. 2. Assembled Model

The robotic automobile model shown in Figure [2] includes all of the necessary components, including the camera, battery, motor driver L2938N, power supply, and more. The camera records a live feed that may be utilised for surveillance, and the vehicle can be operated by orders sent over a phone or computer.

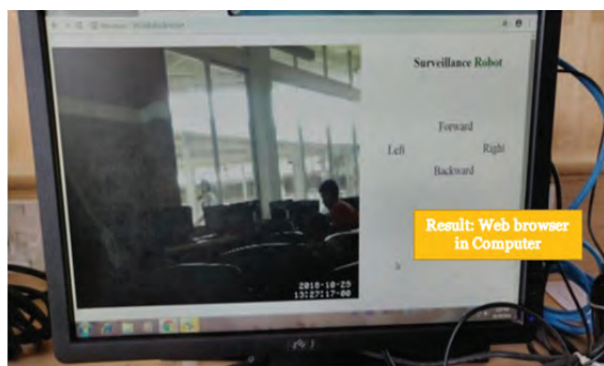


Fig. 3 Live streaming on web-browser

Figure 2 shows the live video taken by the robotic automobile, which can be operated from a phone or desktop, as seen in Figure 3. It may move the automobile forward, backward, right, and left using the controls that are on the web page..

CONCLUSION

Each user will have a more streamlined experience while using the surveillance robot since it will be intended to give a suitable degree of efficiency and simplicity. The purpose of the surveillance robot is to provide monitoring that includes both monitoring of vision and mobility. In order to integrate effortlessly into any warehouse, godown, or multidwelling unit, the surveillance robot may be tailored to meet your specific needs. The surveillance robot is built to be extendable

and to allow for future control updates. This allows it to improve the accessibility of the user and to provide an expedient path out of the traditional system. The design is based on modular designs and total scalability. The development of the GUI-controlled robot for video surveillance represents a significant advancement in military surveillance technology, offering enhanced capabilities for monitoring and reconnaissance in challenging environments. Traditional methods relying solely on human surveillance are often constrained by limitations in accessibility and safety, particularly in remote or hostile areas. The integration of robotics and advanced video transmission technologies addresses these challenges effectively. The robot's capability to transmit high-resolution video feeds in real-time to a remote control center via a secure server enhances situational awareness and decision-making capabilities of military personnel. Operators can remotely maneuver the robot through the GUI, ensuring comprehensive coverage of surveillance areas without exposing personnel to potential risks.

Furthermore, the use of high-speed image transmission ensures minimal latency in video streaming, facilitating immediate response to unfolding events and potential threats. This capability is critical in military operations where timely information and situational updates are paramount for strategic planning and operational execution. The GUI interface provides intuitive control over the robot's movements and camera functionalities, allowing operators to pan, tilt, and zoom the camera for detailed surveillance. Live video feeds enable continuous monitoring of target areas, ensuring persistent surveillance capability over extended periods.

In conclusion, the GUI-controlled robot for video surveillance not only enhances operational efficiency but also improves the safety and effectiveness of military surveillance missions. Future research could focus on enhancing the robot's autonomy, integrating artificial intelligence for autonomous navigation and object recognition, and expanding its application in diverse military and security settings.

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Development of A Multipurpose Agriculture Equipment for Enhanced Farm Productivity

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ABSTRACT

Basic and important equipment used in agriculture to maximize yields is multipurpose equipment. Because the traditional technique of planting and producing crops is labor-intensive, there is a manpower shortage, which causes agriculture to be delayed. To get over these challenges, multifunctional agricultural equipment is produced. The main objective of this project is sprayer and crop cutter. Our aim is to produce a highly efficient multi purpose agriculture machine which will reduce time, cost of labour, and enhance production. Presently, small land holding farmers use work bulls mostly for land preparation. Their use can be increased and made more economical by using them for other farm operations. Multipurpose agriculture equipment plays a pivotal role in modern agricultural practices by significantly enhancing efficiency and productivity. Traditional methods of planting and cultivating crops are labor-intensive, leading to challenges such as labor scarcity and delayed agricultural operations. To address these issues, this paper focuses on the development of a highly efficient multipurpose agriculture machine designed primarily for spraying and crop cutting tasks. The project aims to integrate sprayer and crop cutter functionalities into a single robust machine to reduce labor costs, save time, and increase agricultural output. The equipment is specifically designed to cater to small landholding farmers who predominantly rely on work bulls for land preparation but can benefit from expanding their use to other farm operations.

KEYWORDS: *Multipurpose agriculture equipment, Agricultural mechanization, Sprayer, Crop cutter, Farm production.*

INTRODUCTION

Historically, and for the foreseeable future, India's agricultural sector will support the country's economy. After three days of becoming hungry, a guy will start to argue, then fight, and finally die after around a month. One subfield of applied science is agriculture. Soil preparation, crop production, and livestock husbandry are all part of agriculture, which encompasses both the science and art of farming. It is the world's most crucial enterprise. Traditional farming methods

have been used by small-holders for many years. These individuals often work 2 to 3 hectares of land with the help of human labour and traditional implements like yoke, leveller, harrow, shovel, huge sickle, and so on [1]. Sowing seeds, weeding, and harvesting are all tasks that require these implements. Due to the high cost and limited availability, small land proprietors do not utilise modern farming techniques and equipment. Most farmers still utilise antiquated farming practices because they either don't know better or don't have the

capital to invest in current farming equipment, even though scientific farming methods may save farmers from bankruptcy by producing higher yields of higher quality crops [2]. Because tractors need resources that many Indian farmers do not easily afford, manual tools are still the most common method of land cultivation in India. So, to evaluate the necessity of agricultural mechanisation in India, one must first have a better grasp of the tasks performed by smallholder farmers [3]. For small and marginal farmers, there is a massive chasm between the two ends of the technology acceptance and implementation spectrum. The implementation of more efficient agricultural systems that minimise waste of resources is crucial for the long-term economic security of impoverished farmers in developing nations. Most of the parts are already on hand, but there is a lack of data on the efficiency and availability of machinery, and farmers and agricultural R&D departments are unable to communicate effectively [4].

Characteristics Essential to Indian Farming Earnings potential: The majority of people work in agriculture. Approximately 61% of the overall workforce is employed by it. A quarter of the country's GDP comes from it. The agricultural sector in India is highly dependent on the monsoon. Crop failure occurs when the monsoon is below average, while increased output occurs when the monsoon is above average. Because of the lack of suitable irrigation infrastructure, farmers rely on the monsoon for their harvest. Cultivation that requires a lot of manual labour: The growing human population has put a strain on available arable land. Property holdings become economically unfeasible due to fragmentation and subdividing. Such farms are not suitable for the use of machinery and equipment. **Underemployed:** Farmers only have work for a few months of the year because agricultural output is low due to insufficient irrigation facilities and unpredictable rainfall. They are unable to make effective use of their abilities. Underemployment and hidden unemployment are problems in the agricultural sector. The land holding size is quite tiny because of the extensive subdividing and fragmentation of properties. In India, the average land holding size was 2 to 3 hectares, but in Australia and the United States it was 1993 and 158 hectares, respectively. In India, the methods and equipment used to produce crops are rooted in tradition. Reason being, they are poor and uneducated [5].

Low output is mostly caused by traditional technologies. **Farm output:** India's farm output is severely lacking. The yield per acre of wheat in India is 27 quarts. At 71.2 Qtls/ha, France outperforms Britain, which produces 80 Qtls/ha. In comparison to Norway at 973 USD and the USA at 2408 USD, India's average yearly agricultural labour productivity is 162 USD. **Predominance of food crops:** commercial crops occupy 25% of the farmed land, while food crops such as wheat, rice, and bajra occupy 75%. The agricultural sector is regressing because of this tendency. **Production of Key Staple Crops:** For a long time now, production of key staple crops like wheat and rice has been flat [6]. Concerned about this scenario are our agricultural experts, planners, and policymakers. The disparity between the demand from a rapidly expanding population and the supply would widen if current trends persist [7]. **Costly Farm Inputs:** The rates of agricultural inputs have risen throughout the years. Some examples of farm inputs are HYV seeds, fertiliser, pesticides, insecticides, and the cost of farm manpower. Low and medium land holding farmers are disadvantaged by this growth. **Soil Depletion:** When farmers repeatedly plant the same crop, they deplete the soil of its nutrients [8].

The rainforest is a common place for this to occur. The over-exploitation of groundwater for irrigation purposes has led to its depletion in the arid regions of Punjab, Haryana, and Western Uttar Pradesh. The current status of fresh groundwater in these states is somewhat concerning [9]. These states are on the brink of water scarcity if current agricultural practices persist in the years ahead. **Negative Effects of Climate Change:** Of all the problems that humanity has faced recently, global warming is the most current and pressing. It may expect a rise in sea level, more powerful cyclones, unpredictable rainfall, and a temperature increase of 2° C to 3° C as a result of climate change. Crop yields would be negatively impacted by these alterations [10]. **Worldwide Effects:** The impact of globalisation on India's agricultural industry is plain to observe. It has had an impact on all emerging nations. The most noticeable consequence is the impact on farmers' income and the danger to India's agricultural sustainability. The dropping output prices and increasing input costs are to blame for this. This reflects the fact that farmers are being protected while also receiving lower subsidies [11].

RESEARCH REVIEW

One of the papers that served as inspiration for our agricultural robot and the concept behind it was “Agricultural Robot for Automatic Ploughing and Seeding” presented at the 2015 IEEE International Conference on Technological Innovations in ICT (TIAR 2015) by Amrita Sneha, Abirami, Ankita, Mrs. R. Praveen, and Mrs. R. Srimeena. The goal of this study is to create a robot that can do tasks such as autonomous ploughing and seed distributing [12]. In addition to monitoring humidity levels with the use of humidity sensors, it offers manual control as needed. The AVR At mega microcontroller is the central component here and it oversees the entire operation. At first, the robot ploughs the whole field and then scatters seeds in a parallel pattern. A safe, dependable, and economically viable autonomous multifunctional vehicle is designed, employed, and examined. The robot functions in automatic mode when on the field, but is strictly operated in manual mode when outside of the field. As it does tasks that are tedious and/or risky for farmers, this autonomous vehicle drives across agricultural land’s crop lines [13]. The region is first prepped for spraying, but additional configurations are also built, such as a seeding system, a plug system to access the most important parts of the plants for various jobs (pruning, harvesting, etc.), and a vehicle to transport the harvested fruits, crops, and agricultural trash. This robot can effortlessly navigate soft and damp dirt thanks to its specially developed wheels. Article Title: “Automated Farming Using Microcontroller and Sensors” (IJSRMS) with the ISSN Number: 23493371 With the use of modern farming techniques, crop yields may be increased [14]. As part of this study, it will be measuring soil moisture, humidity, light, and temperature. This article discusses the use of a microcontroller and a GSM phone line to provide automated control features using state-of-the-art electronics. Because the project runs autonomously, fewer workers are needed.

Enhanced farming methods, such as the use of autonomous robots to plant seed products on previously ploughed fields [15].

A four-wheeled, DC-motor-steered robotic vehicle was created. To ensure uniform sowing of seed goods, the seed planting apparatus is fastened to the vehicle.

Depending on the seed product, the gadget will grow the plantation by taking into account specified rows and columns at predetermined distances. A built-in infrared sensor is used for obstacle detection. A 12V rechargeable battery pack powers the whole assembly. The robot also has solar panels that can charge the battery pack. This autonomous machine can prepare beds, map out where to plant seeds, plant those seeds, and then reseed them. It was designed, developed, and manufactured with a number of interconnected systems, including a power source and solar panels, that allow it to dig holes, place seed products, close the soil, and apply water. The robot’s ability to turn is controlled by a system of rack and pinion. The motor’s power input is controlled by a relay switch. It uses an infrared sensor to identify obstacles. There has been a recent uptick in interest in the potential use of autonomous cars in farming, which employs more than 40% of the world’s population.

“IoT Based Smart Agriculture” the 2016 IJARCCCE conference Reducing water tables, drying up rivers and tanks, and uncertain settings necessitate efficient water utilisation, as described in this study by an agricultural robot project model. An algorithm is created with threshold values of soil moisture and temperature, which can be put into a microcontroller-based gateway to regulate the quantity of water. This is done to deal with the issue of temperature and moisture sensors being placed at appropriate places for crop monitoring. Solar panels can provide energy for the system, and a cellular internet interface can enable data examination and irrigation scheduling through a web page using a duplex communication link. Advances in wireless sensor networks have opened up new possibilities for precision agriculture, including the monitoring and control of greenhouse conditions. The agricultural production is falling steadily, according to studies conducted in the field. On the other hand, technology’s application in agriculture is crucial for boosting output while decreasing the need for secondary labour. The goal of some of this study’s research is to aid farmers by developing systems that make use of technology that can increase crop yields (figure 1).

Harvesting refers to the process of cutting a crop once it has reached maturity. Horticulturists employ cuttings, or little pieces of plants, for vegetative (asexual) propagation. The process begins with preparing

a medium, such damp soil, for the propagation of a section of the original plant's stem or root. By "striking," it mean that, under the right circumstances, the plant fragment will start to develop as a new plant apart from the parent. New roots can be generated from a stem cutting, whereas new stems can be produced from a root cutting. Leaf cuttings are little bits of leaf that may be used to establish new plants; these cuttings can eventually sprout roots and stems. Scion cuttings are another name for the plant parts utilised in grafting. ^the first one.



Fig. 1 Crop cultivation

An old method of cloning is the practice of propagating plants from cuttings. The fact that cuttings yield plants that are nearly identical copies of their parents is only one of several benefits of this method. Plants are able to perpetuate their beneficial features through genetic inheritance. The ability to clone a certain plant and guarantee uniformity over crops is a huge boon to commercial producers' bottom lines.

Plants that may be widely cultivated and harvested for food or income are called crops. Crops occur when many plants of the same kind are grown in one area. A majority of crops are grown using agricultural practices or hydroponics. Macroscopic fungi (like mushrooms) and marine macroalgae (like seaweed) are examples of crops that may be cultivated in aquaculture.

Humans and cattle both benefit from the majority of crops that are gathered. Ginseng, yohimbe, and eucommia are just a few examples of crops that are typically harvested intensively from the wild.

Industrial crops, horticultural crops, and floriculture are important non-food crops. Plants cultivated for the purpose of growing other crops are also considered horticultural crops. Beds, houseplants, blooming plants, grown greens, cut flowers, and flowering plants in pots are all considered floriculture crops. Clothing (fibre

crops, like cotton), biofuel (energy crops, like algal fuel), and medicinal plants are the three main uses for industrial crops.

PESTICIDE SPRAYER



Fig. 2 Manual Pesticide Sprayer

Common liquids sprayed by sprayers (figure 2) include water, weed killers, crop performance compounds, pest maintenance chemicals, and components for the production line and industrial processes. A sprayer is a useful tool for farmers who want to treat their crops with fertilisers, insecticides, and herbicides. Sprayers come in different sizes, from compact units that can be carried on a person's back (usually equipped with a spray gun) to larger units that are hitched to tractors, and finally, self-propelled units that resemble tractors and have boom mounts ranging from 4-30 feet (1.2-9.1 m) to 60-151 feet (1846" m) in length, depending on the tractor's engineering design and the size of the land. the first one To project the spray fluid, the objective of a sprayer—a fully integrated mechanical system—is to coordinate the actions of its many sections and components. Depending on the complexity of the system, the delivery of spray fluid can be as simple as a hand sprayer connected to a bottle and primed and pumped by a spring-lever, tube, and vacuum-pressure, or as sophisticated as a 150-foot-reach boom sprayer.

Agricultural sprayers and other more complicated models often have the following parts: a fluid tank, a sprayer pump, a pressure regulator, a spray nozzle (occasionally with a spray gun), valves, gaskets, and fluid piping. Due to the wide variety of sprayer pump designs, each with its own set of requirements for construction materials, inlet/outlet diameters, and performance, the pump itself might be as crucial as the sprayer type. The three most common kinds of sprayer pumps are roller, centrifugal, and diaphragm pumps.

Square tube

This is a square tube with a pesticide sprayer, a crop cutter, a wheel bearing, and freewheel and chain. Hollow bar steel (HSS) with square and rectangular shapes is also known as tube steel or box section. It is common for people to confuse round HSS with steel pipe, even though the two are really classified and sized differently. Common applications for square tubes include structural and maintenance work. Among the many possible uses are in the construction of buildings, fences, and sign posts. It can tell them apart by looking at their outside measurements and wall thickness. Welded structural grade tubing comes in two varieties: A500 Grade B and type A513, which are determined by the dimensions and wall thickness of the tube. Whether it's making repairs, general fabrication, or structural components, any grade will do the trick.

Free Wheel & Chain

The roller chain known as a bicycle chain is what really propels the bike forward; it runs from the pedals to the drive-wheel. Although most bicycle chains are constructed from carbon or alloy steel, a few are nickelplated for either rust prevention or aesthetic purposes. Most new chains are standard length, which is sufficient for most upright bike uses. The drive train won't work unless it remove the right amount of links before installing it. It may shorten it by pushing out the pin connecting the links using a chain tool, and extend it by adding links.

