NSBM GREEN UNIVERSITY TOWN

TIDAC

TECHNOLOGY INNOVATIONS AND DIGITALIZATION ACCOMPANYING CREATIVITY

RESEARCH SYMPOSIUM 2024

ENGINEERING, AND DESIGN IN THE DIGITAL ERA

ORGANIZED BY
FACULTY OF ENGINEERING, NSBM GREEN UNIVERSITY

23rd OF AUGUST 2024, COLOMBO, SRI LANKA

1| Emerging Technologies and the Internet of Things

2| Artificial Intelligence and Data Science

3| Energy, Electrical, and Power Engineering

4| Mechatronics and Control Engineering

5| Civil Engineering, Design, and Quantity Surveying

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PREFACE

We are delighted to present the proceedings of the TIDAC 2024 Research Symposium (Technology Innovations and Digitalization Accompanying Creativity), at the NSBM Green University. This symposium, organized by the Engineering Faculty of NSBM Green University, is an exceptional platform for exploring the intersections of technology, innovation, and creativity in the realms of engineering and architecture.

Under the theme "Engineering and Design in the Digital Era," TIDAC 2024 brought together leading researchers, industry experts, and academics to delve into the transformative impacts of digital technologies on various fields. Over the symposium, participants engaged in dynamic discussions and presentations on a range of cutting-edge topics.

The symposium features an array of main topics; the integration of artificial intelligence and data analytics in engineering and architectural design, the role of new technologies and the Internet of Things in shaping future infrastructures, the amalgamation of innovations in energy systems and electrical engineering for sustainable development, the advancements in mechatronics and control systems for enhanced automation and precision, the modern approaches and technologies in civil engineering to address contemporary challenges and recognition of the impact of digital tools on design processes and quantity surveying practices.

The contributions presented in these proceedings represent a synthesis of the latest research and practical applications in these fields. Each paper reflects the dedication and expertise of its authors, offering valuable insights that will advance our understanding and implementation of digital technologies in engineering and architecture.

It is our privilege to acknowledge the guidance and unwavering support extended by Prof. E. A. Weerasinghe, the Vice Chancellor of NSBM Green University the visionary leader behind the success of this symposium: and Deputy Vice Chancellor, Prof. Chaminda Rathnayaka, for his support and guidance throughout the process. We are also grateful for the expert input and constant guidance of Prof. J. Baratha Dodankotuwa, the Head of Academic Development and Quality Assurance, without which the symposium would not have been a success. We further extend our sincere gratitude to the keynote speakers, session chairs, and all participants whose insights and expertise greatly enrich the symposium. Our thanks also go to the organizing committee

and volunteers for their unwavering commitment and effort in ensuring the success of TIDAC 2024.

As we move forward, we hope that the discussions and research shared through these proceedings will inspire further innovation and collaboration, shaping the future of Engineering and Design in the Digital Era. We wish all the attendees a productive and wonderful time at TIDAC Research Symposium 2024.

Thank you for your engagement and support.

The Symposium Organizing Committee TIDAC 2024

MESSAGE FROM THE CONFERENCE CHAIR

It is with great honor and enthusiasm that I welcome you to the inaugural TIDAC Research Symposium 2024, a landmark event of the Faculty of Engineering at NSBM Green University. This symposium, themed "Designing Tomorrow: Engineering and Architecture in the Digital Era," marks a significant milestone for our faculty as we step onto the global stage, bringing together leading minds in engineering and architecture to explore the latest advancements in these dynamic fields.

The theme of "Technology Innovations & Digitalization Accompanying Creativity" reflects our commitment to fostering a culture of innovation and creativity, essential in today's rapidly evolving digital landscape. This symposium serves as an ideal platform for researchers, academics, industry professionals, and students to exchange ideas, showcase groundbreaking work, and build collaborative networks that will drive the future of engineering and architecture.

This event would not have been possible without the unwavering support and dedication of several key contributors. I would like to extend my deepest gratitude to the Management of NSBM Green University, whose visionary leadership has been instrumental in bringing this symposium to life. To our esteemed academics, your commitment to excellence in education and research has laid the foundation for this event, enabling us to create a platform that reflects the cutting-edge work being done in our faculty. And to our students, your enthusiasm and creativity continue to inspire us all. Your active participation is vital in shaping the future of these disciplines.

As we embark on this exciting journey, I encourage all participants to engage fully with the sessions, share your insights, and seize the opportunities for collaboration that this symposium offers. Together, let us work towards designing a better tomorrow.

Dr. Chandana Perera
Dean - Faculty of Engineering
NSBM Green University

MESSAGE FROM THE KEYNOTE SPEAKER

It is a privilege to contribute to the TIDAC Research Symposium at NSBM Green University. In our digital era, universities are pivotal in shaping the future of research, innovation, and technology. As leading research institutions, they bear the crucial responsibility of advancing knowledge and contributing to societal and national progress.

Universities must conduct groundbreaking research while addressing their country's specific research needs. Aligning research efforts with national priorities and future challenges is essential for ensuring that our academic pursuits have a meaningful impact. Furthermore, the role of technology transfer and management within universities is vital. These processes are fundamental for transforming academic research into practical applications that benefit both industry and society.

By bridging the gap between theoretical research and real-world implementation, universities act as catalysts for innovation. As we navigate the rapidly evolving digital landscape, it is essential for researchers to leverage new technologies to enhance the efficiency and effectiveness of their work. The integration of digital tools, data analytics, and collaborative platforms is not only transforming engineering and architecture research but also reshaping the entire research landscape.

Embracing these digital innovations is crucial for designing solutions that meet the demands of tomorrow. The success of these endeavors will ultimately define the trajectory of progress and significantly impact the quality of life in the years to come.

I am honored to be part of this conference and eagerly anticipate the innovative ideas and collaborative breakthroughs that will emerge from our collective efforts. Together, we can drive forward the boundaries of knowledge and contribute to a brighter future.

Prof. Ananda Jayawardane
Senior Professor in Civil Engineering
Former Vice-Chancellor
University of Moratuwa

MESSAGE FROM THE GUEST SPEAKER

It is a great honor to be part of the "Designing Tomorrow: Engineering and Design in the Digital Era" TIDAC research symposium 2024 organized by NSBM Green University. This event stands as a testament to the dynamic intersection of innovation and creativity that shapes our future.

As we gather to explore the transformative power of digital technologies in engineering and design, it is inspiring to witness the collective commitment to advancing knowledge and fostering groundbreaking ideas. The convergence of these fields is not just about adopting new tools but about envisioning and creating a future where technology and human ingenuity collaborate to address the world's most pressing challenges.

I look forward to engaging with all of you and exchanging insights that will drive the industry forward. May our discussions here pave the way for new opportunities and collaborations that inspire progress and excellence.

Thank you for this opportunity to contribute to such a forward-thinking event. Together, let us design a future that is as innovative as it is inclusive.

Eng. Jayavilal Meegoda
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TECHNICAL SESSION 1A

EMERGING TECHNOLOGIES AND THE INTERNET OF THINGS

(#12) Enhancing Transparency and Traceability in Organic Food Supply Chain Management Systems Using Blockchain Technology

J.M.I Wijesooriya[1], R. A. P. Buddhika[2]

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Abstract

The growth of the organic food sector in Sri Lanka is driven by a rising demand from consumers seeking healthier and eco-friendly options. Yet, conventional supply chain management methods in this industry frequently encounter difficulties regarding honesty, trackability, and deception. This study aims to tackle these challenges by implementing blockchain technology to create a strong supply chain management system specifically designed for organic food products. The decentralized and immutable characteristics of blockchain technology guarantee the secure, transparent, and tamper-proof recording of transactions and data involving various participants such as farmers, processors, distributors, and retailers. This research centers on the distinct needs of the organic food supply chain, underscoring the significance of obtaining certification and adhering to organic regulations. The suggested system boosts the supply chain's efficiency and reliability by automating the verification and validation of key data - like product origin and certification status - through the integration of smart contracts and QR code technology. The research methodology includes creating a prototype system and assessing its efficiency in the Sri Lankan organic food sector. Initial findings show meaningful enhancements in transparency and traceability, decreasing fraud risks and bolstering consumer confidence in organic food items. QR codes provide consumers with in-depth product details, encouraging informed choices. Despite the obstacles noted, like expenses for implementation and training for stakeholders, the results highlight the possibility of blockchain technology transforming the organic food supply chain. Future studies should concentrate on enlarging the system, investigating its usage in different areas, and incorporating more technologies such as IoT for immediate monitoring to guarantee wider acceptance and lasting sustainability.

Keywords: *blockchain, food supply chain, traceability systems, transparency, organic*

Introduction

Demand for organic and sustainably sourced food products [1] requires smarter and leaner supply chain management since traditional supply chain management frameworks are opaque and lack supply chain visibility and thereby, prone to fraud inefficient supply chains, and food safety breaches. This research applies the technology of blockchain to design a supply chain management system for organic food products [2], [3] that using the character of the blockchain and decentralization, non-traceability [4], [5] and other benefits to create a safe, transparent multiple-participant database system. To the best of the author's knowledge, the use of blockchain technology in the context of the organic food supply chain has gained little attention so far. This study fills the above gap by designing and implementing a system within the Sri Lankan organic food industry for the management of fraud and lack of transparency [6] for supply chain management of organic foods.