A freewheel, also known as an overrunning clutch, is a gearbox component that allows the driven shaft to spin at a higher speed than the driveshaft, preventing the driveshaft from engaging with the driven shaft (figure 3).

This mechanism is used in mechanical and automotive engineering. Although they are completely unrelated, an overdrive is frequently referred to as a freewheel. When the rider lets off the pedals, the circumstance known as "driven shaft spinning faster than driveshaft" occurs in the majority of bicycles. The back wheel propels the pedals in a fixed-gear bicycle, which does not have a freewheel. When driving downhill in a car with a manual gearbox, or in any scenario when the driver releases pressure on the gas pedal and closes the throttle, the wheels turn the engine, which may occur at

a greater revolutions per minute (RPM). If the engine's fuel supply is interrupted, the oil won't be able to reach the cylinders, leading to piston seizing and severe damage in a two-stroke engine that relies on a gasoline/oil combination for lubrication.



Fig. 3 Free Wheel & Chain

Bearing

The rolling-element bearing known as a ball bearing employs balls to keep the races of the bearing spaced apart. Supporting radial and axial loads while reducing rotational friction is what a ball bearing is all about. It does this by enclosing the balls in at least two races and then transmitting loads to those balls. Typically, a hub or shaft will link one race to the rotating assembly, while the other remains stationary. When one of the bearing races turns, it also turns the balls. The rolling motion of the balls reduces their coefficient of friction significantly compared to two flat surfaces moving in opposition (figure 4).

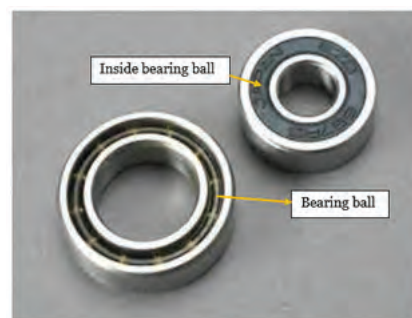


Fig. 4 Shaft Bearing

Wheel

A wheel is a spherical part designed to spin on a bearing axle. There are six basic machines, and the wheel is an essential part of the wheel and axle. When used in conjunction with axles, wheels make it easy to move

or transport large things, whether they are supporting a weight or running a machine. A ship's wheel, a potter's wheel, a flywheel, or any number of other wheels serve different functions. Examples abound in transportation-related domains. A wheel's ability to facilitate motion by rolling in tandem with the help of axles drastically decreases friction. There must be some external force, such as gravity or a torque, acting on the wheel so that it experiences a moment around its axis for the wheel to revolve. A device that the Sumerians developed that makes use of the wheel to mould clay into various forms was the 10MM.

ROD

Reinforcing steel, or simply "rebar," is a type of steel bar that is utilised as a tension device in reinforced masonry and concrete constructions to help and strengthen the concrete when it is subjected to tension. Although its tensile strength is low, concrete is quite strong when compressed. The tensile strength of a structure is greatly enhanced by the use of rebar. The surface of rebar is covered with a continuous pattern of ribs, lugs, or indentations that help it connect better with concrete and prevent it from sliding.

Stainless steel rebar, composite bars composed of glass, carbon, or basalt fibre, and other forms of rebar are all easily accessible. Coating the carbon steel reinforcing bars with an epoxy resin that resists corrosion is another option, particularly for applications in saltwater conditions. In concrete construction, bamboo has shown to be an effective substitute for reinforcing steel. on the subject ([3][4]) These alternative varieties are commonly employed despite their higher price tags or potentially worse mechanical qualities.

FINDINGS AND ANALYSIS

The creation of a multi-function agricultural machine is a huge step forward in agricultural technology, with the goal of making farming more efficient, productive, and environmentally friendly. The many features and advantages of this type of equipment are examined in this talk.

Functions and Versatility

Modern farming relies on versatile agricultural machinery that can carry out a variety of activities. Common features include ploughing, planting, fertilising, spraying pesticides, and harvesting, among others. By minimising the need for several specialised

machinery, this adaptability enables farmers to simplify their operations and save time and resources.

Effectiveness and Efficiency

Maximising efficiency is possible by merging many farming operations onto one equipment. By streamlining their processes, farmers can get more done in less time, which boosts their crop yields and ultimately their bottom line. Waste is reduced and sustainable agricultural practices are promoted by the machine's efficiency in executing duties such as controlled application of fertilisers or pesticides and precision planting.

Versatility in a Range of Crops and Environments

These days, versatile agricultural machinery can handle a wide range of crops and terrains with ease. They have tools and controls that can be adjusted to meet the needs of different crops and soil types. This versatility guarantees top-notch performance in a wide range of agricultural settings, from modest farms to expansive estates.

The Merging of Technologies

These robots often use state-of-the-art technology in their construction, including GPS navigation systems, automated control mechanisms, and sensors that gather data in real-time. Thanks to these technological advancements, smart agricultural approaches may be put into practice, and decisions can be made based on data. To provide just a few examples, sensors report back on things like soil health and crop conditions, while GPS-guided navigation makes sure the field is covered accurately with little overlap.

Environmental and Economic Advantages

Farmers can reap substantial financial rewards by purchasing a multifunctional agricultural machine. It lessens the operating expenses linked to fuel usage, labour, and maintenance. Reduced chemical runoff and emissions of greenhouse gases are further benefits to the environment from the machine's effective use of inputs like pesticides and fertilisers.

CONCLUSION

The major goals of this initiative are to reduce the expenditure on equipment and labour. Pesticide spraying and crop cutting are two of the many uses for our versatile agricultural machinery. Fasteners allow

the equipment to be quickly constructed or rearranged to meet the length and specifications needed for field operation at any step of the agricultural process. Improved output with less labour and lower costs are the results of our team's innovative use of mechanical engineering and agricultural expertise. Multipurpose agricultural equipment is a huge step forward in agricultural mechanisation, and it will help small-scale farmers a lot when they are short on workers and have inefficient operations. This machinery improves farm output by combining spraying and crop cutting functions into one unit, which simplifies farming processes, decreases reliance on human labour, and so on.

An efficient multi-tasking agricultural equipment was the major focus of this project's design and development. Critical demands in crop management, especially during planting, development phases, and harvesting, are addressed by integrating sprayer and crop cutter operations. In addition to maximising agricultural production within constrained periods, this technique minimises operational downtime and optimises resource utilisation.

Additionally, by decreasing labour costs and operational overheads linked with conventional methods, versatile agricultural equipment enables cost-effective farming operations. These mechanised solutions are incredibly advantageous for small landholding farmers since they are efficient and affordable, unlike manual labour or draft animals, which these farmers typically have to rely on due to financial restrictions. Finally, by improving efficiency, decreasing reliance on human labour, and raising farm output, multifunctional agricultural equipment development and deployment contribute to sustainable agricultural practices. The combination of smart farming solutions, improvements in automation, and sensor technologies for precision agriculture might be the focus of future research aimed at optimising agricultural operations for both performance and sustainability.

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Effects of Optimizing Engine Control Software Calibration for Heavy-Duty Diesel Engines Using Gas-to-Liquids Fuel on Performance and Emissions

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ABSTRACT

The optimization of engine control software calibration for heavy-duty diesel engines that run on gas-to-liquids (GTL) fuel presents a considerable opportunity to improve both the performance and emission characteristics of the engines. When it comes to reducing emissions of particulate matter (PM) and nitrogen oxides (NO_x), the use of GTL fuel, which is well-known for its cleaner combustion features and high cetane number, is a feasible option to conventional diesel. The purpose of this research is to evaluate the effects that customized engine control software calibration has on the performance and emissions profile of heavy-duty diesel engines that are fuelled with GTL. For the purpose of determining the impacts on combustion efficiency, power output, and exhaust emissions, the study makes use of a mix of computer modeling and experimental validation. Based on the findings, it has been determined that optimizing software calibration results in enhanced combustion stability, which in turn reduces particulate matter and nitrogen oxide emissions without impacting engine performance. Furthermore, the paper analyzes the viability of incorporating GTL fuel into current engine platforms as well as the problems that are involved with doing so. It highlights the potential for exceeding rigorous emission regulations while simultaneously improving operating efficiency in heavy-duty applications.

KEYWORDS: Engine control software calibration, Heavy-duty diesel engine, Gas-to-liquids fuel, Optimization, Artificial neural networks, Fuel efficiency, Emissions reduction, Injection timing, Exhaust gas recirculation, Rail pressure, Charge mass.

INTRODUCTION

Alternative transportation fuels are being promoted globally for several objectives, such as ensuring energy security, diversifying feedstock sources, addressing environmental issues, fostering economic growth, and optimizing resource use. Two instances of alternative fuels that need specific engine technology are natural gas and dimethyl ether (DME). Both of these fuels are classified as alternative fuels [1]. Renewable

diesel fuels, in contrast, may be directly utilized in conventional engines without any modifications, making them suitable as “drop-in” fuels. These fuels are produced using hydrogenated vegetable and other oils (HVO), and to a lesser degree, FAME (fatty acid methyl ester). Using these alternative fuels to power the engine may not be the optimal decision when it comes to managing emissions and achieving maximum fuel economy [2]. The reason for this is that the engine was

exclusively constructed and engineered by the original equipment manufacturer (OEM) to function only on conventional gasoline. Without initially adjusting the engine calibration for each fuel, it is not possible to make a fair comparison between alternative fuels and traditional diesel fuels [3]. If we can identify the specific adjustments to the calibration that enhance performance with various fuels, we can effectively exploit the potential benefits of alternate fuels. In this scenario, it is feasible to devise software protocols that are compatible with a diverse range of fuels [4].

This study presents findings from an experiment conducted to assess the limits of a state-of-the-art, high-capacity diesel engine fueled by GTL gasoline. By using a model-based transient calibration approach instead of depending on a restricted set of steady-state operating points, highly optimized calibration tables were developed with much reduced effort compared to standard procedures [5]. This was done in order to use well-established, industry-standard transient and steady-state test cycles. This study discusses both model-based calibration and engine optimization using GTL diesel fuel, which have been extensively researched. The following paragraphs include concise background information on each of these themes [6].

TOOLS AND METHODS FOR EXPERIMENTATION

Below can find details on the engine, fuels, and methods

Table 1: Summary of the test vehicle

Manufacturer and model	Emission certification	Configuration	Displacement	Rated power	Rated torque	Induction	Fuel injection	Compression ratio	Stroke	Bore	Typical application
Cummins ISX-15 (2011)	US EPA 2010	In-line, 6 cylinder	13754 cm ³	252 KW @1500 rmp	1150 to 1300 rpm	Variable geometry turboc-harger, after-cooled	Cummins XPI common rail	15:01:02	157 mm	115 mm	On-road truck

Experimental Methods

The test engine was equipped with a transient dynamometer that could detect flow, temperature, and pressure. For the purpose of quantifying gaseous emissions (CO₂, CO, NO_x, and THC) that were collected directly from the exhaust, a typical emissions

that were utilised throughout the 2014–2015 project at the Sasol Fuels Application Centre in Cape Town, South Africa.

Evaluation Tool

Below in Table 1 can see the specifics of the engine platform that was utilised. The engine had completed over 400 hours of testbed running and was completely bedded-in before the project started. The engine comes standard with an exhaust aftertreatment system that includes a diesel particulate filter (DPF), a diesel oxidation catalyst (DOC), and urea selective catalytic reduction (SCR) to regulate nitrogen oxides (NO_x) [7]. With the aftertreatment system operational, exhaust emission tests conducted in accordance with EPA guidelines verified that the 2010 emission limitations were more than satisfied.

The main goal of this project was to measure engine performance without considering after treatment system effects, such as the exhaust back pressure changing with DPF soot loading, and to focus on engine-out emissions instead of tailpipe emissions. Hence, the after treatment system was bypassed. In the following tests, a butterfly throttle installed in the exhaust was used to mimic the backpressure that is typically generated by the factory after treatment system. Because the throttle was stationary, the backpressure changed in relation to the exhaust flow rate.

bench from the Horiba MEXA 7000 series was used. The AVL 483 Micro Soot Sensor, a photoacoustic soot detector, was used to measure the emissions of soot in real time from a diluted sample of exhaust. A coriolis mass flow sensor was used to assess fuel consumption via a mass flowmeter. Figure 1 Consumption of

gasoline while the engine is not running. In order to track combustion characteristics, certain cylinders were equipped with piezoelectric pressure transducers. A frequency of 10" "Hz" was used to record all data from the testbed and the characteristics of the engine control module (ECM). Following the completion of all engine tests, which were carried out after the engine had been allowed to completely warm up, any emission tests that were pertinent were carried out in general compliance with 40 CFR 1065.

Heavy-duty, on-road engines in the United States are often controlled based on their exhaust emissions, which are monitored using the cold-start and hot-start transient FTP and SET cycles, respectively. This makes it possible for the government to regulate these engines. As seen in Figure 2, the engine maps exhibit emissions of nitrogen oxides as well as a short use of gasoline when the engine is shut down. According to 40 CFR 1036.235, greenhouse gas emissions (GHG) are computed by using the SET cycle for tractor engines and the FTP cycle for vocational engines. Both of these cycles are used differently. The World Harmonized Transient Cycle (WHTC) is typically used in Europe for the purpose of determining emissions and fuel consumption, which is often referred to as greenhouse gas assessment, for Euro VI and later combustion engines [8].

Since FTP and SET are separate test cycles, the transient circumstances used to evaluate regulated pollutants are distinct from the supposedly steady-state conditions used to evaluate greenhouse gas emissions (i.e., fuel usage) [9]. Figure 3 Engine maps displaying CO₂ emissions and short-term fuel use while the engine is turned off. As a result, this study employed two separate test cycles to compare the outcomes of the various engine calibrations [10]. For the purpose of evaluating steady-state performance, a ramped test cycle was implemented, which included the 13 speed and load points that are included in the EPA SET test cycle. On the other hand, the FTP test cycle was applied specifically for the purpose of analyzing transient performance [11]. The entire SET test lasts 2400 seconds, whereas the SS test cycle runs the engine for 1100 seconds, with 60 seconds in each mode and 20 seconds for the ramp times. With the exception of the idle mode, which is tested twice, all modes are given identical weight [12].

The time savings compared to the full SET test led to its reduction to this shorter form. Engine maps displaying CO emissions and short-term fuel use while the engine is turned off (Figure 4). It were able to extrapolate the fuel consumption and emissions from the limited test to the full SET test if it was required to do so [13]. This was accomplished by statistically "extending" each steady-state mode to its full length using the averaged data from the last 20 seconds of each mode in the reduced test.

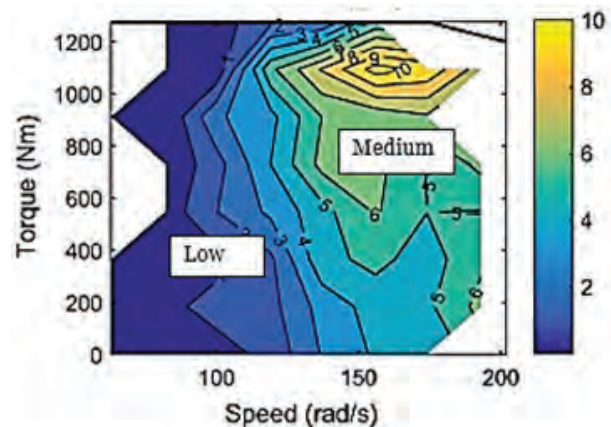


Fig. 1. Engine maps showing engine-out fuel consumption

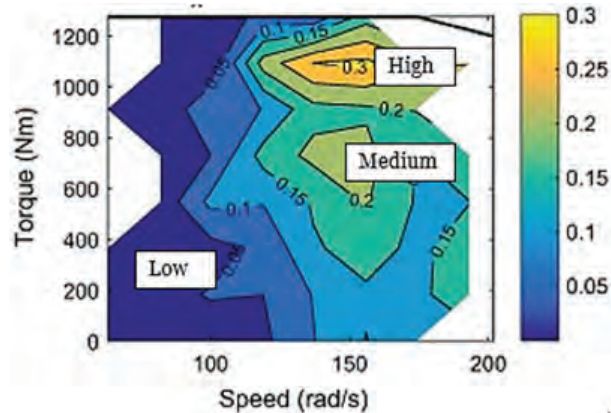


Fig. 2. Engine maps showing engine-out NOx emissions and temporary fuel consumption

Efficiency in Emissions Calculations Following Baseline Adjustment

Prior to the calibration optimization activity, it is necessary to compare the performance of the GTL fuel and the 2D fuel. The comparison should be conducted under both transient and steady-state settings, using the manufacturer's standard, baseline, or default engine

calibration. Figure 3 displays the outcomes of the FTP and SS test cycles. The results include the proportional variations in soot, CO, THC, NO_x, CO₂, gravimetric and volumetric BSFC, and BSEC compared to the prior experiment. The term “brake specific energy consumption” refers to the result obtained by multiplying the brake specific fuel consumption (BSFC) by the lower heating value (LHV) of the fuel. The term BSEC stands for “brake specific energy consumption,” which is itself an acronym. In order to compare engine efficiency, this statistic will be utilised all through this study. At least three separate tests, carried out at various points in the test regimen, were averaged to get these findings. Except for THC in the SS test, all of the differences are significantly different at the 95% confidence interval.

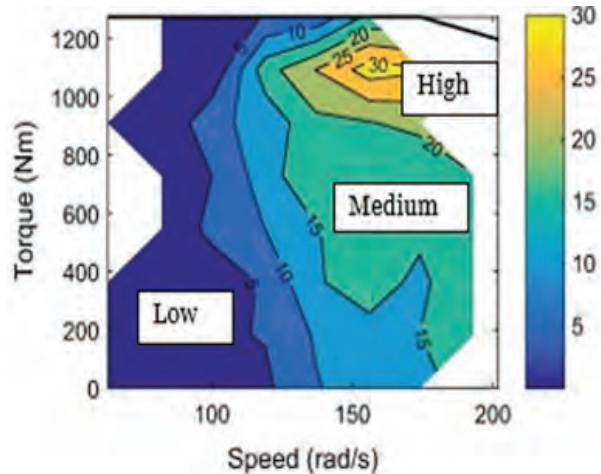


Fig. 3. Engine maps showing engine-out CO₂ emissions and temporary fuel consumption

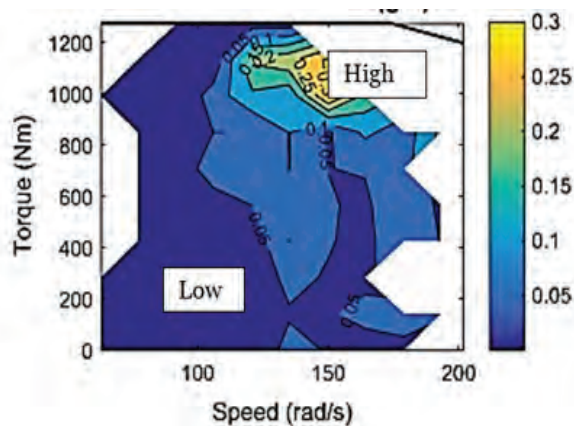


Fig. 4. Engine maps showing engine-out CO emissions and temporary fuel consumption

OPTIMIZATION PROCESS

This project’s calibration optimisations are based on Atkinson’s fast transient calibration method, as detailed in [15]. There are a lot of separate, sequential activities in this procedure, and each one has its own software module based on MATLAB ^B that gives the necessary data processing methods. Incorporating a laborious development effort that would have been out of place for this project into these data processing procedures would have been pointless because they include the outcomes of several years of research and expertise. While this work will show that the methods can be used for steady-state calibration optimisation as well, their primary focus is on optimising transient calibration, which sets them apart from most commercial model-based calibration software.

The entire process, which, in general, comprises the following steps: Identifying the optimisation goals, operational boundary conditions, and pertinent engine system characteristics. Making and carrying out an appropriate experimental strategy to collect the steady-state and transient test data needed to train the model. Testing the engine serves to validate the optimised calibrations..

The trade-offs between various parameters in diesel engine calibration are well-known. Some examples include the well-known trade-off between soot and NO_x, as well as the trade-off between BSFC and NO_x. Given that the exhaust aftertreatment system has the potential to reduce engineout emissions in the on-road application by as much as two orders of magnitude, this raises the issue of what constitutes a “optimal” engine calibration. Comparing the efficiency and emissions of two different fuels was the objective of this study; thus, comparing tradeoff curves, as opposed to individual test results, would be the most helpful approach to accomplish this objective.

Modelling and Data Analysis

Prior to analysis, the test data underwent preprocessing to guarantee that all of the measured parameters were properly aligned in time. This is essential in order to take into consideration the fact that different emissions monitoring equipment have different reaction times and transit delays. Each of the calibration parameters was

checked statistically to make sure there was a sufficient dispersion. If it want our model predictions to be based on interpolation and not extrapolation, this is a must. When training the model, it removed the results from “rogue” tests—those in which the engine behaved erratically or generated excessive emissions.

Making the models for the artificial neural networks (ANNs) is the next stage. An artificial neural network (ANN) architecture and training method that had been previously created and improved were used. Engine fueling, speed, EGR, MCF, SOI, and RLP values, both current and chosen from history, are used as inputs to the model. Instead of using real numbers, commands are utilised. Accurate prediction during transient operation relies on the models being able to deduce the transitory trajectory of the output parameters from the engine’s immediate operational history. Therefore, the temporal constants of the physical processes that lie under the surface and the delays caused by the limited reaction times of the actuators are also taken into consideration implicitly. This eliminates the need to depend on dynamic constraint models or equivalent structures to convert the values of the input parameters from their commanded to their actual states in [14].

Engine operating and emissions characteristics for which transient and steady-state prediction models were created include: Maximum cylinder pressure and torque. Various pollutants, include nitrogen oxides, carbon monoxide, and soot. Turbocharger RPM, Mass Flow, and Exhaust Temperature provide the final predictions of the model are shown below. These examples compare the torque that was actually measured to the torque that was anticipated, as well as the mass fluxes of NOx and soot that were seen and predicted over the FTP and SS test cycles. The numbers that are presented are both the instantaneous and cumulative (integrated) ones, and in each and every case, the values have been modified to take into consideration the highest value that was seen.

Final Product

The following are the trade-off curves representing the outcomes of the steady-state and transient optimisations: What follows, then, are the results of actual measurements, not those of theoretical models. Additionally, the results of two baseline calibration tests, conducted both before and after the tests with the

modified calibrations, are displayed. These tests provide insight into the measurement repeatability. Keep in mind that the optimization-generated calibrations depend on the weighting factors for BSFC, NOx, and soot that were separately specified for the cost functions. The trade-off curves given here are not the only potential solutions to the optimisation issue as specified; in fact, they will vary depending on the values of the relative weighting factors. However, out of the hundreds of computational optimisations carried out throughout the project, they actually constitute the “best” (or Pareto optimum) solutions.

DYNAMIC OPTIMISATION

The outcomes of the temporary computational optimisation. All measured data has been adjusted the 2D fuel baseline calibration indicates that this is the case. Each of the 2D and GTL fuels produced clear trade-off curves.

Optimisation for a Stable State

The result obtained from the 2D fuel base calibration is used to normalize all of the data. The GTL fuel outperformed the 2D fuel in both the BSEC/NOx tradeoff and the transient optimization. Although the GTL fuel resulted in a 2% drop in BSEC, it is evident that the 2D fuel caused a 1% reduction in BSEC at the baseline calibration NOx level. Nevertheless, substantial soot fines were imposed to accomplish this. However, when using GTL fuel, the tradeoff curve intersects with the baseline calibration data point. However, the soot level exceeds the baseline calibration limit by over fifty percent when using 2D gasoline. As a result, the greatest decrease in fuel consumption has been achieved by fully using the soot benefits provided by GTL gasoline. The findings for the 2D fuel, however, indicate that it is not feasible to achieve a decrease in fuel consumption compared to the baseline calibration without potentially generating an excessive level of sulfur dioxide emissions. This may suggest that a baseline steady-state calibration has been finely modified to achieve perfection. The relevant alterations for the steady-state calibration parameters include comparing the levels of SOI to NOx, the average EGR throughout the cycle, RLP, and MCF.

In this scenario, the computation of the averaged

calibration parameter values has included the idle time. This is because the amount of time spent idle is a smaller proportion of the total test length compared to the FTP test. The levels of exhaust gas recirculation (EGR), reactivity loss potential (RLP), and maximum combustion pressure rise rate (MCF) are not only comparable across both fuels, but they also rise in response to a reduction in nitrogen oxides (NOx). This is something that is very evident. When the NOx levels are standardized to 1, the EGR levels show similarity. However, the RLP (Relative Loss of Power) is much greater, while the MCF (Mean Cylinder Pressure) is substantially lower. As the level of nitrogen oxides (NOx) decreases, there is a corresponding increase in the start of injection (SOI), which often results in a delay. When NOx is normalized to a value of 1, the levels are somewhat higher than the baseline calibrations. Specifically, the GTL SOI is slightly higher than the 2D values. The topic of conversation It was concluded that the most efficient method for enhancing engine efficiency in both dynamic and stable operating circumstances was to reduce the MCF (Mean Combustion Fraction).

Calibration optimisations. Cutting down on MCF is a step in the right way for several other crucial metrics: Because less boost pressure is needed, the turbocharger speeds and peak cylinder pressures are decreased. With the target MCF decreased during calibration optimisation, there is no risk of exceeding these mechanical constraints. The functioning of exhaust gas aftertreatment systems is improved by typically increasing exhaust gas temperatures, which are caused by a decrease in total in-cylinder mass. However, it is important in order to prevent exhaust temperatures from exceeding the maximum at full load. Nevertheless, it is also necessary to make a number of warning remarks. Although all mechanical constraints specified in the Calibration Requirements section were carefully evaluated during optimisation, many critical aspects were overlooked. Some examples include the following: the compatibility of the aftertreatment system's functioning with immediate emissions; the longevity of components; not to mention the reactivity of the engine to transients and several other practical application conditions. It was determined that this demonstration project did not have the authority to inquire into the

engine manufacturer's specific understanding of the boundary conditions that apply to these and other aspects.

This research came to a number of important conclusions, one of which is that the lower soot emissions of GTL diesel allow for higher reductions in NOx emissions without compromising the efficiency of the engine. Whether or whether it is possible to reduce MCF in order to boost efficiency, this revelation is relevant regardless of the actual practicality of doing so. Considering the ongoing discussions about reduced regulation NOx limits, as suggested in California, this is a crucial quality to have. There are a lot of additional possible advantages that haven't been measured yet. One way to enhance transient engine responsiveness is to make it easier to control fuelling during severe accelerations. This would help reduce excessive smoke emissions. In cases where achieving a sufficient turbocharger reaction at low engine speeds is an issue, this might work in tandem with "downspeeding" to enhance economy.

It is important to note that this study's findings are mostly relevant to the specific engine hardware implemented. To be more specific, various turbocharger and EGR hardware combinations will have varying pumping losses to mass flow ratio equations. For instance, engines that use low pressure loop EGR systems or don't use EGR at all (like certain Euro VI engines) see much reduced pumping losses due to EGR. In such situations, the use of GTL gasoline could not be very beneficial. On the other side, better results could be achievable with alternative hardware setups if the transient optimisation process could have made use of the GTL fuel's entire soot advantage as a trade-off against fuel consumption.

6. Conclusion

Overall, optimising the calibration of engine control software for heavy-duty diesel engines running on gas-to-liquids (GTL) fuel is a huge step forward in terms of fuel economy and emissions performance. An technique that is data-driven, model-based, and uses artificial neural networks may be used to optimize a number of engine parameters for GTL fuel. These parameters include the timing of the injectors, the rate at which exhaust gas is recirculated, the rail pressure, and the charge mass. A considerable increase in

efficiency was achieved via the use of this optimization strategy throughout both the transient and steady-state test cycles. The research also shown that model-based calibration is an effective method for optimizing engine control settings for alternative fuels, which was a significant finding. Whether in transient or steady-state operation. The findings demonstrated that compared to regular diesel fuel, GTL fuel had clear benefits, most notably a decrease in engine-out NOx emissions with no increase in soot emissions or decrease in fuel efficiency. A decrease in pumping losses as a result of reduced charge mass needs was identified as the principal mechanism responsible for efficiency gains using GTL fuel throughout the optimisation process. Due to GTL fuel's naturally reduced soot concentration, acceptable overall emissions limits were maintained, even though there was a small increase in soot emissions.

This study adds to what is already known about heavy-duty diesel engine alternative fuels by shedding light on the possible advantages and operational ramifications of using GTL fuel. The effects of optimised GTL calibrations on performance and longevity under different operating circumstances could be the subject of future research. Calibration optimisation procedures could also benefit from developments in computational tools and modelling approaches, which might lead to greater accuracy. Aligning with worldwide efforts to decrease emissions and increase energy security in the transportation sector, optimising engine control software for GTL fuel is a viable technique for improving the sustainability and efficiency of heavy-duty diesel engines.

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Automatization of Manual Drainage Cleaning System: Design of An Automatic Waste Collection Vehicle

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ABSTRACT

In many countries, despite the advancement of automation in various sectors, the process of drainage cleaning remains predominantly manual. This paper proposes the concept of an Automatic Drainage Cleaning System to modernize the existing manual methods prevalent in our country. The system aims to address the challenges posed by plastic and floating debris clogging drains and sewer lines. Inspired by the 'Mr. Trash Wheel' concept, the proposed solution involves designing a specialized vehicle capable of autonomously collecting such wastes. The core of the Automatic Drainage Cleaning System is a Raspberry Pi unit serving as the central processing unit that controls the entire operation. A conveyor mechanism integrated into the vehicle facilitates the collection of plastic and floating debris from drains. Motion within the drain and operation of the conveyor system are driven by two motors, ensuring efficient maneuverability and waste collection capabilities. The vehicle navigates through water-filled drains, systematically collecting debris into a designated bin. Continuous monitoring of the bin's fill level is achieved through an ultrasonic sensor, ensuring optimal operation without overflow. The collected waste can be disposed of responsibly after retrieval, contributing to cleaner and more efficient drainage systems. This paper discusses the detailed design and functionality of the Automatic Drainage Cleaning System, emphasizing its potential to significantly enhance the efficiency and sustainability of drainage maintenance practices. By automating the cleaning process, the system reduces the reliance on manual labor, minimizes operational costs, and improves the overall cleanliness and functionality of urban drainage systems.

KEYWORDS: *Automatic drainage cleaning system, Waste collection vehicle, Raspberry Pi, Conveyor mechanism, Ultrasonic sensor, Drainage maintenance.*

INTRODUCTION

To keep one's health in check, one needs a clean and sanitary environment. Nowadays, drainages play a crucial role in maintaining a clean environment. Unfortunately, most areas' drains and sewers are unattended. There is now a major danger to civilization from plastic trash. Instead of properly disposing of

plastic bags and other debris, most individuals just put them down the sink after usage. Clogged drains are only one of the many health issues caused by these plastic wastes. The sewage staff are required to physically clean them once or twice a month. Many people are dying while trying to clear these drains without the right tools. Therefore, to clear these drains, an appropriate automated system is required.

Automatization has taken over most systems in the modern world. The sanitation industry employs over 1.2 million people. Over the years, nothing has changed regarding the working circumstances of these janitors. These workers endure social tragedies on top of the numerous health risks associated with their job. Technologies in engineering, medicine, and legislation can put a stop to this. Engineering safeguards can assist prevent exposures, while medical interventions can aid in the early diagnosis of their consequences. Creating a reliable occupational health service for these employees is one step in the right direction. Therefore, this article discusses the engineering solution to the problem.

Recommended Literature To remove the need for human labor in the drainage cleaning system. Exhibited the use of a mechanical cleaner. The drain pipes are very contaminated. Although it is essential to clean the drainage system, there are instances when it might endanger human lives. To address this problem, they used mechanical semi-automatic drainage water cleaners. To tackle this issue, a mechanical semi-automatic drainage waste cleaner was created. it improves water flow by regularly filtering out garbage. [1] demonstrated an automated technique for cleaning drainage systems, which reduced pollution and other environmental risks. All three components—the propeller, the cleaner, and the pan—contribute to the efficient operation of the drainage system cleaner. [2]. The benefits of an automated drainage water pump monitoring and control system using PLC and SCADA outweigh the risks to human life and cleaning time associated with manual cleaning. Conducted a review on the topic. [3] PLCs and SCADA systems were developed. When clearing up clogs in drainage systems, there is a risk of human death due to the disposal process. They devised the “Automatic Sewage Cleaning System” to get rid of this issue. For optimal water flow, they engineered their project such that gaseous material clearance is handled independently. Utilising all available resources (human, mechanical, financial, etc.) will allow this project to go to completion. Using what was available, they were able to complete the job in an inexpensive and effective manner. They applied his knowledge of automation—the use of mechanical, electrical, and computer-based systems to manage and direct production—to good use [4].

According to Nitin Sall et al., waste water is the water that is used up in residential areas, commercial establishments, and industrial processes. Every day, an average of 200 to 500 litres of water is wasted by each individual. Implementing waste water technology that eliminates contaminants from a drainage system instead of destroying them [5].

CURRENT SETUPS

Most people prefer to clean their drains by hand, which brings us to point 3.1. Someone will need to clear the drains with a shovel. The employment of a net or mesh to collect trash from drain water is also implied. If the drains are clogged, this strategy won't work; instead, someone will need to physically clear the drains. Shown in figure 1 is Manual Cleaning of drainage systems [6]

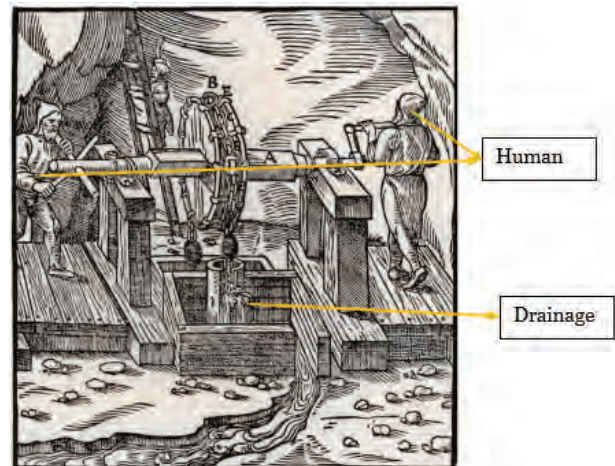


Fig. 1 Manual Cleaning of drainages

Hydro Jetting

It is the standard procedure for drain cleaning in most countries. This method entails a team of three or four professionals using a high-pressure water pump and a specialized nozzle connected to the valve of the hose in order to remove the blockage. Plastic waste, obstructed sewage pipes, and ordinary household objects may all be effortlessly eliminated using a flexible hose that attaches via an adaptable nozzle [7]. The municipal sewer system will remove even the most intractable tree roots from pipelines. Figure 2 illustrates the Hydro Jetting Method. When it lean in this way, the drains will be clean and ready to use in no time. It may change the water flow according to its needs. The one and only

drawback of this procedure is the sheer volume of water and the size of the trucks needed to transport it and all the necessary equipment [8].