Methodology
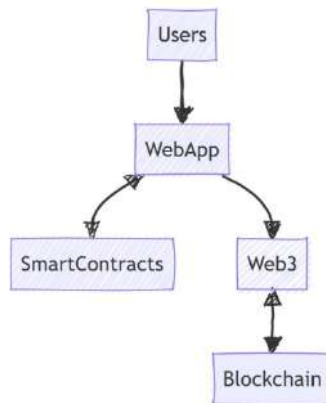
Figure 1: Basic Design

Blockchain based organic food supply chain management system started with the frontend design in React.js. This iteration was to create the basic framework of the website like the login page, home page, and registration page where basic user information of Suppliers, Farmers, Distributors, and Retailers were collected. For each user, a corresponding Ethereum address was provided and every QR code within the system was associated with the user's Ethereum address. After the frontend development, the research went to the deployment of the first contract `UserAuth.sol `in which the coding language used was Solidity [2], [3]. It was developed specifically for Ethereum smart contracts.
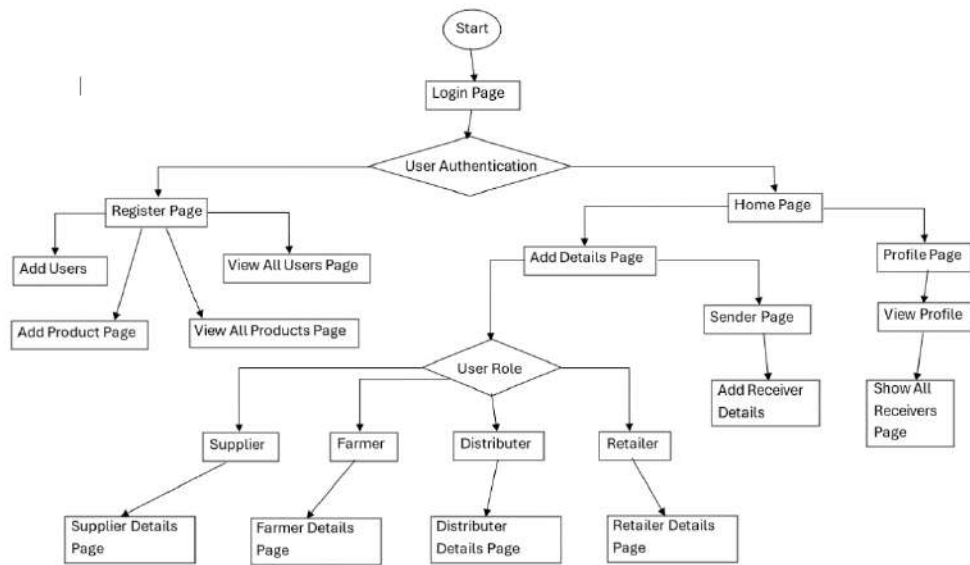
Figure 2: Flow Chart

The further stages of the study concerned the design of smart contracts for managing products in the supply chain. A fundamental contract called the `ProductContract.sol` was designed for the purpose of assigning an Ethereum address to each product which acted as a single point of reference for any transaction relating to the product. It was possible to create web interfaces where users managed their profiles and products; details of products could be uploaded through the web at various points in the supply chain. Chaining was a powerful mechanism that allowed participants to pass products down the chain by using QR codes; the retailer developed a final QR code with the consumers' product information. Indeed, the constant testing presupposes the possibility of designing the system more efficiently, which, in turn, led to the creation of a solid solution that acts as a foundation of the transparency [4], [5] of organic foods' supply chain and helps trace them effectively.

Results and Discussion

This system was proposed in this study to incorporate smart contracts and blockchain technology in the supply chain of organic food to achieve better transparency and traceability. These tools help to secure and protect all the flow of transactions to minimize fraudsters in the system and enhance and improve the trust of consumers in organic food products. QR code integration, furthermore, enhances consumers' power by offering product information. However, some of the drawbacks which were highlighted include among them high setup cost, the issue of training the stakeholders in the new technology,

and technology resistance. However, arising from the above challenges, the following advantages of the system can be noted; As the records are to be shared in a public ledger, the transparency aspect is therefore enhanced As every transaction has a unique QR code attached to it, the issue of traceability is therefore addressed In this system, there is least possibility of fraud because all records are secured and cannot be tampered with The smart contracts make the supply chain operate with a higher efficiency.
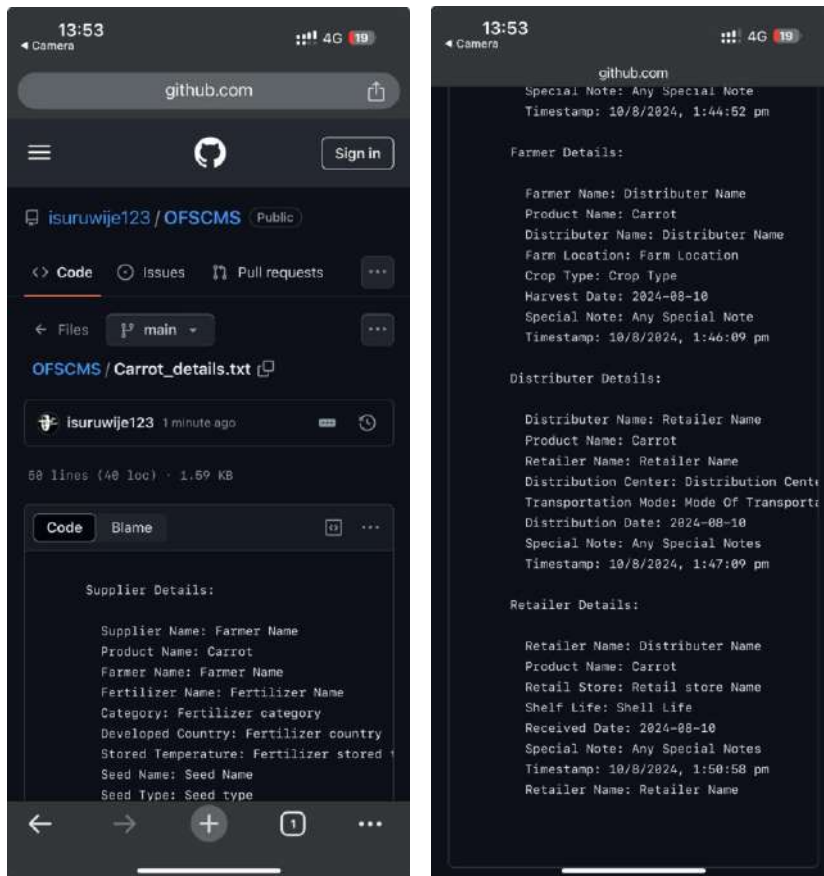
Figure 3: Product Details Which get by Scanning the QR code

Conclusion

This research proves that applying blockchain technology make a great improvement in the transparent and traceability of the organic food supply chain as shown in the developed system. Based on the results, the authors note that blockchain and smart contracts can save the global supply chain from the farm to the fork. More research should be undertaken in areas of extending this application into other fields, adopting IoT for tracking, and extensive research on the effects of blockchain technology in the organic food chain.

Also, enhancing procedures of adoption costs will play a significant role in expanding the application across industries.

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(#30) Dynamic Selection of Encryption Algorithms Using Field Programmable Gate Arrays in Real-Time Voice Communication

W.M.W.P Wijayakoon[1], R.A Prabhath Buddhika[2]

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Abstract

This research proposes a novel method for using a selection algorithm to select the most optimal encryption algorithm using FPGAs as the hardware implementation in real-time voice communication scenarios, where using one significant encryption algorithm always is not preferable during different real-world scenarios.

Keywords: FPGA, cryptographic algorithm, voice encryption, dynamic selection

Introduction

With the evolution of digital communication, the need for secure voice communication has become a major concern. As a result, cryptographic algorithms have evolved as important security mechanisms, to eliminate the problem of unsecure voice data [1].

These cryptographic algorithms are implemented in both hardware and software. Hardware-based implementations are more preferrable, with the increasing demand for secure communication due to both high speed and high volume and enhanced physical security. One such immensely used hardware-based implementation is Field Programmable Gate Arrays (FPGAs). FPGAs are used to meet the evolving security needs of modern communication systems as they provide flexibility and processing speed, facilitating real-time encryption and decryption of voice data [2], [3].

Existing FPGA-based systems rely only on a single encryption algorithm, which doesn't address the concurrent needs for security, performance, and resources utilization. This research proposes to bridge this gap in existing solutions by developing a dynamic selection algorithm that automatically selects the most suitable encryption algorithm based on real-time analysis of audio parameters and resource utilization. The purpose of this dynamic approach is to enhance both the security and performance of real-time voice communications [4].

Methodology

1. Voice Data Acquisition: In this section, real-time voice input is captured from the microphone and the analog audio signal is then converted to a suitable digital format in order to do the audio parameter calculation and analysis. Also, the voice input is saved for further processing.

2. Audio Parameter Analysis: Audio parameters like sample rate, amplitude range, duration of the audio, frequency content, and spectral analysis are obtained using MATLAB in the prototype model. These parameters are used to determine the complexity of the audio signal, in order to select the optimal encryption algorithm.

3. Algorithm Selection: The selection algorithm is developed using a simple decision logic, where the earlier analyzed audio parameters are used to select the optimal encryption algorithm from algorithms like AES, blowfish, and RSA. For example, in scenarios where the audio input is with high-frequency content and time duration, the system selects a faster and less computationally intensive encryption algorithm. For scenarios with low frequency content and a smaller number of samples use a more secure encryption algorithm, which is more computationally intensive [5], [6], [7].