Fig. 2 Hydro Jetting Method

Drain Augers

These tools remove stubborn blockages from drains effectively and safely, without the use of toxic chemicals. They have a motorised piece of machinery coupled to a long, flexible pipe via wires [9]. A coiled wire snakes its way down the drain and eventually finds the clog. The next step is to turn on the motor and gradually lower the end of the wires into the obstruction. This obstruction can then be removed and disposed of. In place of a motor, some augers come with a bolt that may be turned by hand [10]. It may hear these called “drain snakes” as well.

PROPOSED SETUP

An alternative to laborious manual drain cleaning is the primary goal of the system as a whole. What have here is a system that functions like a car, with the motor driver IC L293D acting as the brain and the raspberry pi serving as the actuators [11]. A snippet of code about motor controls is already loaded into the raspberry. In tandem with the wheel control motor, another motor governs the conveyor system’s rotation. The system’s

central conveyor is responsible for collecting floating trash from the water and depositing it into a container. On top of the container sits an ultrasonic sensor that keeps tabs on it [12]. Once the bin reaches a certain capacity, the ultrasonic sensor promptly recognizes it. Subsequently, the motors are deactivated by the python code implemented on the raspberry pi. In addition, a text message will be sent to the selected recipient over the SMTP protocol to inform them on the status of the bin. Mr. Trash Wheel was the inspiration for the vehicle’s basic premise. Figure 3 Trash Wheel located near Baltimore [13].

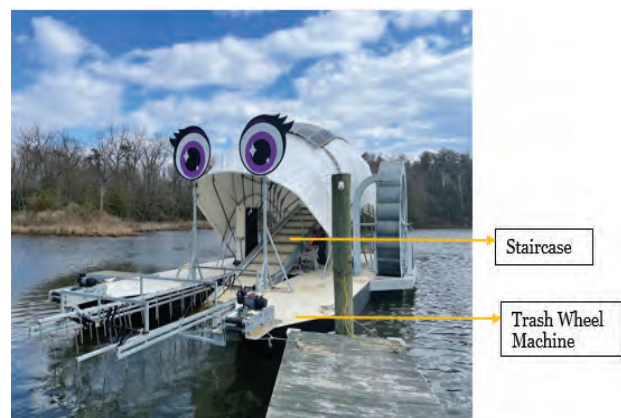


Fig. 3 The Trash Wheel in Baltimore

OPERATING COMPONENTS

Raspberry PI

In this project, a Python script is used to control the motors and set off an alert when the garbage can reaches a certain level. The raspberry pi is used for this purpose. Model B Raspberry Pi 3 (Figure 4) illustration.

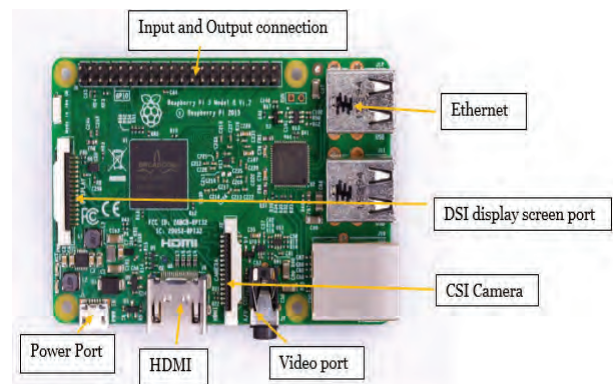


Fig. 4 Model B Raspberry Pi 3

L293D

It need a motor driver to power the 12V motors since the raspberry pi's highest voltage is just 5 V, which is insufficient. The L293D IC, a raspberry pi, two motors, and an electrical source will all work together to achieve this goal [14].

Motors

The project makes use of two motors in this case. One propels the complete system through the water by means of the aerator-modeled wheels. One is the debris-lifting system, which is linked to the conveyor via gears [15].

The HC-SR04 is an ultrasonic sensor

The purpose of the ultrasonic sensor is to monitor the state of the container. Connected to the raspberry pi, it continuously monitors the distance between the sensor and the bin's filled level using the python code in raspberry. The moment this distance exceeds the predetermined threshold, the motors will be shut off and an email will be sent to the specified receive (figure 5).

IN WORKING

There are three subsystems that make up the majority of the system. It is them.

- Conveyor System
- Warning System
- Vehicle motion system

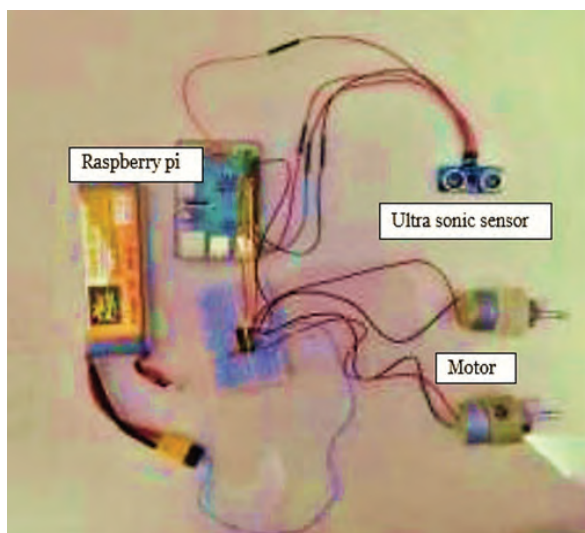


Fig. 5 Experimental Circuit setup

Conveyor System

The lifting of the wastes is controlled by this major component. A raspberry pi regulates the motor, which in turn controls the device. Conveyors turned as a result of motor rotation. The garbage is collected as the conveyor spins, and when it reaches the topmost position, it is deposited into the bin. Consequently, this will lead to the safe removal of trash from water and the cleaning of water surfaces. A set of plastic gears will link the conveyor system's shaft to the motor. In the event that the motor is turned, a plastic gear that is linked to the motor will turn still another plastic gear, which will then turn the shaft of the conveyor system (figure 6)

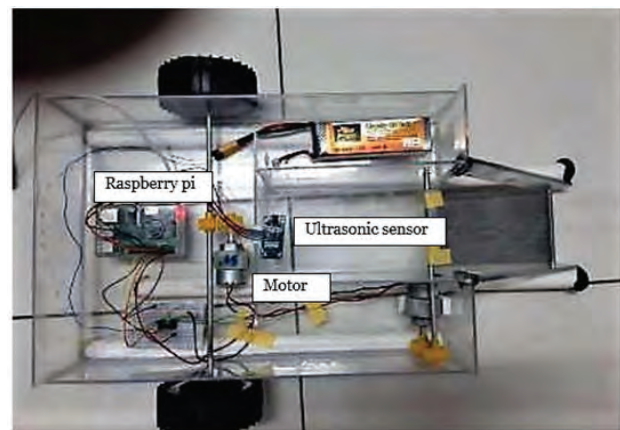


Fig. 6 Designed system

Warning System

Checking on the dump collector bin's state is what the warning system is all about. The raspberry pi also controls this system. An ultrasonic sensor is its main component. On top of the container sits the sensor, which is fastened to the raspberry pi. With the help of Python programming, the sensor will continuously measure the extent to which the bin is being filled. There is a particular level at which the threshold level is established. The motors, which are controlled by the raspberry pi using L293D, will be shut off as a result of the alert that will be triggered by the sensor. As soon as the dump hits this threshold, an alarm message will be sent to the receiver that has been chosen via the use of the Single Mail Transfer Protocol (SMTP). This trash can has to be emptied in order for the system to resume its normal operation, which will be accomplished by restarting the program.

System of Motion for Vehicles

The movement of the system is achieved by the use of two wheels that are suspended on the rear end of the vehicle. There is a shaft that is connected to a plastic gear, and the wheels are attached to that shaft. This plastic gear will then be joined to the motor by means of another plastic gear when that has been completed. Therefore, when the power is connected, the motor begins to spin, and the wheels, with the assistance of plastic gears, roll in the opposite direction of the clock toward the motor. The wheels are constructed in the “Water wheel aerator” type, which means that when they spin, they push the water back, which causes the vehicle to go forward; this is how the wheels work. This facilitates the system’s mobility and the collection of garbage that obstructs its path.

CONCLUSION

A fundamental issue with drainage cleansing is well addressed by the project. In comparison to the previous methods, this one is superior and lessens the dangers associated with drain cleaning. The system is easy to use and offers a lot of versatility. The level of operation of the vehicle determines the cost of the system. To that end, the “Automatic drainage Cleaner” project aims to provide a practical and cost-effective method for cleaning drain water of detritus such as plastics, garbage, and other floating pollutants. Using this equipment will drastically cut down on the need for human labor. The fishing industry may also make use of it for the collecting of deceased fish. The development of the Automatic Drainage Cleaning System represents a significant advancement towards modernizing and improving the efficiency of drainage maintenance processes. This system addresses the persistent challenge of manual cleaning methods by introducing automation through innovative design and technology integration.

By leveraging the capabilities of a Raspberry Pi as the central control unit, coupled with a robust conveyor mechanism driven by dual motors, the system effectively automates the collection of plastic and floating debris from drains and sewer lines. The vehicle’s ability to navigate water-filled drains autonomously and monitor waste collection using an ultrasonic sensor ensures a systematic and efficient cleaning operation.

The implementation of such automated systems offers several compelling benefits. Firstly, it reduces reliance on manual labor, thereby enhancing safety and reducing labor costs associated with traditional cleaning methods. Moreover, the system’s continuous operation capability minimizes the risk of drainage blockages and overflows, contributing to improved infrastructure reliability and reduced maintenance downtime. Furthermore, the Automatic Drainage Cleaning System contributes to environmental sustainability by preventing plastic and debris from entering water bodies. By intercepting waste at the source, the system supports cleaner waterways and reduces the environmental impact of urban runoff. The successful deployment of this system relies on effective integration with existing drainage infrastructure and operational protocols. Collaboration with municipal authorities and stakeholders is crucial to ensure seamless deployment and integration into urban drainage management frameworks.

In conclusion, the Automatic Drainage Cleaning System represents a pivotal step towards sustainable urban drainage management. By automating the process of waste collection from drains and sewer lines, the system not only improves operational efficiency and reduces maintenance costs but also contributes to environmental protection and community well-being.

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Novel Approaches to Affordable Point-of-Care Diagnostics via Atom Stamp Printing

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ABSTRACT

Advances in atom stamp printing have opened promising avenues for revolutionizing affordable point-of-care diagnostics. This novel technology enables precise manipulation and deposition of atomic layers onto substrates, facilitating the development of ultra-sensitive biosensors and diagnostic devices. Atom stamp printing leverages the principles of atomic layer deposition (ALD) to achieve controlled deposition of functional materials at nanoscale resolution. This abstract explores recent innovations and applications of atom stamp printing in the field of point-of-care diagnostics, emphasizing its potential to enhance sensitivity, specificity, and affordability of diagnostic tools. The discussion covers key aspects such as the integration of atomically thin films for signal amplification, the scalability of manufacturing processes, and the customization of diagnostic platforms tailored to specific biomarkers or pathogens. By bridging the gap between advanced materials science and clinical diagnostics, atom stamp printing offers a promising pathway towards decentralized, cost-effective, and rapid diagnostic solutions capable of addressing global healthcare challenges. Its ability to detect heavy metal ions quickly and inexpensively at the point of care addresses critical needs in public health and environmental pollution control. Overall, ASP-based fabrication of μ PADs represents a notable advancement in the field of paper-based diagnostics, offering enhanced performance characteristics and broader applicability. Future research directions may focus on expanding the range of analytes detectable by ASP-fabricated μ PADs and optimizing their integration into practical diagnostic workflows.

KEYWORDS: Atom stamp printing, Point-of-care diagnostics, Atomic layer deposition (ALD), Diagnostic devices, Rapid prototyping, and Healthcare technology.

INTRODUCTION

Over the course of the 1990s, the idea of a “lab on a chip (LOC)” was put up, which coincided with the development of microfluidic technology. This technology is able to do biochemical analysis on a chip that is as tiny as a few square centimeters, and it can also carry out activities such as sample mixing, purification

[1], and separation while simultaneously conserving both space and money. This is the most crucial aspect of this technology [2]. It is the first to suggest the use of microfluidic paper-based analytical devices (PADs) as an alternative to the conventional microfluidic chips that were composed of glass [3-4] and silicon[5]. These PADs have the advantages of being simple to fabricate, having a low cost, being portable, and being able to

be disposed of [6]. The area of point-of-care testing (POCT) has shown a significant amount of interest in these devices since their introduction [7].

Creating μ PADs involves using a hydrophobic treatment on paper to generate distinct parts that are hydrophilic and those that are hydrophobic. This is the primary concept underlying the creation of these devices [8]. By doing so, the flow of fluid will be restricted and directed. There are several ways that may be used in the process of creating μ PADs at the present time. The methods that are included in this category include photolithography [9], wax printing [10], paper cutting [11], drawing, inkjet printing, laser cutting, and stamping [12]. It created history when they used the photolithography method and an SU-8 photoresist to manufacture a hydrophobic pattern on paper for the very first time [13]. This breakthrough was a historical moment. Using filter paper that had been prepared with a solution of octadecyl trichlorosilane and then subjected to strong UV light, he and his colleagues [14] developed high-resolution micro PADs. The measurements of the hydrophilic channel were $233 \pm 30 \mu\text{m}$ in width.

Wax printing was used [15] and in order to achieve the goal of producing μ PADs in a manner that was both inexpensive and expedient. Paper patterning with wax is a simple approach that can be done at home with just a professional wax printing equipment and a heating board or oven. This method is one of the easiest available. In the event where high resolution μ PADs are not needed for the experiment, it is possible to obtain a lower manufacturing efficiency in comparison to other methods by using simple paper cutting and drawing. The production of micro photonic arrays (PADs) by the use of inkjet printing with “chemical sensing inks” was completed in the year 2008. They achieved a channel accuracy of $550 \mu\text{m}$, which is considered to be rather excellent. Up until now, laser cutting has been the most efficient approach for achieving a channel resolution of $62 \pm 1 \mu\text{m}$ on paper. This technology is suitable to any paper that has a hydrophobic surface coating of 20, which includes wax and parchment paper. The paper must undergo extra chemical treatment in order to complete this step, which is more complicated than the previous one.

A few examples of stamps are a stamp made of paper and tape, a high-relief stamp made of polydimethylsiloxane

(PDMS), a stamp made of iron or steel, and a flash foam stamp (FFS). On the other hand, stamping is yet another industrial process that has been used really often. For the purpose of printing the desired design on paper using the hydrophobic material, stamps are often used. Due to the prominence of hydrophobic solvent in the printing process, hard stamps, like the majority of the ones described above, are notoriously difficult to create. Additionally, they share many of the problems that are associated using wax printing, such as having a poor resolution. One technique to overcome the drawbacks that are linked with these procedures is to make use of an FFS, which offers a relatively high resolution via the use of PDMS, a hydrophobic solvent, and also has the benefits of being easy to run and inexpensive. More than thirty minutes are added to the total amount of time that is necessary for the manufacturing process as a result of the preparation method, which is quite time-consuming. This is particularly true when the stamps are submerged in PDMS solvent.

In addition, the stamp must be resoaked after each use, which adds additional time to the process, and it can only be used for a limited number of prints. It is thus necessary to take into consideration the time investment, the financial benefits, and the ease of the stamp that are considering employing.

Atom stamps (ASs), which are sometimes referred to as machine-engraved penetrating stamps, provide advantageous characteristics such as low cost, high efficiency, and high resolution. These stamps may be crafted manually or with the assistance of a laser engraving machine. It is possible to manually carve the stamp pad in situations when a high resolution is not required for micro peripheral area devices (PADs). The manual production process is more cost-effective, but it requires a higher level of knowledge and experience. An AS may also be referred to as a laser engraving seal stamp due to the fact that it is possible to utilize a laser engraving machine in conjunction with well-known drawing software such as AutoCAD and CorelDRAW in order to create pattern patterns. Printing may be accomplished with an AS stamp because of its microporous nature, which enables it to absorb ink. Additionally, the operation of the stamp is simple, making it easy to print with it. Through the use of an AS, a unique method for the production of μ PADs,

which is referred to as ASP (AS printing), was created in this study. In order to manufacture PADs, the essential processes include soaking a pattern stamp in PDMS solvent, printing it on paper, and lastly putting it in a vacuum drying box or oven for several minutes to end the manufacturing process. These steps are necessary in order to create PADs.