4. FPGA Implementation: The selection algorithm is currently prototyped in MATLAB to validate the selection logic and performance of encryption and decryption. In the next phase, the selection algorithm is implemented using Vivado to simulate the FPGA environment. Finally, the algorithm is to be deployed on an FPGA board in order to demonstrate the real-time dynamic encryption switching based on real-time conditions.

```
Pseudocode:
function select_encryption_algorithm {
    if frequency_energy > 0.5*total_energy AND N > 300000 then
        selected_algorithm = AES
    elseif duration > 6 AND amp_range > 0.8 then
        selected_algorithm = Blowfish
    elseif total_energy > 1.0e5 then
        selected_algorithm = RSA
    else
        selected_algorithm = AES
} End
```
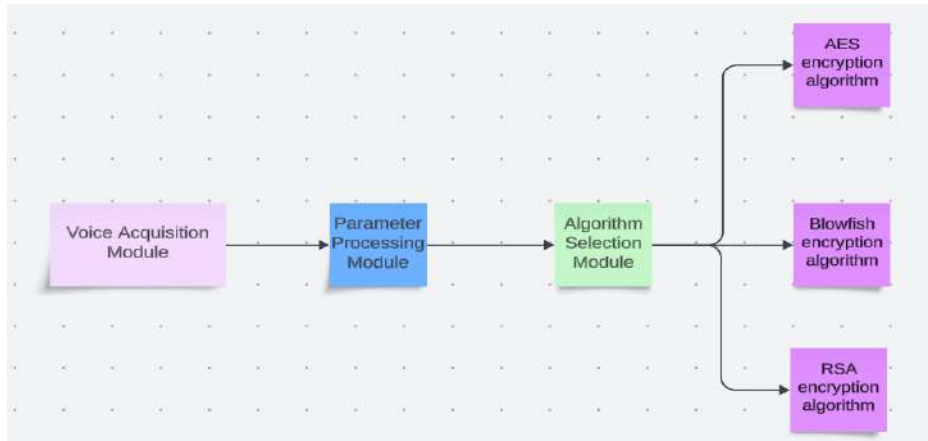
Figure 1: Process of selection algorithm development

Results and Discussion

The results obtained from the MATLAB prototype show that the real-time voice input obtained from the microphone effectively analyzes the audio parameters and then through the selection logic, selects the optimal encryption algorithm accordingly. For example, when we input a voice input with a lower time duration, the prototype selects the AES algorithm for the encryption process.

Conclusion

This research shows the importance of a dynamic selection algorithm for real-time voice communication on FPGAs. The currently developing system plans to balance the security and performance of the encryption process by dynamically adjusting the encryption algorithm according to voice parameters of the real-time voice input, which has already been tested using MATLAB.

Directions for Future Research

In future work, we can integrate additional cryptographic algorithms and more decision-making heuristics to further enhance the dynamic selection process.

Additionally, we can also apply machine learning techniques as part of the selection algorithm which can be used to enhance the decision making further. This can be achieved by training models on a variety of predefined real-time communication scenarios.

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(#31) Design of an Integrated Embedded System for Automated Soil Nutrient Management

K.R.M. Rifak[1], R.A. Prabhath Buddhika[2]

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Abstract

Precision agriculture is increasingly recognized as a crucial approach to enhancing crop yields while reducing resource consumption and environmental impact. One significant challenge within this domain is the precise application of nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), according to the spatial variability of soil. Traditional nutrient applications and current automated methods often lack the precision to adjust for such variability, resulting in inefficiencies and suboptimal crop performance. This research addresses this gap by developing a master-slave system that optimizes NPK delivery based on real-time data. Current methodologies in precision agriculture typically rely on static models for nutrient distribution, which fail to account for the dynamic nature of soil nutrient requirements. This research builds upon these foundations by incorporating a system where the master device calculates the required NPK levels for slave devices, utilizing coordinates to fine-tune nutrient application. This approach not only improves nutrient efficiency but also ensures that each section of the field receives the appropriate amount of nutrients, thereby enhancing overall crop health and yield. The significance of this study lies in its potential to transform traditional farming practices by introducing a more adaptive and precise nutrient management system. The proposed system can dynamically adjust nutrient delivery, addressing the spatial variability within fields more effectively than existing methods. This research is pivotal as it bridges the gap between static nutrient models and the need for real-time adjustments in modern agriculture.

Keywords: soil nutrient management, embedded system, automation

Introduction

Precision agriculture is increasingly recognized as a crucial approach to enhancing crop yields while reducing resource consumption and environmental impact. One significant challenge within this domain is the precise application of nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), according to the spatial variability of soil. Traditional nutrient applications and current automated methods often lack the precision to adjust

for such variability, resulting in inefficiencies and suboptimal crop performance [1],[2]. This research addresses this gap by developing a master-slave system that optimizes NPK delivery based on real-time data.

The failure to account for the dynamic nature of soil nutrient requirements causes generalized fertilizer application. This research builds upon these foundations by incorporating a system where the master device calculates the required NPK levels for slave devices, utilizing coordinates to fine-tune nutrient application. This approach not only improves nutrient efficiency but also ensures that each section of the field receives the appropriate amount of nutrients, thereby enhancing overall crop health and yield [1],[3].

The significance of this study lies in its potential to transform traditional farming practices by introducing a more adaptive and precise nutrient management system. The proposed system can dynamically adjust nutrient delivery, addressing the spatial variability within fields more effectively than existing methods. This research is pivotal as it bridges the gap between static nutrient models and the need for real-time adjustments in modern agriculture [1],[2],[3].

Methodology

The proposed system is designed to optimize NPK nutrient delivery using a master-slave architecture. The master device communicates with multiple slave devices via wireless communication. This methodology ensures seamless command transmission and data reception between the master and slave devices.

To initiate the process, the master device acquires coordinates from an initial slave device, which serves as the reference point for calculating distances to neighboring slave devices. The distance calculation considers the coordinates of both the initial and neighboring devices, providing accurate distance measurements crucial for determining the required NPK levels.

Using the calculated distance, the master device determines the required NPK levels for each neighboring slave device. The nutrient requirements are adjusted based on the distance from the initial device.

The calculated NPK values are then transmitted to the respective slave devices using the wireless communication module. This ensures each device receives

precise instructions tailored to its specific location, enhancing nutrient application efficiency across the field

Results and Discussion

The development of the NPK monitoring system for precision agriculture has made significant progress in both the hardware and software domains. The master and slave device code has been partially implemented, alongside the design of the printed circuit board (PCB). The master device, designed to control and send commands, communicates with the slave devices through wireless communication. Each slave device, fixed in a predefined matrix-like grid, receives commands to adjust solenoid valves for nutrient delivery.

Results

1. Master Device Implementation: The master device code can initialize and manage a map of slave devices indexed by their grid coordinates. It sends commands to specific slaves based on nutrient deficiencies detected.

2. Slave Device Implementation: Each slave device receives commands and adjusts the solenoid valves accordingly.

Discussion

The system's design demonstrates a novel approach to precision agriculture by employing a fixed-location matrix indexing method for managing slave devices. This reduces the complexity and ensures consistent coverage of the agricultural field. However, the full functionality and reliability of the system can only be validated with physical hardware testing.

The primary limitation of the current implementation is the lack of real-world testing. The absence of actual hardware components restricts the ability to assess the system's performance in dynamic agricultural environments. Future work will focus on completing the hardware integration and conducting comprehensive field tests to validate the system's efficacy in real-world conditions

Conclusion

This research presents a novel approach to precision agriculture through the development of a master-slave system designed for the accurate delivery of NPK nutrients. By leveraging coordinates, the system calculates precise

distances between devices, allowing for customized nutrient distribution based on spatial data.

However, the study also identified areas for further research. The current spatial variability for nutrient calculation, while effective, may benefit from incorporating additional environmental variables such as soil type and moisture levels. Future studies should explore these factors to enhance the precision of nutrient delivery even further.

This research has successfully demonstrated the potential of integrating advanced technologies in precision agriculture. The master-slave system for NPK delivery offers a promising solution for optimizing nutrient distribution, improving crop yields, and promoting sustainable farming practices. Future research should continue to refine and expand upon this system to fully realize its potential and address the evolving needs of the agricultural industry.

Directions for Future Research

Future research should focus on refining the nutrient calculation model to account for a broader range of environmental variables. Incorporating soil moisture levels, pH, and other soil characteristics could significantly improve the accuracy of nutrient requirements, leading to even more efficient and effective fertilization strategies.Additionally, exploring machine learning algorithms to predict crop nutrient needs based on historical data and growth patterns could further optimize the system. Predictive models could provide proactive nutrient management, adjusting delivery schedules and quantities based on anticipated crop demands.

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(#48) Real-Time FPGA-Based Audio Processing for Enhanced Acoustic Feedback Suppression

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Abstract

This research aims at proposing a solution to the problem of feedback in audio systems using FPGA technology. Howling or feedback is a kind of acoustic feedback that may lead to deterioration of sound quality, interruption of communication, and even destruction of the used equipment. Based on the parallel processing of FPGA, high-coefficient filters are designed for precise noise reduction. The given research is based on the design and simulation of an adaptive filter that employs the LMS algorithm. MATLAB is used for simulation while Vivado is used for implementation on the FPGA development board and the real-time implementation of the algorithm. The obtained results prove the ability of the LMS algorithm to attenuate the feedback noise with adaptive coefficients and low residual noise. The research provides directions for further study of the more sophisticated adaptive filtering methods and applications for larger audio systems. The concept of using FPGA for audio systems can be promising for improving the performance and the proposed idea can be further developed for real implementation.

Keywords: *howling suppression, fpga, adaptive noise cancellation, least mean square, vivado*

Introduction

Acoustic feedback, or the howling phenomenon, is a cyclic process where amplified voice signals are re-emitted by a speaker, leading to audio degradation, communication disruption, and potential equipment damage [1].

Although there are existing solutions for this problem in the industry, this research introduces the novel integration of FPGA technology. FPGA's capability for parallel processing allows it to handle high-coefficient filters, which can implement highly accurate and efficient noise suppression[2]. This study uses the LMS algorithm as an adaptive filter, which effectively works

with any noise type [3]. The research scope includes designing the algorithm, simulating it using MATLAB and Vivado, and implementing it on an FPGA development board.
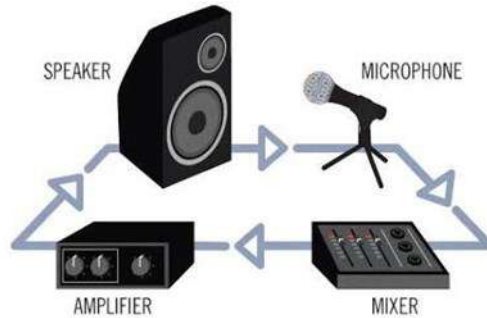
Figure 1: Reason for Feedback Noise *[Image Source: https://m.sohu.com/a/409165410_681125/?pvid=000115_3w_a]*

In the literature review of my research, I have referred to various research papers that are relevant to my topic. These research papers collectively contribute to the understanding and advancement of the relevant topics in my research, providing a solid foundation for my study. Among the notable studies I have explored are,

- "Adaptive Howling Suppressor in an Audio Amplifier System" by W. Loetwassana and R. Punchalard. This research focuses on developing an adaptive howling suppressor using audio amplifier systems [4].
- "An Open Audio Processing Platform with Zync FPGA" by Kevin Vaca. The paper discusses the implementation of an open audio processing platform using Zync FPGA, which offers flexibility and versatility in audio signal processing [5].
- "Study of Howling Suppression Based on FPGA and Wavelet Packet Transform" by Xiaomeng Ma, Zhijun Li, Wei Wang, and Zhiping Chen. This study investigates howling suppression techniques using FPGA and wavelet packet transform, aiming to mitigate the occurrence of howling in audio systems [6].
- "Steady-State Analysis of Continuous Adaptation in Acoustic Feedback Reduction Systems for Hearing-Aids" by Marcio G. Siqueira and Abeer Alwan. The research focuses on the analysis of continuous adaptation algorithms for acoustic feedback reduction in hearing aids, exploring methods to improve feedback cancellation performance [7].

Methodology

The research methodology comprised three key phases. First, the LMS algorithm was mathematically studied and designed for real-time acoustic feedback cancellation. This algorithm employs the steepest descent method to adjust filter coefficients, minimizing the mean square error (MSE) between the desired and actual signals [8]. I developed a block diagram for my application using the LMS algorithm.

In this scenario, the noise in the desired signal and the noisy signal itself serve as the input signals.
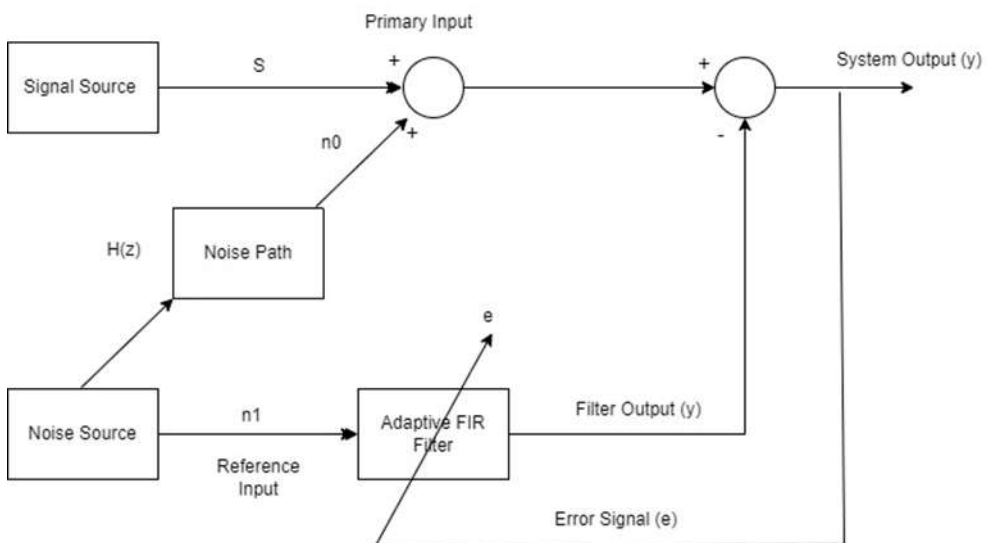
Figure 2: Block Diagram of Feedback suppressor using LMS Algorithm

Second, simulations were conducted using MATLAB to model the LMS adaptive filter while simultaneously developing Verilog code to simulate the LMS algorithm in Vivado. After validating the simulations in both MATLAB and Vivado, the LMS filter in MATLAB was replaced with the function developed in Verilog. This was achieved using Vitis Model Composer to run the Verilog code. The simulation phases included validating the LMS filter performance, observing coefficient changes, and testing noise estimation capabilities.

Finally, the implementation phase involved deploying the algorithm on an FPGA development board, generating bitstreams, and performing real-time testing to refine the algorithm for optimal performance.
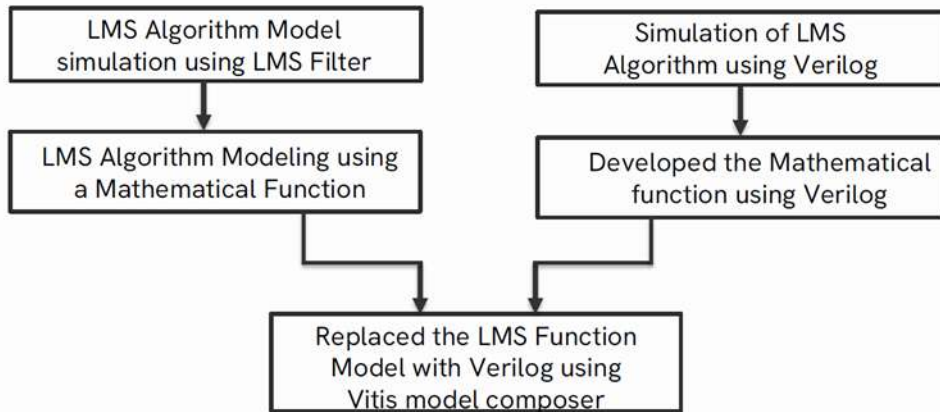
Figure 3: Model Development Process
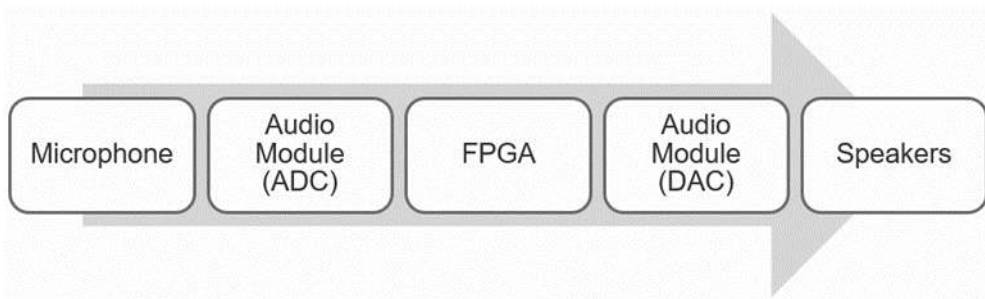
Figure 4: Implementation Plan

Results and Discussion

The simulations confirmed the effectiveness of the LMS algorithm in real-time noise suppression. The MATLAB Simulink models demonstrated the algorithm's ability to adaptively filter out feedback noise, with consistent updates to filter coefficients ensuring minimal residual noise.
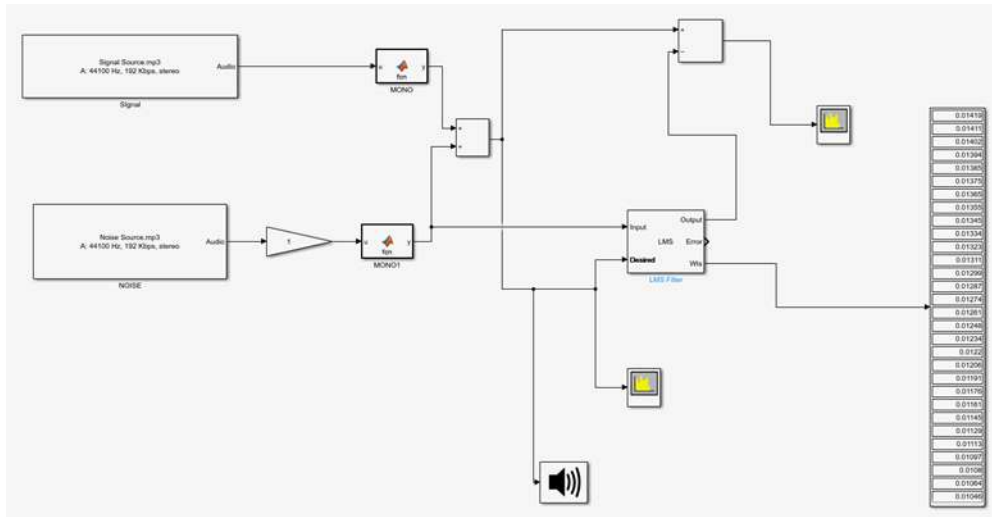
Figure 5: MATLAB Simulink Model using MATLAB Library