There are a number of approaches that have been developed for the purpose of detecting heavy metal ions using μ PADs. These techniques include colorimetric detection, fluorescence detection, and electrochemical detection. By using a colorimetric method to simultaneously detect iron and nickel ions, it demonstrated that “multichannel” PADs are effective in detecting heavy metal ions. This was shown via their experimentation. It developed a new paper-based sensor by using the fluorescence quenching ability of gold nanoparticles (Au NPs). This sensor was able to detect and detect light. It took just fifteen minutes to get the detection method working. Using paper-based capacitance sensors (PCSSs), created a technique of chemical identification and quantitative detection that is more environmentally friendly. This approach includes the quantitative detection of heavy metal ions. This technology integrated electrochemical and paper-based methodologies, which resulted in the elimination of the need for large-scale equipment in the detection operation. Among these three methods, colorimetry is by far the most widely used because of its straightforwardness, ease of operation, and lack of complexity in terms of satisfying the most essential needs of on-site detection. To put that into perspective, the colorimetric method has a low degree of precision, which makes it very difficult to achieve accurate quantitative detection.

Electrochemical detection is able to give quantitative detection and overcomes the problem of inadequate accuracy, despite the fact that it is difficult to carry out and requires testing equipment that is relatively expensive. Despite the fact that it is difficult to use and calls for specialized detection equipment or reagents, fluorescence detection has the potential to provide focused detection with high accuracy while simultaneously decreasing certain critical interference. During the course of this inquiry, the colorimetric method was chosen as the method of choice for detecting $\text{Cu}^{(2+)}$. A proof of concept was achieved by the use

of micro PADs manufactured by ASP for the purpose of semiquantitative detection of $\text{Cu}^{(2+)}$ through the utilization of a colorimetric approach. Instead of using the colorimetric technique for detection, another option is to use distance-based detection, which is a quantitative approach that is more effective and has greater accuracy. This is an alternative to the colorimetric method. These were the first to propose the distance-based technique, and they demonstrated how it could detect glucose, nickel, and other substances on micro PADs. After that, used the distance-based technique in order to detect copper ions by using a porphyrin derivative. The lowest detection limit that was achieved was 1 mg/L. Combining the colorimetric methodology with the distance-based method is what this study does in order to achieve the goal of quantitatively measuring the concentration of $\text{Cu}^{(2+)}$.

In order to further demonstrate the versatility of our micro PADs, a soil-liquid extraction device (PSED) that is based on paper was supplied. For the purpose of achieving integrated extraction and filtration, this device used 3D μ PADs in conjunction with a micropump that was handcrafted. In order to extract heavy metal ions from soil, centrifugation, oscillation, and other solid-liquid extraction procedures sometimes need specialized equipment such as centrifuges and ultrasonic vibrations. Because of this, it is essential to develop an extraction device that is both inexpensive and straightforward in order to meet the requirements of on-site detection in areas that have limited resources. This is because the conventional method does not conform to the concepts of affordability, mobility, and miniaturization in the POCT field. During our experiment, the PSED that was evaluated here took use of the natural characteristics that paper has, such as its low cost, portability, and filterability, and it performed better than other extraction devices that were competing with it.

MATERIALS AND METHODS

Substances and equipment

The National Standard Substances Research Centre in China provided us with a copper solution that had a concentration of one gram per liter. Brilliant, China was the source of both the ammonia and the copper that were used as substances. For the aim of extraction, Henan University of Technology's Chemistry Research

Laboratory dissolved diethylenetriamine pentaacetic acid (DTPA). One might deionize their water at home, in the comfort of their own environment. First, we took soil samples from Lingshan Village in Jiyan, China; second, we went to a smelting factory in Zhengzhou, China; and third, we went to a greenhouse in Tangshi, China. Because of its individual qualities, each of these spots was hand-picked. All of the laser engraving equipment was bought from a company in China named Laser Star. The atomic absorption spectrometer was bought from a seller called Thermo Fisher, which is an American company. We bought the D-Force 400 3D printer from Triangle Laboratory Co., Ltd., a seller based in Jiangsu, China. Fused deposition molding (FDM) is the technique that this printer uses. The micropump and power amplifier were both constructed by hand.

Choosing paper

The first stage in creating v PADS is selecting an appropriate kind of paper. This study compared three distinct varieties of filter paper, namely Whatman No. 1, No. 4, and No. 5. Because of its intermediate pore size and flow velocity, No. 1 filter paper has the advantage of being simpler to observe and identify. Hence, it is often used in the manufacturing of vPADs⁴⁵. Because of its large opening, filter paper No. 4 shows a greater flow rate and makes it difficult to see the fluid's movement and reaction visually. Because of its thicker construction, the hydrophobic agent has a more difficult time penetrating its centre than it would with No. 1 filter paper. The small pore size of No. 5 filter paper causes fluid to flow slowly, makes paper bonding more difficult, and prevents hydrophobic solvents from penetrating. As a result, the experimental and production stages relied on No. 1 filter paper. Table 3 contains the paper specifications.

Manufacturing of the AS

A unique sponge material with a microporous structure is used to make the AS, as shown. The ink-retaining layer and the engraving layer are two separate components. It shows the two layers, one for the reservoir and one for the lithography. It shows that microporous structures are present on both the surface and the interior of the AS. Although the reservoir layer's pores efficiently absorb the hydrophobic solvent, the holes on the surface, which are crucial for microstructure creation, are smaller.

Submerging the stamp in water for two or three minutes before to carving is vital for preventing the AS from overheating and affecting its accuracy. The last step in AS manufacturing is to send the pattern made in AutoCAD or CorelDraw to the laser engraving equipment. A laser spot with a diameter of 38 micrometres and a beam width of 300 micrometres is used for laser engraving. Five hundred millimetres per second is the engraving speed. The depth of the engraving is proportional to the current that is employed during the engraving process. The standard current measurement is 10 milliamperes (mA). It is possible to employ a current of fifteen milliamperes for deeper etching. It shows the same process.

Manufacturing of μ PADS

It shows the engraved AS, which was then submerged in the produced PDMS solvent. The PDMS and curing agent were combined in a ratio of 10:1, and the mixture was then placed in a vacuum drying box. The bubbles were removed, and it took about ten minutes for the AS to completely absorb the hydrophobic solution. For more information, refer to step 3. By adjusting the immersion period from two minutes to five minutes, we were able to determine that the best time for printing distinct patterns on paper is five minutes after the original immersion time. The filter paper that has been treated with PDMS is capable of achieving hydrophobicity. The contact angle between water and the hydrophobic surface may reach 137 degrees, without altering the flow of fluid in the hydrophilic portions. It is important to note that a contact angle more than 90 degrees is considered to be hydrophobic, while a contact angle less than 90 degrees is considered to be hydrophilic.

RESULTS AND DISCUSSION

Examining micro PADS for resolution using the ASP approach

Resolution is a crucial aspect to think about while assessing the performance of μ PADS. In this context, "resolution" means both the smallest possible width of the paper's hydrophobic barrier and the smallest possible channel width for fluid movement. For resolution, we assess both of these dimensions. It demonstrates the design that was used to build the structure of the hydrophilic channels (0.3-1.3" "mm)

and the hydrophobic barriers (0.2-1.1 mm). A blue dye was put into the channels in order to get a precise observation of the flow across the hydrophobic barriers and the hydrophilic channels. It is evident that the liquid flowed freely with a hydrophilic channel width of 0.4 inches, but flow was blocked with a hydrophobic barrier width of 0.2 inches. In the μ PADs, the expected and actual widths of the hydrophilic channels and hydrophobic barriers differ.

Results from measurements and the fitting line, however, showed that the hydrophilic channel's actual widths were often less than its theoretical ones. Contrarily, the predicted theoretical widths of the hydrophobic barriers were often larger than their actual widths. That happened because the hydrophobic components were printed onto the filter paper using AS production, which caused the PDMS to disperse and penetrate. In addition, it should be mentioned that there is a relationship between the theoretical value and the real value that is approximately proportional. Hydrophobic barriers have a correlation coefficient (R^2) of around 0.999, whereas hydrophilic channels have a value of about 0.9965. The hydrophobic barriers had a minimum width of 312 μ m and the hydrophilic channels a width of 328 μ m, as seen under a microscope.

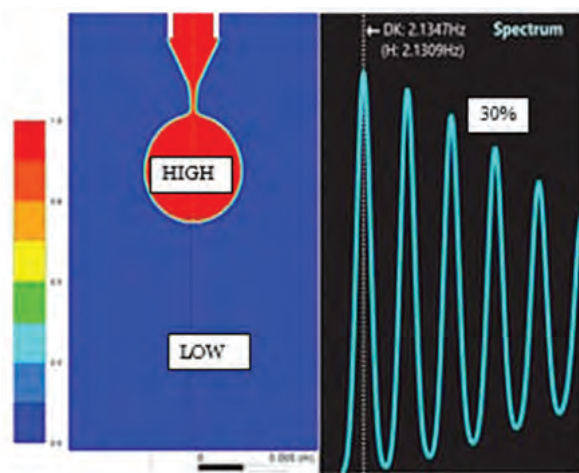


Fig. 1 Computer-based fluid dynamics (CFD) simulations of the region, the adaptable mesh, and the drop kinematics

With a minimum hydrophilic channel width of $62 \pm 1 \mu\text{m}^{20}$, μ PADs manufactured by laser cutting have the potential to reach the best resolution among the various ways of producing μ PADs. On the other hand,

specialized paper materials are required, the endeavor is expensive, and the process is difficult to carry out. Adaptable mesh, drop kinematics, and computational fluid dynamics (CFD) models of the region are shown in Figure 1. Drawing and cutting are two methods that are not only inexpensive but also simple to use.

The ASP methodology was used to investigate the resolution of μ PADs. Illustrating the structural characteristics of the hydrophilic channels. b Examining hydrophobic barriers from a structural perspective. Performing blue dye tests to detect the presence of hydrophilic channels. Hydrophobic barriers were tested using blue dye. Comparison of the breadth of hydrophilic channels between theoretical and experimental measurements. The user's text is simply "f". An examination of the disparity between the anticipated and actual widths of the hydrophobic barrier. The hydrophilic channels had a width of around 2000 μ m, suggesting a low level of resolution (^{15,16}). Wax printing requires printers with a resolution of 600 micrometres to the power of 12, whereas inkjet printing requires printers with a resolution of 550 micrometres to the power of 17. Wax printers have a low demand among consumers, because inkjet printing requires specific machinery. FFSL and ASP are two stamping methods, however, ASP exhibits much more precision. This is seen in the dimensions of the hydrophilic channels and hydrophobic barriers, which measure 632 ± 27 and 306 ± 20 μ m, respectively (reference 25). On the other hand, FFSL has a much lower level of resolution. ASP is more adept at effectively producing μ PADs compared to FFSL. Table 1 presents a thorough comparison of the methods used in the production of microfluidic paper-based analytical devices (μ PADs).

Table 1 compares various manufacturing processes for micro PADs, emphasizing their respective advantages and limitations. Injection molding is noted for its high throughput and cost-effectiveness in mass production but may require significant upfront tooling costs. Laser cutting offers precision and flexibility in design iterations but can be slower and more costly per unit. 3D printing enables rapid prototyping and complex geometries without tooling but may lack the material properties needed for high-volume production. MEMS (Micro-Electro-Mechanical Systems) fabrication

ensures precise control and integration of micro-scale features but typically involves higher fabrication costs. Each process differs in terms of scalability, material compatibility, and production speed, highlighting the trade-offs between cost, customization capabilities, and scalability in manufacturing micro PADs.

This paragraph provides a concise comparison of manufacturing processes for micro PADs, addressing key factors such as production scalability, cost implications, and technological capabilities. Adjustments can be made based on specific details or additional comparative points relevant to this study.

Table 1 Comparison of the manufacturing processes for μ PADs.

Method	Advantages	Disadvantages
Photolithography	Ultra-high resolution	High expense and a complicated process
Wax printing	Simple to manufacture and inexpensive	The resolution is low.
Inkjet printing	Both high resolution and speed	Unique printing devices
Cutting	Low in cost and simple to administer	The resolution is low.
Laser cutting	Ultra-high resolution	The technique is complicated, and specialized paper materials are required.
FFSL	Low in cost and simple to manufacture	The resolution is low.
ASP	Cost-effective, quick, with a high resolution, and simple to manufacture	The resolution is low.

Table 2 presents a comparative analysis of the costs associated with the ASP and FFSL methodologies for cost allocation in manufacturing. The ASP methodology, based on Activity-Based Costing principles, focuses on assigning costs to specific activities within the production process. This approach allows for a more

granular allocation of costs, enhancing transparency and accuracy in cost identification. In contrast, the FFSL methodology, also known as Full-Costing or Full Absorption Costing, allocates all production costs, including fixed and variable overheads, to each unit produced. While FFSL provides a comprehensive view of total production costs per unit, it may oversimplify cost drivers and lacks the specificity of ASP in attributing costs directly to activities. The analysis reveals that ASP tends to be more resource-intensive in terms of data collection and analysis but provides managers with detailed insights into cost drivers and potential efficiencies. Conversely, FFSL offers simplicity in its application but may distort cost allocations, especially in heterogeneous production environments. The choice between ASP and FFSL depends on the complexity of the production processes and the desired level of accuracy and detail in cost reporting

Table 2 Comparative analysis of the costs associated with the ASP and FFSL methodologies

Materials	Amount
Filter paper	40x40 mm ²
Atom stamp	40x40 mm ²
PDMS	04 g
Flash foam	40x40 mm ²
Tracing paper	40x40 mm ²
Mask	1 piece of paper

CONCLUSIONS

The use of PADs, a novel kind of sensing device, has found applications in a wide variety of sectors, including environmental monitoring and food safety, to name just two of those fields. In the last several years, there has been a significant rise in the amount of research that has been conducted on the manufacturing process of vPADs. In this work, a novel approach using ASP was offered as a means of fabricating μ PADs. The micro PADs that were produced using ASP used hydrophilic channels with a diameter of 328 μ m and hydrophobic barriers with a measurement of 312 μ m in order to obtain a high resolution. In comparison to other printing technologies such as photolithography, inkjet printing, and wax printing, ASP stands out due to its inexpensive cost, straightforward operation, fast preparation time, great sensitivity, and outstanding resolution.

Due to the fact that the hydrophobic substance cannot contaminate the hydrophobic channels when employing PDMS, which is a see-through liquid, this approach is applicable in a variety of scenarios. This was accomplished by combining a colorimetric methodology with a distance-based detection method, which allowed us to show that ASP-fabricated micro PADs are capable of detecting $\text{Cu}^{(2+)}$ at a concentration of 1 mg/L. A brand new solid-liquid extraction device, also known as a PSED, was being considered for the purpose of removing heavy metal ions from soil. By combining the extraction, filtration, and collecting processes, this apparatus reduces the amount of sample that is lost and fulfills the criteria of POCT while the number of experimental samples that are required is reduced. In addition to being inexpensive, free of pollution, and having a high extraction efficiency, it is also extremely versatile and can be modified to match the needs of the majority of solid-liquid extraction processes.

Furthermore, this device is not limited to the ground. Not to mention how simple and cheap the device is to manufacture (3D printing). Places with limited budget and no specialist equipment may find it suitable since it may be modified to fit extraction needs. Prior to their usage, the device must undergo improvements to their user-friendliness, level of integration, and the production of working POCT products.

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IoT-Controlled Seed Sowing System for Efficient Agricultural Operations in Small-Scale Farming

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ABSTRACT

In the realm of agriculture, there is a critical need for technology that is accessible, user-friendly, and capable of enhancing productivity while reducing labor and costs. Addressing these challenges, we introduce a novel IoT-controlled seed sowing system designed to optimize the sowing process, thereby saving time and money for farmers. The traditional method of seed sowing is labor-intensive and time-consuming, making it a bottleneck in agricultural activities. Our IoT-controlled system integrates functionalities such as ploughing, sowing, and leveling, essential for small-scale farming operations. It aims to streamline these processes, ensuring seeds are planted precisely in desired positions. Key features of our seed sowing system include versatility across different farm sizes and crop types, robust construction, and reliability. These qualities are essential for ensuring widespread applicability and durability in varied agricultural settings. The system facilitates automated control via IoT, enabling farmers to manage sowing operations remotely and adjust parameters such as seed spacing and planting depth. This automation reduces human error and enhances planting accuracy, ultimately improving crop yield potential. Furthermore, the design emphasizes simplicity and user-friendliness, ensuring that even inexperienced farmers or workers can operate and maintain the machine effectively. We have prioritized affordability by using cost-effective materials, making the system accessible to small-scale farmers with limited resources. The IoT connectivity not only enhances operational control but also enables real-time monitoring of sowing activities, contributing to better decision-making and resource management on the farm. In conclusion, our IoT-controlled seed sowing system represents a significant advancement in agricultural technology, addressing the pressing need for efficiency, cost-effectiveness, and ease of use in seed planting processes. By leveraging IoT capabilities, we aim to empower farmers with tools that improve agricultural productivity and sustainability.