This is evident from the comparison of spectra before and after applying the LMS filter.
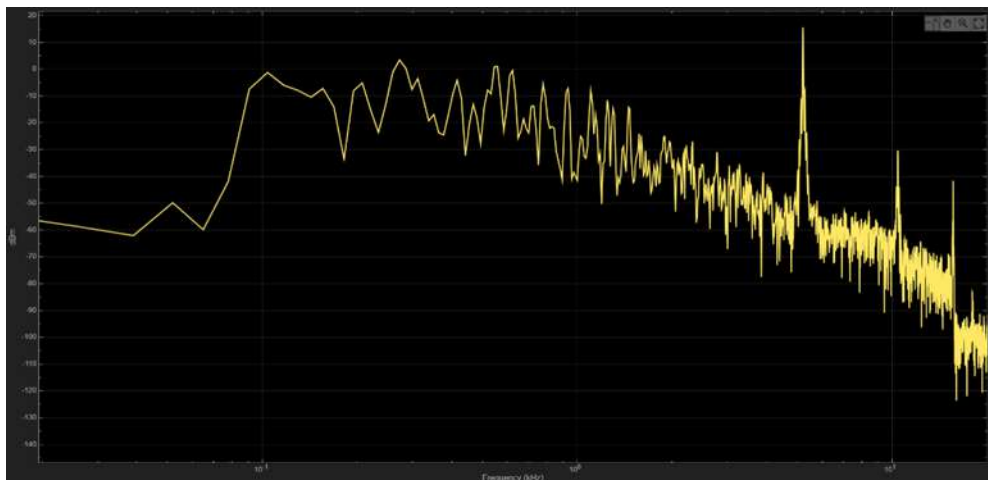
Figure 6: Noisy Signal (Before entering LMS Algorithm)
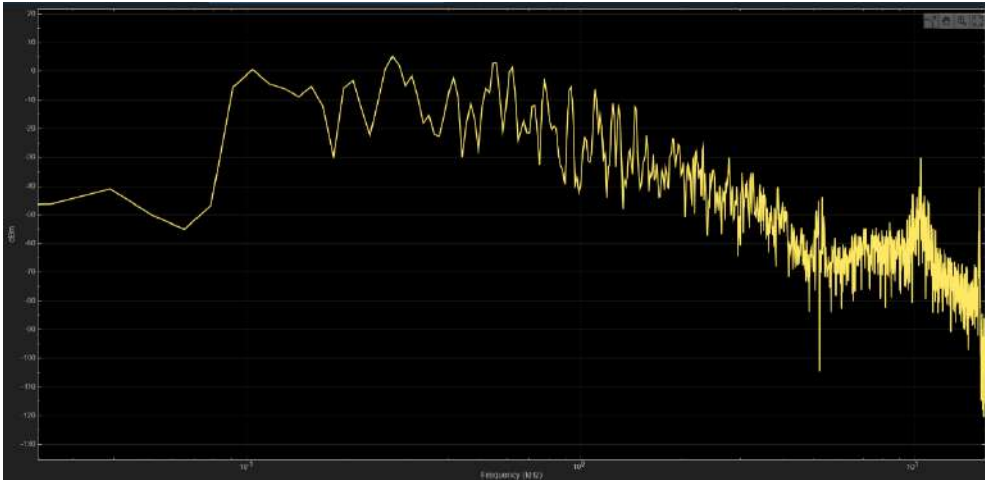
Figure 7: Filtered Signal by LMS algorithm

Additionally, we observed the dynamic changes in filter coefficients as noise passed through the filter, highlighting the adaptive nature of the algorithm.
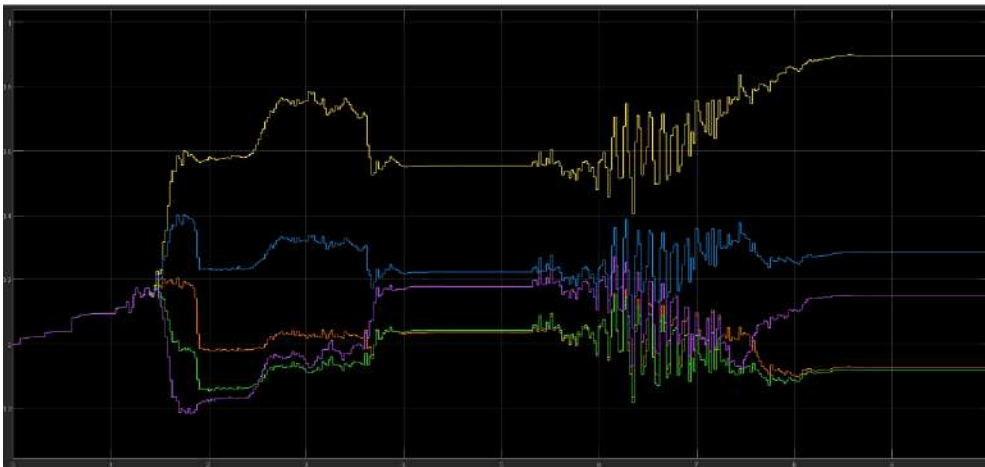
Figure 8: Coefficient Change Over Time

Before developing the Verilog code, a MATLAB function was created to replace the LMS filter, which successfully worked as demonstrated by the function block model. This step ensured that the algorithm's logic was sound before transitioning to hardware implementation.
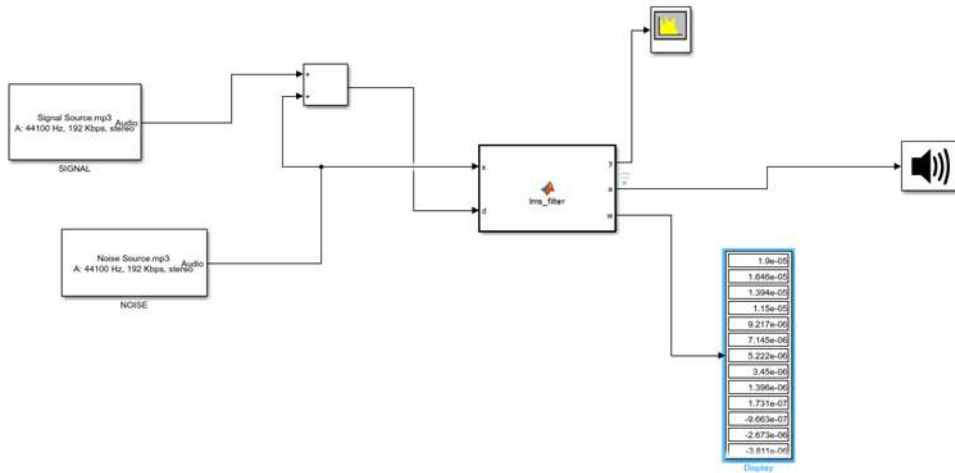
Figure 9: Simulation using Mathematical Function

The transition to Verilog code and subsequent simulation in Vivado maintained the algorithm's integrity, proving its suitability for FPGA implementation. Key observations included the algorithm's computational efficiency and stability in handling unpredictable noise. After developing the Verilog code, it was simulated and verified using a test bench, confirming the algorithm's performance in the FPGA environment.
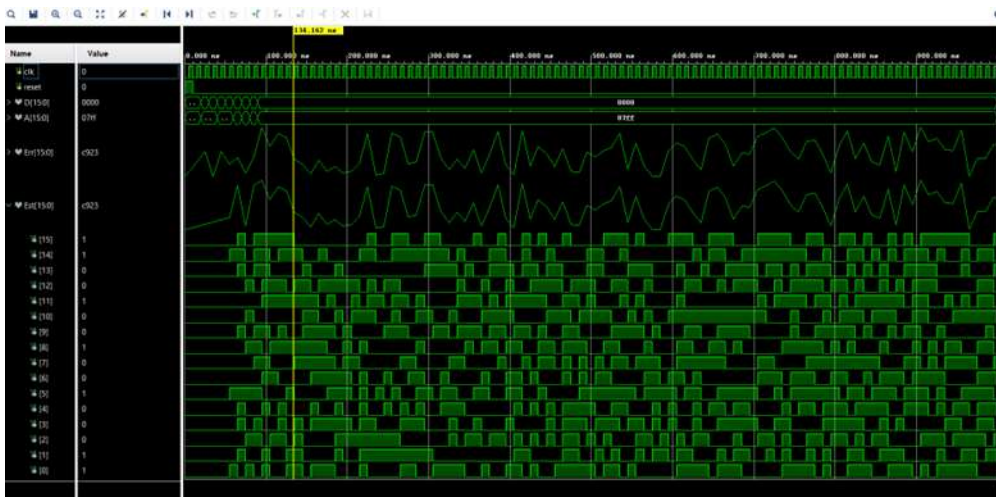
Figure 10: Behavioural Simulation

Conclusion and Future Work

This research successfully designed and simulated an LMS algorithm for real-time acoustic feedback cancellation, demonstrating its potential for FPGA-based implementation. The findings underscore the algorithm's adaptability, simplicity, and efficiency, making it a viable solution for enhancing audio system performance. The upcoming implementation phase will focus on real-time testing and refinement to ensure robustness in practical applications.

Future research should explore the integration of advanced adaptive filtering techniques to further enhance noise suppression capabilities. Additionally, investigating the scalability of the algorithm for larger and more complex audio systems would be beneficial. Further studies could also address the limitations encountered, such as software compatibility and hardware costs, to make the solution more accessible and cost-effective.

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(#50) Implementation of Electronic Voting System Based on Blockchain Technology for Elections in Sri Lanka

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Abstract

The traditional paper-based voting system in Sri Lanka, while foundational to its democratic process, faces significant challenges such as human errors, delays in result tabulation, and the potential for fraud. This research explores the viability of implementing a blockchain-based e-voting system to enhance transparency, security, and efficiency in the electoral process. Utilizing Ethereum for its robust smart contract capabilities, the system was designed to manage voter and candidate registration, voting, and vote counting. A user-friendly interface was developed to facilitate voter interaction, while security measures were implemented to protect the integrity of the voting process. Data such as candidate and voter images are stored off-chain using IPFS to ensure decentralized and secure storage. This study demonstrates the potential of blockchain technology to address the limitations of traditional voting systems, providing a secure and transparent alternative for future elections in Sri Lanka.

Keywords: *Blockchain, Electronic Voting, Decentralization, Private Blockchain, Public Blockchain*

Introduction

The electoral process in Sri Lanka, traditionally reliant on paper-based voting, faces significant challenges such as human errors, delays in result tabulation, and the potential for fraudulent activities, all of which compromise the accuracy and integrity of election outcomes [1]. Blockchain technology, known for its immutability, transparency, and decentralization, offers a promising solution to these issues [2]. However, integrating blockchain into e-voting systems introduces its own set of complexities, including balancing decentralization with controlled access, ensuring the security and verifiability of user identities, and addressing scalability concerns. Understanding the unique context of Sri Lanka's electoral landscape is crucial for tailoring

blockchain solutions to meet the nation's specific needs. This research aims to investigate the viability of implementing a blockchain-based e-voting system in Sri Lanka, evaluating its potential to enhance transparency, security, and efficiency in the electoral process.

Related work

The evolution of voting mechanisms has been a focal point of scholarly examination, particularly in the context of ensuring secure, transparent, and efficient electoral processes. Traditional voting systems, characterized by manual counting and inherent vulnerabilities such as fraud and delays [1], have prompted the exploration of electronic voting (e-voting) solutions. E-voting systems have been adopted by several countries, including the US, UK, Brazil, Estonia, Norway, India, and Switzerland, each encountering unique challenges related to security, transparency, and integrity. Estonia, despite its pioneering efforts, has faced significant security vulnerabilities [3], [4], while Switzerland struggles with system visibility and auditing [5]. Failures in countries like Finland, Germany, and France underscore the persistent challenges of e-voting systems [6], [7]. Blockchain technology, with its promise of enhanced security and transparency, has been proposed as a solution, with research focusing on both public and private blockchain-based systems. Public blockchains, such as Ethereum, offer transparency but pose risks of data exposure and scalability issues [8], [9]. Conversely, private blockchains, like Hyperledger Fabric, address privacy and scalability but challenge the balance between transparency and controlled access [10]. The research highlights the need for further exploration to address these complexities and develop robust blockchain-based e-voting systems.

Methodology

This research follows the DSRM framework to develop and evaluate the blockchain-based e-voting system for Sri Lankan elections. The methodology consists of the following key stages.

1. **Problem Identification and Motivation**: The study identifies issues like fraud, delays, and lack of transparency in Sri Lanka's electoral process, motivating the use of blockchain technology to improve election integrity and efficiency.

2. **Objective Definition**: The goal is to create a blockchain-based e-voting system that enhances security, transparency, and efficiency while being scalable and user-friendly.

3. **Design and Development**: The system is built using Ethereum for its smart contract capabilities, with a secure voting interface, smart contracts for vote management, and IPFS for secure off-chain data storage.

4. **Evaluation**: The system was evaluated based on its performance in the test scenario. Results. showed that the system effectively allowed only eligible voters to vote, prevented double voting, and ensured votes were cast only during the election period.
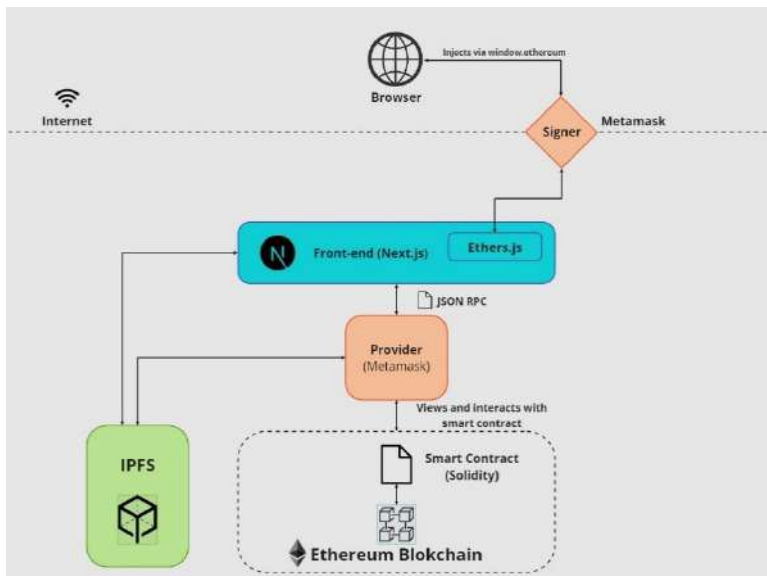
Figure 4: Architecture diagram of the dApp

Results and Discussion

The developed blockchain-based e-voting system was evaluated to determine its effectiveness in ensuring secure, transparent, and reliable voting. The prototype was deployed on a local machine, and a series of tests were conducted to simulate an election scenario.

The evaluation involved registering 100 voters, of which 80 were eligible and 20 were not. The primary goal was to assess the system's capability to accurately verify voter eligibility, securely record votes, prevent

double voting, and ensure that voting could only occur during the designated election period. The performance of the system was measured using the following metrics:

- **Voter Eligibility Verification:** The system correctly allowed all 80 eligible voters to cast their votes while preventing the 20 ineligible voters from participating in the election. This demonstrates the system's effectiveness in accurately verifying voter eligibility.

- **Multiple Voting Prevention:** The system successfully prevented any voter from casting multiple votes, ensuring the principle of "one person, one vote" was upheld throughout the election process.

- **Election Period Enforcement:** Votes could only be cast during the specified election period, with the system automatically preventing any voting attempts before or after this period. This feature ensured that all votes were cast within the legitimate timeframe.

- **Transaction Processing Time:** The average time taken to process a vote transaction was within acceptable limits, ensuring a smooth voting experience. The processing time included verifying the voter's identity, recording the vote, and updating the blockchain.

- **Security Validation:** The use of smart contracts and the decentralized nature of the blockchain ensured that all recorded votes were immutable and tamper-proof. Additionally, the system was able to prevent unauthorized access, thereby safeguarding the integrity of the election process.

The evaluation results suggest that the developed e-voting system effectively addresses key challenges in electronic voting, such as voter eligibility verification, transaction security, double voting prevention, and system scalability. The system's ability to accurately identify and reject ineligible voters, prevent double voting, and enforce the election period highlights its potential to prevent voter fraud and maintain the integrity of the election process.

However, while the prototype performed well in a controlled environment, further testing is necessary to evaluate its performance in more complex and large-scale scenarios.

Conclusion and Future Work

This research successfully demonstrates the feasibility of using the Ethereum blockchain to develop a secure and transparent electronic voting system for Sri Lankan elections. The prototype system effectively addresses challenges in traditional voting, such as unauthorized voting, double voting, and vote manipulation. Evaluation in a controlled environment confirmed the system's ability to enforce voter eligibility, prevent multiple voting, and restrict voting to the designated period.

Future work should focus on scalability testing, optimizing transaction processing times, enhancing security measures, improving user accessibility, ensuring legal compliance, and conducting real-world pilot tests. These efforts aim to refine the system for broader adoption and potential deployment in real elections.

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TECHNICAL SESSION 1B

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

(#21) Deep Learning-Based Road Sign Detection and Recognition System for Autonomous Vehicles in Sri Lanka

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Abstract

In Sri Lanka, like many other countries, road signs play a crucial role in guiding traffic and ensuring road safety. In this research project, I propose a deep learning-based road signal detection and recognition system tailored specifically for Sri Lankan road conditions. My approach involves utilizing convolutional neural networks (CNNs) for image recognition using a comprehensive dataset of Sri Lankan Road signs, leveraging their ability to extract intricate features from visual data. We will use a moving vehicle with a camera installed to test and execute our system, mimicking actual driving situations. The vehicle's onboard technologies will use the trained model to enable real-time detection and recognition of road signs. We want to test the system extensively on various road types and climatic circumstances throughout Sri Lanka in order to assess its accuracy and resilience. A dependable and effective road signal detection and recognition system designed especially for Sri Lankan Road conditions is one of the research's anticipated results. Autonomous vehicles can operate securely and effectively, improving overall road safety and traffic efficiency in Sri Lanka, by precisely recognizing and interpreting road signs in real-time.

Keywords: Deep Learning, Autonomous navigation, Object detection, Road Sign Recognition

Introduction

Transportation is about to undergo a transformation thanks to the development of autonomous vehicles, but ensuring their safety is a significant hurdle. The goal of this project is to develop a deep learning-based system for Sri Lankan Road sign identification and recognition. This project aims to construct an accurate, real-time traffic sign recognition system by utilizing convolutional neural networks (CNNs), which are recognized for their capacity to extract complex characteristics from visual data [1], [2].

The CNN model will be trained using a large dataset of Sri Lankan Road signs, guaranteeing localization to particular traffic situations. The effectiveness of the device will be assessed through testing it in a moving car that has a camera installed, mimicking actual driving conditions. The onboard technologies of the car will use the trained model for in-the-moment detection and identification [3].

The anticipated result is a dependable and effective system for detecting and recognizing road signs, which will boost traffic efficiency, increase road safety, and forward the development of autonomous vehicle technology in Sri Lanka. In order to support the safe and efficient use of autonomous vehicles in Sri Lanka, this localized solution seeks to overcome the unique difficulties presented by the nation's road system.

Methodology

The methodology of this research encompasses four critical steps as data collection, model training, real-time implementation, and performance optimization. Every stage is carefully planned to guarantee the creation of a reliable and effective system for detecting and recognizing traffic signs that is specific to Sri Lankan circumstances. This methodology ensures a systematic and thorough approach to developing a state-of-the-art road sign detection and recognition system that is both reliable and optimized for real-world application in Sri Lanka [4], [5].

- Data Collection has been done majorly in two ways. Firstly, look for a dataset that already has access. And found a dataset from a website that is freely available and had access to download. Secondly, did it manually by passing through the roads and collected the images in different environment types [6], [7]. Mainly focused on 12 road sign types. After collecting the data image preprocessing and annotation is done for 15 classes. The Roboflow tool was selected as the annotation tool.
- Model creating and training a convolutional neural network (CNN) model using this annotated dataset. As the CNN model, YOLOv8m was selected. Set up a deep learning local environment using a framework that is a cloud-based platform such as Google Colab.
- After training, the model will be integrated into a moving vehicle's onboard technologies, enabling real-time traffic sign detection and recognition.

- Refining the model and system settings based on field testing results to enhance accuracy and ensure efficient processing [3], [8].