KEYWORDS: *IoT, seed sowing system, Agricultural technology, Small-scale farming, Automation, Efficiency, crop yield, IoT connectivity, User-friendly design, Cost-effectiveness.*

INTRODUCTION

India has achieved significant advancements in the field of agriculture during the last four decades. The agriculture sector has effectively fulfilled the growing

need for food. The importance of increasing the amount of land used for agriculture has decreased over time, since much of the rise in output over the last twenty years can be mainly attributable to improved productivity [1]. Agricultural production has played a substantial role

in the overall development. Increased production has helped reduce hunger, increase agricultural income, and provide employment opportunities, both directly and indirectly. The prosperity of India's agriculture may be ascribed to a series of stages [2]. The main factors that propelled agricultural growth during this time were the widespread distribution of new crop types, greater utilisation of resources, and investments that led to the expansion of irrigated regions. Regions that have been significantly impacted by the introduction of 'Green Revolution' technologies have seen a decline in their growth [4-5]. In order to enhance crop output, maximise resource utilisation, and shift towards a more sustainable and economically beneficial agricultural industry, it is necessary to use innovative technology [6]. Indian farmers in Culturia have more obstacles in ensuring the quality of agricultural goods compared to their counterparts, mostly owing to their reliance on traditional farming methods [7].

Seeding in small areas is often accomplished by the physical process of cutting holes or slits with a stick or tool, followed by the meticulous placement of seeds by hand [8-10]. Experienced farmers often use the technique of dibbling in multi-row conventional seeding methods, whereby seeds are manually metered [11]. Currently, there is a shortage of skilled workers in the agriculture industry in many countries, which is adversely affecting the production of developing nations [12]. Hence, it is essential for the sector to use automation to tackle this problem.

Around 70 percent of India's population depends on agriculture as their main means of sustenance [12]. Hence, it is essential that we get expertise about cattle. Our initiative aims to optimise the process of cultivating a wide range of crops, such as sunflower, baby maize, peanuts, beans, lady's finger, pumpkin, and pulses like black gramme and green gramme [13]. Our objective is to reduce human work and optimise agricultural yield. The distance between the two seeds is controlled and modified using a microcontroller [14]. Various types of seeds may be sown using different distances. Use remote switches to modify the trajectory of the Robot when it approaches the edge of the field. Tractors are often used on farms to sow seeds [15]. Human assistance is often required in the traditional technique of sowing. Nevertheless, it necessitates a substantial

duration and continually faces a shortage of personnel. India's economy relies mostly on agriculture and is mainly rural.

Issue Description

India is mostly an agrarian nation. 50% of India's population relies on agriculture. For India to achieve a GDP growth rate of 9-10% over the next 30 years, it would need around 70 million people, which is more than twice the population of the United States. However, this goal cannot be accomplished without a significant transformation in the agriculture sector. Currently, the majority of countries lack a proficient labour force in the agriculture industry, which is hindering the progress of emerging nations. Consequently, producers have to use enhanced methods for their agriculture practices. Hence, it is imperative to address this issue promptly. This obviates the need for manual labour and further prevents the wastage of seeds.

Influenced by the Problem

While embedded electronics-based initiatives catch our attention, it's important to remember that embedded systems provide a plethora of extra advantages. An example of a possible use for source code delays is controlling the speed of a DC motor or other electrical component. Due to the fact that the project is concentrated on the application of Internet of Things (IoT) technology in farming, there is ample motivation to see it through to its end. The system consists of several parts, such as controllers, interfaces for DC motors and ultrasonic sensors, and linear actuators. Valves, such as seed distribution valves, rely on these parts to function.

ANALYSIS OF THE EFFICACY OF SEEDING DEVICES IN RELATION TO OTHER SOWING TECHNIQUES

Ultrasonic sensor

In order to identify potential barriers during planting seeds, the writers of this study used a camera for video interaction. It is possible to use intelligent robots that can spread the seeds mechanically, eliminating the need for human intervention. The system makes use of several automated procedures that need little human intervention [5]. Autonomous agricultural robots with built-in control systems and a range of potential uses

in horticulture are the focus of this project's prototype development efforts. A robotic farming machine's overarching principle is to effortlessly filter out unwanted plants or crops while selectively harvesting them. The ESP8266 Wi-Fi microcontroller serves as the central component of the system module. The module establishes a Wi-Fi connection with the central server, transmitting data via the HTTP protocol based on JSON utilising IP cameras. Aiming for minimal reaction time and maximum resource conservation, the programme code in the module is intentionally kept as basic as feasible. Electric control, automated door locks, data on power usage, Infrared furniture and cameras that allow for direct room monitoring are only two of the elements that are included in the modules of this tested and effective smart home system.



Fig. 1: A component of the ultrasonic sensor

By using ultrasonic waves, a device known as an ultrasonic sensor is able to determine the distance between itself and an item. Transducers are used by ultrasonic sensors in order to transmit and receive ultrasonic pulses, which are then used to transmit information on the proximity of objects. Sound waves with a high frequency are reflected off of boundaries, resulting in various echo patterns created. This module operates on a straightforward premise of operation. It sends out an ultrasonic pulse with a frequency of forty thousand hertz, which travels through the air and, if there is an obstruction or an item, bounces off the sensor. The distance may be determined by calculating the amount of time it takes for sound to travel and the

speed of sound. When it comes to identifying items that are transparent, the ultrasonic sensor has exceptional performance. Figure 1 depicts the many components that make up ultrasonic sensors. When it comes to the measurement of liquid level, applications that employ infrared sensors, for instance, have a difficult time dealing with this specific use case since the target is translucent.

It is possible for ultrasonic sensors to detect things regardless of their color, surface, or substance when they are used for presence detection. Wool, for example, is a very soft material that will absorb sound. It is a dependable option. When the sensor is attempting to determine the distance between itself and an item, it measures the amount of time that has passed between the time that it emits sound from the transmitter and the time that it makes contact with the receiver. The formula that may be used to calculate this is $D = 1/2 \times T \times C$, where D represents the distance, T represents the time, and C is the speed of sound, which is about 343 meters per second. For instance, if a scientist directs an ultrasonic sensor towards a box and the sound travels backwards for a duration of 0.025 seconds, then the distance between the ultrasonic sensor and the box may be calculated as follows: $D = 0.5$ multiplied by 0.025 multiplied by 383.

Relay



Fig. 2: Relay

The relay board is a computer circuit board with a series of relays and switches. It has an input terminal and an output terminal and is used to control the power supply. Figure 2 Components of the relay. The relay board provides individually programmable real-time control for each of the multiple onboard relay channels. Relays basically allow relatively low voltage, higher power circuits to be easily controlled. The relay accomplishes this by using his 5V output from the Arduino pin to energize an electromagnet and close a physical switch inside to turn the high power circuit on or off.

The DC Motor

Direct current (DC) motors are a kind of rotary electric motor that are able to transform the electrical energy that is supplied by direct current (DC) into mechanical energy. A magnetic field is the source of the most common kind, which is based on the force that it produces. An internal electromechanical or electronic mechanism is included in almost all kinds of direct current (DC) motors. This mechanism is responsible for modifying the flow of current in some component of the motor on a periodic basis. The direct current (DC) motor was the first motor to come into widespread usage because it could be supplied by the DC lighting power distribution system that was already in place.

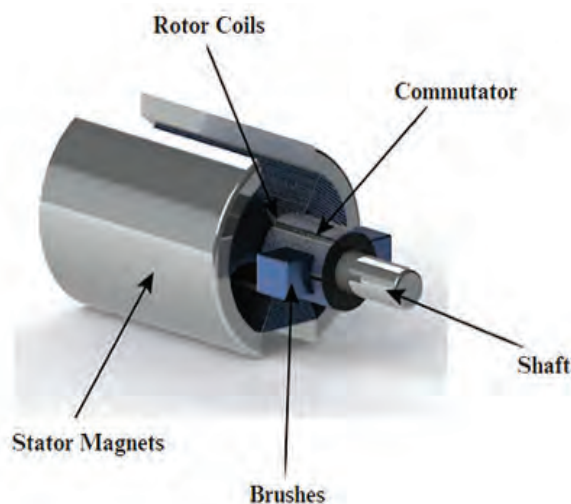


Fig. 3: Components of a Direct Current Motor

It is possible to regulate the speed of a direct current (DC) motor across a broad range of speeds by using different supply voltages or by adjusting the amount of current that flows through the field windings. It is common for tools, toys, and appliances to make use of small DC motors. Figure 3 illustrates the many components that make up a direct current motor. Universal motors are brushed motors that are driven by direct current (DC) and are lightweight. They are used in portable power tools and equipment. Electric cars, elevators, hoists, and steel rolling mills are all examples of modern applications for large direct current motors. The development of power electronics has made it feasible to switch from direct current (DC) motors to alternating current (AC) motors in a variety of sectors.

NodeMCU

A combination of the words “node” and “MCU” (microcontroller unit) is what gives the moniker “NodeMCU” its meaning. It is more accurate to say that the word “NodeMCU” relates to the firmware than it does to the development kit that is linked with it. Firmware and the design of prototype boards are both available as open source. NodeMCU is a firmware that is available for free and may be used for the development of open source prototype boards. The term “NodeMCU” is a fabricated term that is derived from the combination of the words “node” and “MCU (microcontroller unit)”. It is more accurate to say that the word “NodeMCU” relates to the firmware than it does to the development kit that is linked with it. The design of the prototyping board as well as the firmware are both available for public use. Lua is the scripting language that is used by the firmware.

In addition to being built on the Espressif Non-OS Software Development Kit for ESP8266, the firmware is based on the eLua project. We use a wide variety of open source projects, including SPIFFS. As a result of the constraints imposed by the source, the user is required to choose modules that are pertinent to the project and develop a firmware that is to their liking. There is also support for 32-bit ESP32 that has been developed. A board that functions as a dual in-line package (DIP) is a piece of prototype hardware that is often used. This kind of board integrates a USB controller onto a surfacemount board that is quite tiny and contains the microcontroller and antenna. By using the DIP format, prototyping on a breadboard may be accomplished with relative ease. His ESP-12 module for the ESP8266 served as the blueprint for this concept in the beginning.

DC Motor Driver: L298N Driver

The L298N is a dual H-bridge motor driver that is capable of controlling the speed and direction of two DC motors via the use of concurrently. This module is capable of driving DC motors with peak currents of up to 2 A and voltages ranging from 5 to 35 inches of volts. For the sake of explanation, let's take a more in-depth look at the pinout of the L298N module. Controlling the direction of rotation of a DC motor is accomplished by the use of H-bridge technology by the L298n motor

driver module. For the purpose of controlling the direction in which the DC motor rotates, this method makes use of an H-bridge to alter the polarity of the input voltage of the DC motor.

Controlling DC and stepper motors is the responsibility of the L298N module, which is a dual full-bridge motor driver module that operates at high voltage and high current. These are able to manage not only the speed of the two DC motors but also the direction in which they rotate. The twin channel H-bridge motor driver integrated circuit L298 is what this module is made up of. When it comes to controlling the speed and direction of a DC motor, this module employs two different methods. This is the pulse width modulation (PWM) that regulates the speed, and the H-bridge that regulates the direction in which the rotation occurs. Dual direct current (DC) motors or a single stepper motor may be controlled concurrently using these modules.

IC for the L298N Motor Driver

A high voltage, high current twin full bridge motor driver integrated circuit is referred to as the L298. The inductive loads that are controlled by this device include relays, solenoids, DC motors, and stepper motors. It accepts conventional TTL logic levels, which are control logic. It is an integrated circuit with 15 pins. The datasheet for the L298 indicates that its working voltage ranges from +5 to +46" V, and the maximum current that it is permitted to draw from each output is 3" A.

APPLICATION OF THE BLYNK

Using smartphone—an iOS or Android device—may utilize Blynk, an Internet of Things platform, to control Arduino, Raspberry Pi, and NodeMCU. With the help of this application, a graphical user interface, or human machine interface (HMI), may be created by gathering and sending the correct address on the widgets that are available. Blynk was created with the notion of the Internet of Things in mind. In addition to many other amazing capabilities, it can display sensor data, store data, and visualize data. Hardware may also be controlled remotely by it.

Three of the most important components of the platform are as follows:

- The Blynk App gives everyone the ability to develop stunning user interfaces for projects by using a wide variety of widgets that we provide.
- In addition, the Blynk Server is in charge of all the communications that take place between the smartphone and the hardware. Our Blynk Cloud is available for use, or may host own private Blynk server locally. Not only is it open-source, but it is also capable of quickly managing thousands of devices and can even be run on a Raspberry Pi.
- The Blynk Libraries, which are available for all of the most prominent hardware platforms, make it possible to communicate with the server and process all of the instructions that are coming in and going out.
- Just for a moment, picture this: whenever hit a button inside the Blynk app, the message is sent to the Blynk Cloud, where it miraculously finds its way to the hardware. Exactly the same thing occurs when everyone go in the other way, and everything takes place in the blink of an eye.

WORKING PRINCIPLE OF BLYNK APPLICATION

While Blynk is in the process of implementing a price system for its widgets, the idea of “energy” is being used. Everyone are able to start a new project on the Cloud server with a total of one thousand energy units. Then researchers could have to pay 200 units for an LED widget, which would leave with 800 units for other widgets. Next this work able to choose own energy constraints while using a private server. Again everyone able to set up server such that it would provide 100,000 energy units to new participants. Everything is entirely up. Obviously, have the option to buy more energy units to spend on the Cloud Blynk server. This is a valid consideration, particularly if the users of Blynk project are located in different parts of the globe (in which case latency is not a significant problem). The private Blynk server, on the other hand, provides with extra advantages:

- Essentially endless energy units, allowing to construct any Blynk application can image, regardless of its complexity.

- A low amount of latency, which is advantageous in situations when the program is used in a restricted geographical region and responsiveness is of utmost importance.
- Complete authority over data files. Maintaining own backups of private server, moving server to a different host, implementing whatever security procedures like, and exercising fine-grained control over users are all options available.

SCHEMATIC PROCEDURE

Battery is used as the power source in the model that has been presented. The movement is caused by DC motors that are installed in the wheels. Both the procedure of spreading seeds and the operation of dropping seeds from the seed drum are carried out without any amount of seeds being wasted. The seed sowing process is additionally equipped with an ultrasonic sensor that is installed on the front of the machine to ensure accurate navigation over the field. Following the completion of each row, the seed sowing process should be reversed and the process should begin again on the second row. The sensor is used to do this, and an application that can identify the end of the line is responsible for controlling it. As a matter of custom, the process of seeding is limited to a single row, after which it must be manually transferred to the subsequent row. When sensors are added to this suggested paradigm, the amount of human involvement is reduced. Using a Node MCU that is attached to the sensor, control is carried out.

An L298N driver circuit is what is responsible for driving the DC motor. The technology used for sowing is so effective that it reduces the amount of time needed and eventually reduces the amount of labor required. For the purpose of communicating with mobile devices and the seed sowing mechanism, the GSM module is used. After that, the servo motor is used in order to open and close the hopper that is situated inside the seed sowing mechanism. There is no tendency for the sowing depth to slow down or speed up the development of the plants, and the yield remains the same. The sowing depth is determined accurately. Seeds are planted in rows that are precisely aligned, which leads to accurate planting, which in turn leads to extremely excellent food and economic development. Due to the fact that the DC motor that is used here is driven by a rechargeable battery, the

whole system is sustainable for the environment. Figure 4 as a block diagram of the figure.

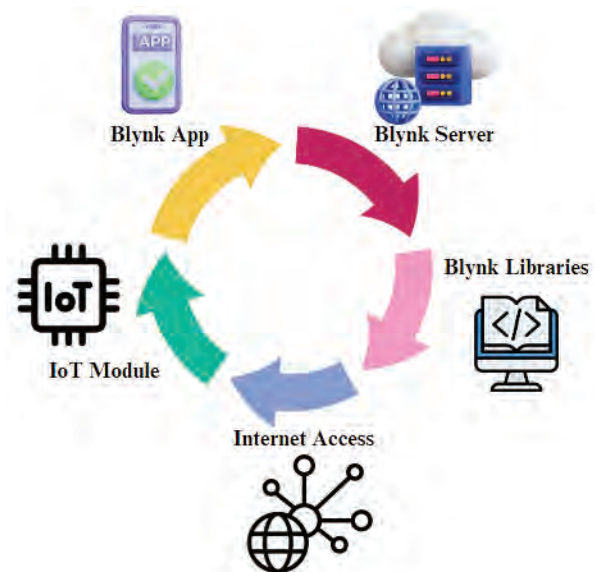


Fig. 4 Block diagram

Using, Benefits, and Drawbacks of the Application

1. Farming and farming The structure of the seed drill's furrow opener differs from one place to another because of the different soil characteristics that are present in each area. The vast majority of seed and fertilizer ballers come with a pointed tool that is designed to make a tiny slit in the ground for the purpose of seed planting.
2. For the purpose of assisting farmers in saving both time and money, create a seeding robot that can be controlled by the internet of things and can plant seeds in the required place. It is a piece of machinery that is used by farmers on a smaller scale to carry out tasks such as planting seeds.
3. Planting lands Seeds are dumped on the ground, which results in the loss of seeds and harm to the seeds. Since seeds are costly and cannot be afforded by farmers, it is imperative that they be planted in the soil in the appropriate manner.
4. It is suitable for use in farming on a very modest scale.
5. It is suitable for usage in locations with low water levels.

Benefit

1. Cut down on the amount of physical labor
Relocating a stationary conveyor system may be a laborious process, as anybody who has done it before will attest. Without the need to install physical equipment, new jobs, work cells, and directions may be established practically instantly with this seed sowing system. It can be simply reprogrammed to modify course or operation.
2. Less labor is needed streamlining transportation in compliance with traffic, missions, and vehicle fleets. Work is dynamically allocated among the same
3. Better planting efficiency, higher yield, and safer crops.
4. A quicker seeding rate.
5. With a small team of agricultural laborers, the seeding procedure may be finished fast.

Negative aspect

1. Electronic components are not designed to withstand extreme temperatures and vibrations.
2. Places with high water levels shouldn't use it.
3. Because of the muck and clod, accuracy should be reduced.

CONCLUSION

This system's primary goal is to plant the seeds. The correct order in which the seeds are sown ensures effective seed germination. In this case, there has also been a significant decrease in seed waste. To cut down on seed waste, this technique was created for seed planting. Here, the seeds are sown in the ground in the correct order with the aid of a seeding system. The Seed Sowing method may be used to carry out the planting procedure for crops like onions. The farmers will benefit from this effort by being able to cultivate more effectively. The project may be expanded to include any other crop kind, including fruits, paddy, etc. A DC motor with a wheel may be used in the design of the system. It may thus be used in the area of agriculture in real time. The integration of IoT capabilities allows for remote monitoring and control of seed sowing operations, enabling farmers to optimize planting strategies and

minimize resource wastage. Automated functionalities such as adjustable seed spacing and precise planting depth contribute to improved crop yield potential and overall farm productivity. Moreover, the system's user-friendly design ensures accessibility for farmers of varying skill levels, facilitating adoption and utilization across diverse agricultural landscapes.

The emphasis on affordability through the use of cost-effective materials and simplified maintenance procedures further enhances the system's appeal to small-scale farmers, who often operate under tight budget constraints. By reducing manual labor requirements and increasing operational efficiency, By encouraging resource efficiency and reducing environmental effect, the IoT-controlled seed sowing system supports sustainable agriculture practices in addition to saving time and labor expenses. In conclusion, the IoT-controlled seed sowing system exemplifies how technological advancements can revolutionize traditional agricultural practices, offering practical solutions to improve efficiency, reduce labor burdens, and enhance agricultural outcomes for farmers worldwide.

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Design and Development of A Residential Solar Power Generation Automatic Solar Tracking System

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ABSTRACT

One renewable and sustainable energy source that has been around for a while is solar electricity. Reduced energy costs and environmental impact are just two of the many benefits of using solar power in home settings. Optimizing solar panel alignment with the Sun throughout the day to maximize energy collection is the main emphasis of this article, which focuses on the construction of an autonomous solar tracking system. An automatic mechanism that constantly changes the solar panels' orientation to keep them in line with the Sun's position is the major focus of this research. If this wants the solar panels to get the most out of the sun and produce the most electricity, this automated adjustment is a must. The light-dependent resistor, also known as an LDR, is included into the system in order to monitor the movement of the Sun across the sky and to detect variations in the intensity of the sunlight. In order to ensure that the solar panels remain in a state of consistent alignment with the position of the Sun throughout the whole day, a DC-g geared motor mechanism is used to spin them in response to the output of the sensor. In order to manage sensor data and motor operations, the system is dependent on a microprocessor. Additionally, the system utilizes two relays in order to control the DC-g geared motor. The design has an emphasis on affordability and efficiency while simultaneously optimizing for use in domestic settings and low power consumption. Due to the fact that the system has been subjected to hardware testing that indicates its capability to detect and follow variations in the intensity of the sunlight, it is able to optimize the amount of solar power that is produced regardless of the changes in motor speed. The results show that the panels may be consistently oriented to get the most sunlight for energy production. Finally, this research presents an automated solar tracking system that may improve the efficiency of home solar power systems. Homeowners may lessen their reliance on the power grid and enjoy greater energy efficiency by using technologies to enhance the positioning of solar panels.

KEYWORDS: Energy efficiency, Solar power production, Light-dependent resistors (LDRs), DC-g geared motors, Microcontrollers, Automated alignment, Solar tracking systems, Renewable energy, Residential applications.

INTRODUCTION

Over the last decade, an increasing number of homes have installed electric solar systems to supplement their main power supply. Reason being,

solar power is a limitless source of energy that will only grow in significance as a means of generating both electrical and thermal energy for human usage. Another promising energy source for the future is solar power. An automatic solar panel known as a solar tracker

actually tracks the Sun in order to maximize power production [1]. The heliostat is a famous example of a solar tracker; it's a mobile mirror that fixes its position in relation to the sun, but there are many more methods. An active tracker's controller responds to the direction of the sun by commanding the tracker's motors and gear trains to move in a certain direction. Solar cells, solar day-lighting systems, and solar thermal arrays are just a few of the many potential uses for the solar tracker [2]. Devices like solar cells, which need more sunshine for greater efficiency, find the solar tracker to be a very helpful tool [3].

A large number of the solar panels were mounted on an immovable object, such a roof. Since the sun is constantly changing positions, this strategy won't work. A sun tracking device may be used to actively monitor the sun's movement across the sky, allowing the solar panel to track its rays. Because the panel is functioning at peak efficiency while facing the Sun, the maximum amount of energy may be absorbed [4]. Optimizing the solar cells for optimal efficiency is the primary goal of this endeavour [5]. Solar trackers are plentiful, but their high prices make them out of reach for most people. This is because the industry for solar trackers is very old, and only a small number of nations, including the United States and South Korea, really utilize them [6]. For household application, a large-scale solar tracker is not appropriate. Consequently, this project will create a Sun tracking system tailored to home usage in order to accommodate affordable solar cells [7].

One study employed light-dependent resistors (LDRs) as a sensor, while another used photodiodes [8]. At the same time, a DC motor with a gear was used in [5] and a stepper motor in [9]. The development costs of these projects are costly, controlling the motor speed is complex, and designing with microprocessors is challenging [10].

The sun tracking solar system model is the central focus of this project [11]. It is a gadget that follows the sun's movement independent of motor speed. Also, the design is intended for domestic usage, and its primary purpose is to enhance total power production via the use of a single-axis sun tracking device [12].

The light dependent resistor (LDR), which is widely used in sun tracking systems, has been selected as the

sensor. This is because light-dependent resistors are light-sensitive. As the intensity of the light shining on the LDR increases, its resistance will decrease [13]. The PIC16F877A was selected as the controller. The PIC code will instruct the driver to pulse the motor in order to move it. [14] A bidirectional DC motor control system based on relays has been implemented for the driver. Because it is easy to regulate the motor to turn both clockwise and counterclockwise, the motor controller was selected [15]. A DC geared motor was also considered because to its low rpm and hold torque of up to 24" kg.cm. Finally, as integrated circuits only need 5 V to function, the LM7805 is used to transform the input voltage from the source to a 5 V output.

METHODOLOGY

This project is broken up into two distinct phases: the creation of the hardware and the development of the code. Presented below is a block schematic of the project, or Figure 1.

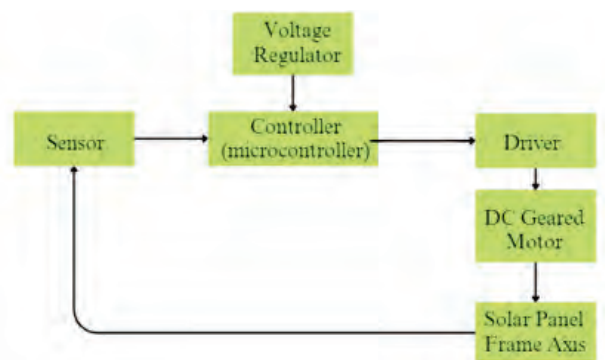


Fig. 1: An outline of the project in block diagram

It is a balanced concept that is used in the construction of the project, which implies that two signals from different sensors are compared to one another. A light sensor that has been used is the Light Dependent Resistor, which is more often referred to as an LDR. The two light sensors are separated by a divider, and if the solar panel is not oriented in a direction that is perpendicular to the sun, the divider will throw a shadow on one side of the light sensor. This shadow will be visible to the person who is using the light sensor. The PIC16F877A microcontroller, which acts as the controlling circuit's brain, is in charge of directing the movement of the motor via the use of relays. It is accountable for this particular function. The microcontroller is the hardware

component that is accountable for processing the information that is obtained from the sensors. The microcontroller will send data to the bi-directional DC-gear motor via the relay in order to ensure that the solar panel is oriented in a direction that is perpendicular to the sun. This will ensure that the solar panel continues to generate electricity. The relay is responsible for controlling the motor's rotation in either a clockwise or anticlockwise manner, depending on the direction of rotation. Following the coupling of the solar panel to the motor, the solar panel will react in a way that is defined by the direction in which the motor is traveling.

THE PROGRAMMING

PIC16F877A is the microcontroller that is used in this solar tracker system, and it is prepared to be converted into an ADC converter. Figure 2 is a flowchart that illustrates the programming of the PIC16F877A.

THE FINDINGS AND THE ANALYSIS

The system is the controller design that is the primary emphasis of the system. A number of measurements taken from the hardware have been gathered and discussed, and the system that was developed has been put through its paces. The goal of the usage of a typical solar panel was just to demonstrate that the system that was created is capable of functioning in the appropriate manner. Because of this, the influences of the environment, such as the weather conditions, are not taken into significant consideration during the testing of the hardware.

A Sensor

The voltage output of the LDR, as measured by the hardware, is shown in Table 1. Exposure to sunlight causes V_{LDR} to be 0.74 V, whilst its absence from sunlight causes V_{LDR} to be 1.53 V. This demonstrates that a low voltage at the LDR is caused by the intensity of sunlight.

The voltages reported by the solar sensor's Light Dependent Resistor (LDR) are shown in Table 1. These readings, taken during hardware testing, help to define how the LDR reacts to different kinds of light. The voltage output from the LDR circuit under each of the lighting conditions is noted in the table. This data is essential for comprehending the sensor's response to

varying degrees of ambient light, which in turn sheds light on its functionality and its uses.

Table 1: Measurement of the hardware-based LDR output voltage from a solar sensor circuit

To sunlight	V	V
Exposed	2.75 V	0.45 V
Not exposed	3.42 V	1.65V

Table 1 presents a detailed measurement of the output voltages generated by a Light Dependent Resistor (LDR) within a solar sensor circuit. This hardware-based testing involves systematically varying light conditions to observe corresponding changes in the LDR's output voltage. Each entry in the table corresponds to a specific illumination level, providing quantitative data on how the LDR responds to different intensities of light.

These measurements are crucial for assessing the sensor circuit's sensitivity and accuracy in detecting light levels, which is fundamental for applications such as automatic lighting control, solar tracking systems, or ambient light sensing in electronic devices. Engineers and researchers can analyze the data from Table 1 to calibrate the sensor circuit, validate its performance against design specifications, and optimize its functionality for specific operational requirements.

Control unit - Microcontroller

Eqs. 1 and 2 demonstrate the process for calculating the required voltage for ADC conversion. It may find out the sample condition using [200] _16. The PIC16F877A will set pin 33 and 34 to low (0) if the voltage at both of its analogue inputs is less than 0.2" "V. With an analogue pin input differential greater than 0.2 V, pin 33 or pin 34 will provide a high output (1).

$$V_{\text{step}} = \frac{V_{\text{reference}}}{\text{ADC bit}} \quad (1)$$

Because the PIC16F877A is a 10-bit ADC module, $V_{\text{reference}}$ is the same as V_{DD} , which is 4.94 V. The result is 0.00482" "V"Step ".

$$\text{ADC output} = \frac{\text{Desired Voltage}}{V_{\text{step}}} \quad (2)$$

Equation 2 may be used to determine the ADC output using the estimated V_{step} ". Take 3.75 V as an example of the ideal voltage. Therefore, [777] _10 or [309] _16 is the value for ADC.

Controller for DC-geared motors

To regulate the rotation of the DC geared motor, a relay driver has been used. The bidirectional DC-geared motor control circuit employing a relay.

This causes the motor's rotational direction to be affected, either clockwise or counterclockwise, as seen in Table 2 of the voltage readings from the LDR sensors. Table 3 displays the current working status of the motor. The motor's working characteristics under different circumstances are listed in Table 2. Voltage, current, rotational speed (RPM), torque, and, if temperature data are being tracked, other relevant metrics are usually included in this table. To assess the motor's efficiency under varying loads, ambient conditions, and control settings, engineers and technicians may refer to the table, where each row denotes a distinct operating state or test condition. For the motor system to function at its best, identify its operational limits, and guarantee safe operation, this data is crucial.

Table 2: Status of the motor's operation

Direction	Stop	Clockwise	Counter-Clockwise	Stop
RB0	0	1	0	1
RB1	1	0	1	0

The developed system is able to function as anticipated, enabling the DC-geared motor to spin in either a clockwise or counterclockwise orientation, as shown by the results of the hardware testing. This is based on the data that is available from the sensors (LDRs), which are able to measure the quantity of sunlight that strikes them. The created system is unique in that it does not take into account the speed of the motor. This is due to the fact that the DC-geared motor has a low output rated speed of 17 revolutions per minute (rpm) and a high output rated torque of 1960 millinewtons (mN.m). As a consequence of this, the design process does not place an emphasis on the speed of the engine. The system that was created takes into consideration the direction in which the motor rotates, which is handled by doing so by taking into consideration the relay driver circuit.

Model for Solar Energy Systems

The details of the model for a single-axis solar tracking system are shown in Table 3. The built hardware of the planned system is shown in Figure 2.

Table 3: System for Monitoring Solar Energy

Design Aspect	Specification
Panel chassis made of aluminum bar, dimensions.55 inch by.55 inch	Bases: 20 mm x 3/4 inch PVC pipe
Size	28cm x 40cm x 32cm
Weight	Weight: 1.2 kilograms (with the panel included)

Table 3 is a detailed outline of Solar Tracking System (STS) specifications. Typical entries in this table that include important parameters are:

- Whether it's a single-axis or dual-axis tracking system, the tracking mechanism describes how the system follows the sun.
- Requirements for Power Supply: Specifications for the voltage and current required to run the system.
- Accuracy: The tracking system's ability to precisely follow the sun's location.
- The system's tracking range is the maximum angle or direction it can modify in order to follow the sun's movement.
- Operating temperature range, humidity tolerance, and, if applicable, data about weatherproofing are all part of the environmental conditions.

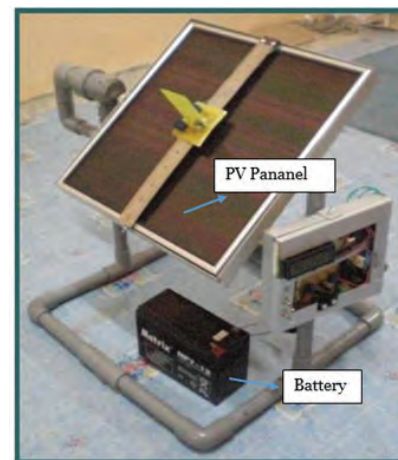


Fig. 2: System hardware built from the blueprints

Figure 2 depicts the physical implementation of a system constructed based on detailed blueprints or schematics. This hardware setup typically includes components such as microcontrollers, sensors, actuators, and other electronic modules assembled according to engineering

designs. The figure serves as a visual representation of the actual physical arrangement, showcasing how individual parts are interconnected and positioned within the system.

Collecting Solar Panel Data for Hardware Evaluation

The daily data of voltage, current, and power that were acquired from the solar tracking system and the static solar panels are shown in Figure 3. It is possible for a static solar panel to generate a maximum of 125.334 mW of power, 5.94 mA of current, and 21.1 V of voltage. During the same time period, the solar tracking system has the potential to generate a maximum of 137.160 mW of power, 6.35 mA of current, and 21.6 V of voltage. Solar tracking systems are able to absorb more sunlight than fixed solar panels, which results in a greater power output. This is because the solar tracking system is able to move about.

CONCLUSION

An effective model of a single-axis solar tracking system has been created. The controller element of the system is the primary focus of the design process. The primary goal is to create circuits that can regulate the direction of rotation of a DC-gear motor independent of the motor's speed. Regardless of the speed of the motor, the system can detect and follow the intensity of the sun so that it may gather the greatest amount of solar power. Due to the DC-gear motor's low output rated speed and high output rated torque, motor speed is not a crucial factor in the designed system. So, it doesn't matter what kind of motor speed controller unit is used; what matters is that the motor's speed and torque meet the specified requirements. Any DC geared motor may be utilized with this system. In the home, the built-in system model may be used to provide alternative power, particularly for low-power and non-critical equipment.