Results and Discussion

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Validating runs/detect/train/weights/best.pt...
Ultralytics YOLOv8.2.42 🚀 Python-3.10.12 torch-2.3.0+cu121 CUDA:0 (Tesla T4, 15102MiB)
Model summary (fused): 218 layers, 25848445 parameters, 0 gradients, 78.7 GFLOPs
                      Class  Images  Instances   Box(P        R      mAP50  mAP50-95): 100%|
                        all     290        378   0.857    0.919      0.896      0.689
    children crossing ahead      43         43   0.876    0.982      0.972      0.834
                green light      34         59   0.875    0.932      0.925      0.617
                   hospital      17         17   0.833    0.824      0.945      0.777
    level crossing with gates    26         26   0.969    0.962      0.974      0.858
                 no horning      28         28   0.977        1      0.995      0.826
               no left turn      37         37   0.488    0.973      0.491      0.414
                 no parking       4          4   0.849        1      0.995      0.675
              no right turn      45         46   0.532    0.978      0.629      0.524
                  no u turn      36         36   0.957    0.944      0.975      0.808
  pedestrian crossing ahead      15         15   0.931    0.904      0.942      0.704
        red and yellow light      5          8       1    0.838      0.955      0.69
                  red light      21         39   0.894    0.863      0.931      0.642
                       stop       5          5   0.869      0.8      0.938      0.595
               yellow light      10         15   0.942    0.867      0.878      0.683
Speed: 0.4ms preprocess, 10.5ms inference, 0.1ms loss, 5.3ms postprocess per image
Results saved to runs/detect/train
ultralytics.utils.metrics.DetMetrics object with attributes:
```

Figure 1: Model Validation
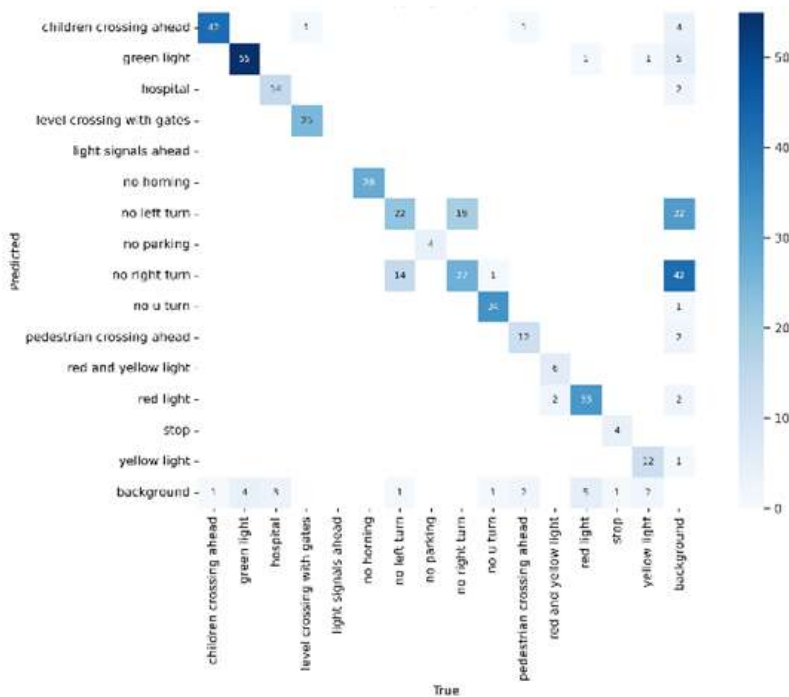
Figure 2: Confusion matrix

Figure 1 and Figure 2 show the model training results of the research.

Conclusion and Future Work

With this research, a deep learning-based system for detecting and recognizing road signs that is adapted to Sri Lankan Road conditions has been successfully developed. With a large dataset of Sri Lankan Road signs and CNNs, the system achieves reliable and accurate real-time recognition. Field testing and integration with onboard vehicle technology confirm its effectiveness and reliability, enhancing traffic efficiency and road safety in Sri Lanka.

Future research will focus on expanding the dataset to include more diverse road signs and various environmental and weather conditions to further improve the system's accuracy and robustness. Additionally, exploring advanced deep learning techniques and hybrid models could enhance performance and processing efficiency. Real-world implementation and extensive field trials across different regions in Sri Lanka will provide valuable insights for refining the system.

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(#25) Utilizing data analysis algorithms for personalized marketing strategies in Sri Lanka's supermarket chains

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Abstract

This research investigates the application of data analysis algorithms for personalized marketing strategies within Sri Lanka's supermarket chains. Amidst a dynamic retail landscape, innovative approaches to customer engagement are crucial, and leveraging data analysis algorithms offers opportunities to tailor marketing efforts to individual consumer preferences. The study focuses on evaluating algorithms such as collaborative filtering, clustering methods, Association Rule Mining (ARM), and Decision Trees to identify customer interests and segment the customer base effectively. Central to this research is the role of data analysis in providing insights into customer preferences, enabling precise segmentation and predictive modeling. The study aims to fill gaps in personalized marketing by examining the feasibility and impact of these algorithms on customer engagement in Sri Lanka. Methodologically, the research involves collecting and preprocessing historical purchase data from a regional supermarket in the southern province of Sri Lanka. Techniques like association rule mining and clustering are employed to extract meaningful patterns and segment customers. Preliminary findings reveal distinct buying patterns and frequent itemsets crucial for crafting personalized promotions. The Apriori algorithm identifies strong buying patterns, while K-Means clustering highlights actionable customer segments. Despite challenges related to data quality and algorithm implementation, this research contributes to the existing body of knowledge by comparing various data analysis algorithms in personalized marketing, aiming to enhance customer engagement and drive business performance.

Keywords: Supermarkets, Personalization, Target Marketing, Data Analysis, Customer Segmentation, Customer Interest Analysis

Introduction

This research aims to investigate the utilization of data analysis algorithms for personalized marketing strategies within Sri Lanka's supermarket chains. The

dynamic retail landscape in Sri Lanka necessitates innovative approaches to customer engagement, prompting the exploration of advanced technologies such as data analysis algorithms. Leveraging advanced technologies such as data analysis algorithms holds immense potential to revolutionize traditional marketing approaches, offering unprecedented opportunities to tailor promotional efforts and product recommendations to individual consumer preferences [1]. Personalization in marketing occurs when vendor organizations use data to tailor messages to the preferences of particular users [2]. Leveraging historical purchase data, the research seeks to evaluate the effectiveness of algorithms like collaborative filtering, clustering methods, Association Rule Mining (ARM), and Decision Trees in identifying customer interests and segmenting the customer base.

Importance of Data Analysis in Personalized Marketing

Data analysis is central to this research, providing deep insights into customer preferences and enabling precise segmentation and predictive modeling. This approach allows for the crafting of tailored marketing messages and optimizes resource allocation, thereby increasing return on investment (ROI) [3].

The Research Gap

The research aims to fill gaps in personalized marketing within Sri Lanka's supermarket chains by addressing the lack of studies on data analysis algorithms in the local retail industry. It seeks to explore the feasibility and impact of these algorithms on customer engagement and business performance. Additionally, the research contributes to existing knowledge by comparing and contrasting various data analysis algorithms in the context of personalized marketing. By evaluating algorithms such as collaborative filtering, clustering methods, ARM, and Decision Trees, the study aims to identify the most effective algorithms for customer segmentation and interest identification [4].

Research Methodology

The research methodology spans data collection, preprocessing [5], analysis, and system architecture development. The research will involve collecting and analyzing historical purchase data to evaluate the effectiveness of data analysis algorithms. The Algorithms will be utilized for Customer segmentation and Customer interest identification. Segmentation can be done under Demographic data, Geographic data, Psychographic data, Attitudinal data, Sales data, that indicates shopping behaviors, and Behavioral data.

Data Collection and Preprocessing

Data was sourced from a regional supermarket in the southern province of Sri Lanka, including key variables such as customer ID, product codes, product names, customer address, customer contact number, and transaction dates. Data preprocessing involved cleaning, transforming, and reducing the dataset to make it suitable for complex algorithmic analysis [5].

Data Analysis

The data analysis phase employed association rule mining and clustering techniques to extract meaningful patterns from the dataset. Association rule mining [6] was used to identify frequently bought items by customers, while clustering techniques segmented the customer base into groups with similar purchasing behaviors. Three association rule mining algorithms Apriori, FP-Growth, and ECLAT were considered [7], each offering different computational speeds, memory requirements, and suitability for larger datasets.

Results and Findings

The findings and discussions section will present the results of the analysis, examining the performance of different algorithms in customer segmentation and interest identification. Preliminary results revealed distinct buying patterns and frequent itemsets crucial for crafting effective marketing strategies. For example, the Apriori algorithm [8] identified rules with varying degrees of support and confidence, indicating strong buying patterns that could inform personalized promotions and recommendations. The clustering analysis, particularly using K-Means [9], provided actionable segmentation of the customer base, highlighting clusters with diverse and active purchasing patterns. The limitations of the study include the availability and quality of data, as well as potential challenges in algorithm implementation and adaptation.

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(#29) Intelligent Chatbot to Optimize University Communication Channels Integrating Text Data Mining

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Abstract

This study presents the development of an intelligent chatbot designed to optimize university communication channels at NSBM Green University. The chatbot intends to efficiently manage repetitive requests by incorporating advanced text data mining techniques, decreasing the administrative strain on staff and increasing the student experience. The chatbot was built utilizing the Design Science Research Methodology (DSRM) and tools like Python, Rasa, Anaconda, and Visual Studio Code. Initial testing yielded encouraging results, with effective handling of routine requests and plans for further improvements, such as multilingual assistance and advanced AI approaches. Continuous feedback and improvements are critical for fine-tuning the chatbot's performance to match the changing needs of the academic community.

Keywords: AI-guided chatbots, university Communication, text data mining, natural language processing

Introduction

University communication channels are frequently updated with repetitive inquiries regarding course details, faculty information, enrollment, and various administrative processes. Traditional methods for handling these questions, such as in-person visits to the help desk and phone calls are not only inefficient but also time-consuming for staff and students. The aim of this study is to develop an intelligent chatbot to optimize university communication processes by integrating advanced text data mining techniques. The importance of this work lies in its ability to reduce administrative burden, simplify the student registration process, and provide detailed information to students, thereby increasing user experience and overall productivity [1]. Moreover, this aims to address the gap in educational chatbot solutions by developing a chatbot that automates routine inquiries and provides students with in-depth information about the university's academic