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Development of A Spray-Painting Robot for Interior Wall and Irregular Surface Applications

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ABSTRACT

Despite the widespread use of robotics in various industries, the application of automated spray-painting systems for irregular surfaces, such as interior walls and complex mechanical parts, has received limited scientific attention. However, the demand for such systems is significant in industries like automotive manufacturing, construction, shipbuilding, and production, where efficient and cost-effective surface coating is crucial. In the course of this study, the development and deployment of a spray-painting robot that is capable of printing or coating on both normal flat surfaces and irregular curved surfaces is the primary emphasis. In order to accomplish this goal in an effective manner, a cartesian robot with three degrees of freedom (DOF) has been created. Over the course of the painting process, the end effector of the robot is fitted with a sonar sensor that allows it to monitor the contours of the surface and keep a consistent distance between the spray nozzle and the area being painted. In order to achieve exact movement inside the x-y-z cartesian coordinate space, the three-degrees-of-freedom cartesian robot, which is controlled by an Arduino microprocessor, makes use of three gear motors. A rack and pinion mechanism is responsible for guiding the movement of the spray nozzle along the z-axis, while two chain-sprocket systems are responsible for facilitating the movement of the spray nozzle along the x and y axes. This configuration enables the robot to correct for irregularities along the z-axis that are up to three inches in length in relation to the x-y plane, which guarantees that the spray application will be uniform. Experimental results validate the robot's capability to maneuver smoothly in the x and y directions while accurately following the contours of irregular surfaces. Moreover, the system demonstrates potential benefits such as reducing human exposure to hard-to-reach and hazardous environments, thereby enhancing safety and hygiene standards.

KEYWORDS: *Sprayed-on robot, Industrial automation, Surface coating, Robotics, Uneven surfaces, Cartesian robot, Sonar sensor, Automated painting system, Microcontroller, Arduino, Manufacturing applications.*

INTRODUCTION

Coatings such as paint, ink, varnish, etc. are applied to surfaces using the spray painting technique. The target is hit by liquid spray jets that are directed at high pressure [1]. Paint was applied by hand and left to dry at

room temperature for days in the pre-industrial period due to solvent evaporation. Paint must be dried in ovens since the procedure became uneconomical due to mass manufacturing. Paint for automobiles sometimes included heavy elements like lead and chromium until very recently [2]. Due to their low environmental impact,

water-based acrylic polyurethane enamels have lately replaced traditional clear coats as the preferred base coat material [3-4]. To achieve the appropriate atomization and pattern in airless painting, a high-pressure pump is used, with a pressure ranging from 300 to 7,500 psi, to atomize the coating using various tip sizes. Industrial and marine coatings that need a high level of durability often use this technique [5]. Human painters run the risk of developing eye and metastasis problems because to the chemicals used in painting [6]. Furthermore, painting is tedious, time-consuming, and energy-consuming due to its nature, which requires repetitive effort and hands-uptlifting. Automation in painting has several benefits, but one of the most important is that it helps save resources (such as electricity, energy, and materials) [7-8] while simultaneously improving accuracy, precision, and quality. Production time will be reduced and output will be increased if robots and construction workers are effectively integrated into joint jobs [9]. The option to avoid putting human workers in hazardous and unclean conditions would be provided [10].

Building painting robots is the subject of several studies. A large-scale construction site tested one of them—a prototype of an autonomous plastering robot [11]. With the use of range mapping sensors, it can concurrently operate its operations and measure the surface area, all while being monitored by an operator. Plastering should take less than half the time and utilize half the quantity of material that manual labor requires. Different studies only showed a few of additional navigation mechanisms [12]. It put forth an idea for a high ladder vehicle. Under this arrangement, the print head travels vertically (along the y-axis) along the ladder, while the truck is moved sporadically to provide horizontal motion. Additionally, the print head may change the distance from the wall by moving along the z-axis. This concept works well in areas where there is plenty of room for trucks to manoeuvre [13]. It shown that automated painting aims to improve efficiency while also guaranteeing quality [14]. A robot arm with exceptional accuracy is necessary. The normalized coordinates of the colors to be regenerated are transformed into the movement speed of the end effector and the valve opening module of the mixing board by an automated control system [15].

It provided an explanation for why humans are unable to achieve the same level of efficiency as robots while painting. A method for making an industrial manipulator that can paint surfaces more efficient was introduced by Johan et al. in 2010. This method relies on the premise that the end effector's motion is impervious to quality control errors. Maintaining a consistent speed all the way through is more crucial. An paper on automated painting was published in 2013 in the International Journal of Innovative Research in Science, Engineering, and Technology. The writers mounted a sprayer on a movable platform. One uses an infrared device to detect the presence of walls, while another uses a solenoid valve to control the flow. According to a different study published in 2014 by Thakar et al., coated industrial goods are better protected against rust, although spraying takes a long time and more and more competent workers are needed. As a result, a semiautomatic coating process that is well-suited to and beneficial to these sectors calls for fresh conceptualization of the coating task [9]. Swarkar et al. (2018) created an autonomous spray-painting device. To move the spray cannon vertically along the y-axis, the authors used a threaded rod; to move it horizontally along the x-axis, they employed a rack and pinion gear and a connecting rod.

In 2018, John et al. created yet another painting automaton. In order to begin painting, the authors used an ultrasonic device to locate the surface of the wall and a solenoid valve to control the airflow. The top and bottom frames are painted vertically, while the rock is painted horizontally. A microcontroller known as an Arduino board controls the motion of dc motors.

Prior studies on painting automation mostly focused on painting walls, both inside and outside. A little amount of their study on painting objects with uneven, curving surfaces was released. Nevertheless, painting is necessary for a large number of components in the commercial sector, such mosaic doors and vehicle parts with curved surfaces. As a result, a novel painting robot is created that is equally adept at following flat and bumpy surfaces.

PLANNING AND BUILDING

Idea Visualization

Spraypainting robot designed with the help of

computers. Considering the nozzle's movement in three-dimensional cartesian space, the robot is constructed. Using the sonar sensor, we can locate tasks and keep them at a constant distance from the nozzle. The necessary torque and motion in each of the three joints are supplied by three gear motors. On the underside of the base is where will find the control unit. There are two x- and y-chain drives that help move the nozzle. Not to mention that the nozzle's z-axis motion is controlled by a rack and pinion. The top portion of the whole moving body is led and supported by the upper link alone. With the lower lubricated angle bar, the bottom section moves freely.

As seen in Figure 1, the rack is created in Solidworks with 32 teeth, with a pressure angle of 14.5 degrees and a pitch of 3.5mm.

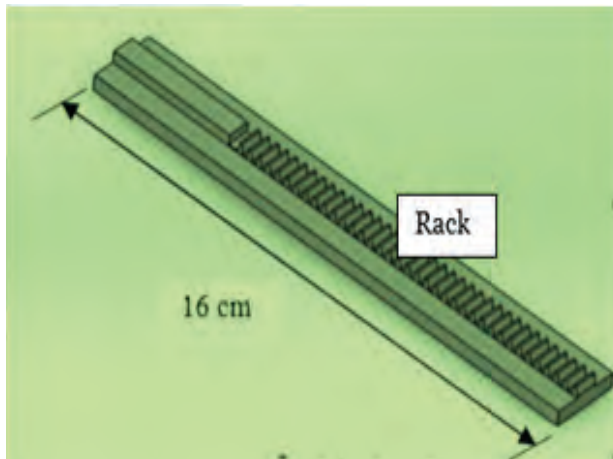


Fig. 1. 3D Rack Model

Production Process

The system is built via a series of manufacturing activities. What follows is an explanation of the main procedures.

Procedure for Cutting

As seen in Figure 2, the stainless steel pipe, bar, and mild steel angle bar are cut to size for the columns and links using a manual grinder. The foundation is made from two mild steel angle bars that are 25" long each. A pair of rectangular stainless steel pipes with a diameter of 25 mm and a length of 56 cm each are prepared for use as columns. Cutting 8 mm diameter stainless steel tubing to 46" cm lengths yields three guided links.

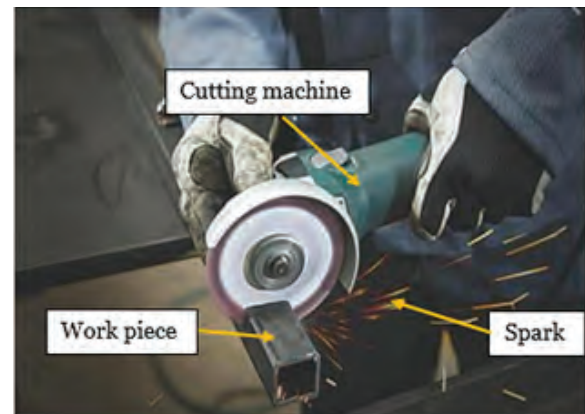


Fig. 2 Procedure for Cutting

The Process of Welding

Figure 3 shows the finished product of the CNC process. Racks with teeth that are exactly 1 mm broad on the face may be manufactured using CNC technology. The job is completed with an end mill cutter that is 0.5" (or 13 mm) in diameter.

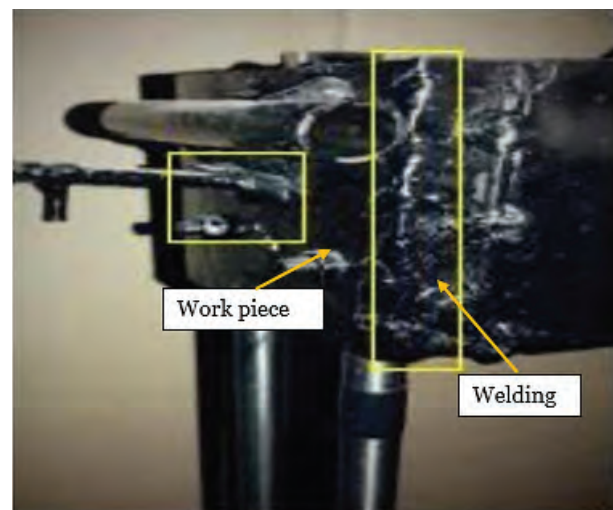


Fig. 3 Welding Procedure

The Method of Drilling

Figure 4 shows the drilling operation used to create couplers, fastening clamps, bolted joints, and other similar components. Drill bits come in a range of diameters, from 4.5 mm to 10 mm, and each has its own specific application.

Estimating the Speed of a Drill:

$$\text{revs per minute} = (C \times 4) / d$$

where, rpm is the unit of measurement for drill speed.

“C” stands for the recommended feet per minute for cutting.

For all RPM computations (apart from metric), 4 remains constant.

“d” stands for the drill’s diameter.

To cut MS using a 0.5-inch twist drill, the speed would be 1600 rpm, calculated as $(200 \times 4) / 0.5$.

So, the drilling machine would be adjusted to drill at a speed close to 1,600 RPM. Pick a speed that’s close to the suggested RPM for the equipment.

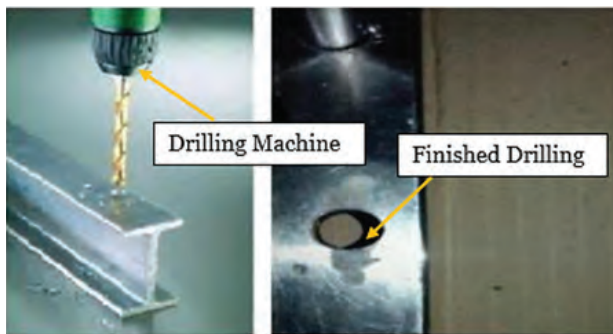


Fig. 4 The Drilling Process

Procedure for Tapping

Drilled couplers may have their inner threads made for bolt attachment using the tapping process seen in Figure 5. Initially, a 4.2” (mm) drill is executed and tapped with an M5 tap.

CNC Programming

After the CNC operation is complete. CNC machinery allows for the production of racks with teeth that are precisely 1 mm wide on the face. To accomplish the task, a 0.5” “mm end mill cutter is used.

How to Choose and Measure Chain-Sprockets Chain Length Calculation

$C=18$ ”. That’s 46” “cm” of space between the two sprockets.

The front sprocket has a number of teeth, $F=10$.

The rear sprocket has a number of teeth, $R=10$.

An easy-to-understand equation in inches:
 $L=2(C)+(F/4+R/4+1)[12]$

A 107-centimeter chain would be 42 inches long, calculated as $2(18)+(10/4+10/4+1)$.

Consequently, a roller chain that is 107” long is used.

Electronic and Electrical Parts

This robotic system was built using a number of electrical components that allow the operator to set defense settings and operate the device accordingly. Here are a few examples: Arduino UNO/ Arduino Mega

HCSR04, a sonar sensor, a DC gear motor, a 12V power adapter, and an L298N motor driver

With a maximum range of 4 “m, this device’s sonar sensor is composed of a transmitter, receiver, and control circuit.

Results in The Case for Direct Current Gear Motors: Motor-1 and Motor-2 have a 12v rating and a 60 rpm rating. Function () The rated torque is 12.23 kg-cm < 2. Motor 3 has a horsepower rating of 12 volts and revolutions per minute (rpm). The torque that is rated is 6.5 kg/cm.

“ $N_1=0.5$ ” kg (Motor-1) is the paint head load.

$N_2=2$ ” kg (Motor-2) is the horizontal sliding load.

The load $N_3(=)$ that slides vertically motor-3, weighing 1”

In a lubricant-filled situation involving a steel rod and a steel surface, the frictional force, $F_f = \mu N_1 = (0.16 \times 0.5)$ kg = 0.08” kg, and $\mu_k = 0$.

The necessary torque is 0.16 kg-cm, which is equal to 0.08 kg divided by 2 cm, where cm is the radius of the pinion.

Therefore, Motor-1 is perfect for the task.

The value of F_f is equal to μN_2 times 0.16 times 2 kg, which is 0.32 “ kg.

The torque required is the product of 0.32 kg and 4.85 cm, where r is the radius of the sprocket, and the result is 1.552 kg-cm.

Motor-2 is therefore capable of doing the task with ease.

Formula $F_f = \mu N_3 = (0.16 \times 1)$ kg = 0.16” kg.

The required torque is 0.776 kg-cm, which is equal to 0.16 kg times 4.85 cm, the radius of the sprocket.

To that end, Motor-3 is more than capable.

ELECTRICAL SCHEMATIC FOR CONTROL

The control unit makes use of two Arduino boards, as seen in Figure 6. The 12" V motors are powered by two h-bridge motor drivers. An Arduino UNO is used to detect the surface's distance from the sonar sensor.

To begin, the LED will blink if the item to be painted is moved closer to the predetermined distance that has been specified. The next step is to put the item in the right spot. It won't see the LED light up until the item is inside the nozzle's effective range.

The nozzle will go from the object's left to right corner when Motor-2 begins to rotate in a single direction. After then, the nozzle will be lowered by rotating motor-3 clockwise. Once again, motor-2 will spin in the other way to go backwards. When it reaches the bottom right corner of the item, it will have completed the final stage of motor-3.

Whenever the paintbrush encounters an uneven surface during the painting process, motor-1 will rotate in a clockwise or anticlockwise motion to maintain a pre-defined spacing.

COMPLETED FRAMEWORK

After all the mechanical, electrical, and electronic parts were assembled, the real structure of the produced system is depicted in Fig. 5.

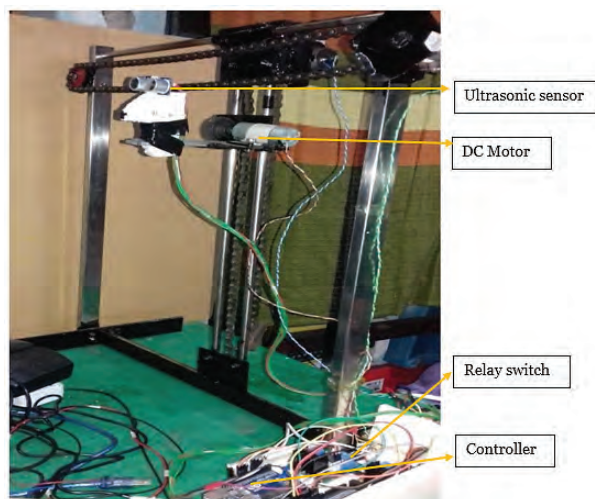


Fig. 5: Model of a Robotic Painter

DISCUSSION AND FINDINGS

The painting robot was presented with an item with an uneven surface. The robot's nozzle began its journey from the upper left corner to the upper right, and then it descended to the lower right before beginning its journey back to the upper left.

It maintained a consistent distance of 6" "cm" between the nozzle and the surface while covering an area of 198" "cm² (18" "cm²) in under 30 seconds.

Z directional motion was a perfect fit for maintaining a consistent distance at the uneven (convex/concave) section. It has the capability to smooth out parts of objects with up to a 3-centimeter maximum irregularity.

CONCLUSIONS

Improving the capacity to paint on both flat and curved surfaces while decreasing the amount of human intervention in the painting process is the overarching goal of this research. This will have applications in many various sectors, including furniture, automobiles, shipbuilding, and more. With less human intervention, the automated painting process increases precision while decreasing costs. There is an increase in paint booth productivity and a decrease in the cycle time for painting a single component. In addition, the system verifies its speed and surface smoothness while painting. It is also possible to paint the outside of a ship with this robot by installing a rail system beneath its base. With the ability to increase the component size, it finds further usage in large-scale paint shops as well. Under order to make it operate under different settings and for different purposes, there is a lot of room for development.

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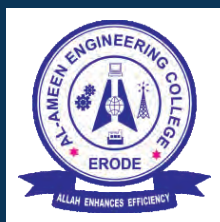
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PUBLISHED BY
INDIAN SOCIETY FOR TECHNICAL EDUCATION
Near Katwaria Sarai, Shaheed Jeet Singh Marg,
New Delhi - 110 016

Printed at: Compuprint, Flat C, Aristo, 9, Second Street, Gopalapuram, Chennai 600 086.
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