offerings and career prospects, leveraging AI and text mining capabilities. Furthermore, this study investigates the development and implementation of an intelligent chatbot at NSBM Green University, focusing on improving efficiency and accuracy in common inquiries [2].

Methodology

The chatbot's development followed the Design Science Research Methodology (DSRM), beginning with defining use cases and conversation flows for an intuitive user experience. A robust Natural Language Understanding (NLU) model was trained using high-quality data, and the chatbot was integrated with external APIs for real-time information retrieval. Then, the chatbot was rigorously tested through both automated and user-based testing to ensure reliability and effectiveness. Initial deployment occurred on a separate testing website to collect controlled feedback. Continuous monitoring and maintenance are conducted to ensure optimal performance, with regular retraining of the NLU model based on user interactions and feedback. The development tools used include Python, Rasa, Anaconda, and Visual Studio Code (VS Code) [3].

Results and Discussion

The core of the chatbot is built using Python, Rasa, Anaconda, and Visual Studio Code (VS Code). Python's NLP and machine learning libraries, alongside Rasa's conversational AI framework, form the foundation [4]. Anaconda manages packages and dependencies, ensuring stability, while VS Code serves as the IDE for writing and debugging code. Initial testing of the chatbot on a separate website showed it could handle routine inquiries effectively, providing accurate and timely responses. To ensure the chatbot's effectiveness and gather comprehensive feedback, a beta version was released to a group of 20 users, consisting of students at NSBM Green University and few employees at Hayleys Fentons Ltd. The beta version was made available to these users over a one-week period. During this phase, participants were encouraged to interact with the chatbot, ask questions, and use it for routine inquiries. This real-world testing allowed to assess how well the chatbot handled different types of queries, including its response accuracy, speed, and ability to maintain a natural conversation flow. Throughout the beta phase, feedback was collected through direct interviews. User feedback was generally positive, with suggestions for improving the user interface and interaction flow. The ongoing integration of text data mining techniques aims to further enhance the chatbot's capabilities. By leveraging text mining, the

chatbot will be able to analyze and extract useful information from large volumes of textual data, providing more detailed and comprehensive responses to complex queries. This integration is expected to significantly improve the chatbot's ability to support students in making informed decisions about their academic and career paths.

Conclusion

The intelligent chatbot developed in this research represents a significant advancement in optimizing university communication channels. By automating routine inquiries, the chatbot alleviates staff workload, improves operational efficiency, and enhances user experience. The integration of text mining capabilities further empowers students with comprehensive information, facilitating informed decision-making. As the project progresses, continuous improvements and user feedback will be crucial in refining the chatbot's performance and ensuring it meets the evolving needs of the university community [5] [6].

Future Work

Future work will focus on fully integrating text data mining techniques, improving the chatbot's NLP capabilities, and conducting extensive user testing to gather feedback. Additional plans include developing the chatbot to support three languages: English, Sinhala, and Tamil. This multilingual capability will ensure accessibility and inclusivity for all students [7]. Moreover, the chatbot will enable students to submit responses and inquiries directly to the university, categorizing messages using keywords and routing them to the relevant department for efficient handling. These steps are essential for optimizing the chatbot's features and ensuring it effectively meets the needs of students, faculty, and staff at NSBM Green University. Additional research may explore the use of advanced AI techniques such as sentiment analysis and contextual understanding to further enhance the chatbot's interaction quality.

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(#41) Deep Learning-Based Real-Time Cloud Detection and Tracking for Cloud Path Prediction

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Abstract

Due to the fast fluctuation behavior in solar irradiance, cloud movements have a great influence on the stable operation of solar PV power generation. The following paper is designed and implemented to predict cloud movement paths through a real-time cloud detection and tracking system using deep learning with ground-based total sky images. It makes accurate cloud detection possible via the YOLOv8m object detection model, cloud tracking via BoT-SORT, and cloud movement path prediction via Kalman filtering. Velocity is calculated from the displacement of cloud centroids between frames. The results are an improved short-term solar power generation forecast that mitigates fluctuations in the power ramp rate. Although computationally intensive, the model provides a reliable path prediction for clouds, benefiting grid stability. Future work will thus include computational efficiency optimization and expanding the dataset to different weather conditions so that the forecast is more robust and adaptable.

Keywords: *Ramp Rate Control, Total Sky Images, Real-Time Cloud Detection, Cloud Tracking, Cloud Path Prediction*

Introduction

The integration of large scale solar photovoltaic (PV) power into the national grid poses challenges to stability of the grid, causing ramp rate fluctuations due to unpredictable and intermittent nature of solar generation caused by cloud movements [1]. According to that in Sri Lanka, as the time frame extends from seconds to six minutes, the variability progressively rises until it reaches 70% of the plant-rated capacity. The main effect of that is the cloud coverage. When the sun is blocked by cloud clusters, the solar irradiance changes rapidly within very short period of time. [2]. So, solar PV forecasting method which utilizes ground based Total Sky Images to address these issues and enhance the grid stability in real time [3].

Solar photovoltaic (PV) power forecasting has advanced with machine learning (ML) and deep learning (DL) techniques, improving accuracy over traditional methods [4], [5]. Ground-based sky images have been used for short-term solar power forecasting using cloud path predictions [6], with CNN-based models like EfficientDet-D2 [7].

However, these methods face challenges in real-time applications due to high computational demands and difficulty in accurately detecting clouds under various conditions. This research aims to address this gap by developing a deep learning-based real-time cloud detection and tracking model to predict cloud paths using ground-based total sky images. This research helps to predict cloud paths accurately for forecasting short-term solar PV generation while balancing computational demands, aiming for reliable and efficient grid integration to mitigate ramp rate fluctuations.

Methodology

A 170° wide-angle fisheye lens camera was installed at a 2MW solar PV power plant in Hambantota district to capture total sky images at 10-second intervals. The collected images will be annotated to create a labelled data set and then used it to train the CNN-based YOLOv8m model to accurately detect the cloud, then BoT SORT method used to track the clouds. Each cloud is tracked with its own ID.

To determine the velocity of the clouds displacements between frames are taken, for that centroid of the bounding boxes of each cloud ID are used. Then cloud path will be predicted by using centroids and velocity of the clouds.

Results and Discussion

Table I: Cloud Detection Validation Results of the model

Class	All	Clouds	Sun
Images	174	174	149
Instances	1845	1696	149
Precision	0.871	0.804	0.938
Recall	0.841	0.767	0.915
mAP50	0.88	0.811	0.949
mAP50-95	0.613	0.596	0.63
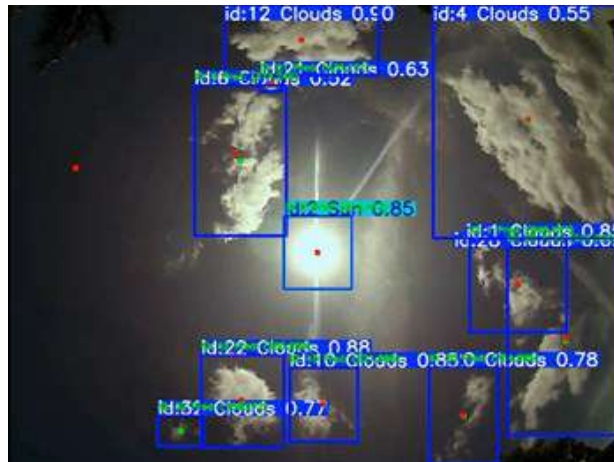
Figure 1: Predicted Clouds with Detected and Tracked Clouds

After tracking the clouds with an ID then extracted the centroids of the clouds using the coordinates of the bounding boxes. Using those centroids, the velocity of each cloud was calculated using displacement among image frames. Then after adding the Kalman filtering method to predict the cloud paths. This Kalman filter predicts cloud paths using centroids which are extracted by the bounding boxes and velocity calculated. As the next step of this research can be integrates these predictions with solar irradiance and historical PV generation data to forecast real-time PV power generation. The resulting forecasts improve the stability and reliability of solar PV power generation by effectively mitigating power ramp rate issues. Despite the challenge of high computational requirements, the model's ability to enhance grid stability and reduce reliance on backup power sources marks a promising step toward sustainable energy integration.

Conclusion

According to the methodology proposed, developed a deep learning-based real-time cloud detection and tracking model using YOLOv8m. The predicted velocity from cloud movements calculates the cloud path to take short-term decisions on the power ramp rate fluctuations of the solar PV systems. Though computationally demanding, this result encourages good short-term forecasting accuracy and contributes toward grid stability. Future works shall be focused on improving computational efficiency and augmenting datasets to increase the model's robustness and applicability under different sky conditions.

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(#49) AI Enhanced Recommendation System for University Libraries in Sri Lanka: Improving Information Retrieval and User Experience

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Abstract

The integration of recommendation algorithms into library systems has revolutionized how patrons find and interact with library materials. By addressing the problem of information overload, these systems offer customized recommendations based on individual user interests, enhancing the traditional library experience. This study focuses on developing an AI-enhanced recommendation system for university libraries in Sri Lanka, with a particular emphasis on optimizing book searching and selection for university students. Key challenges include the "cold start" problem and biases from previous user data, which affect the accuracy of recommendations. This research aims to develop comprehensive methods to address these issues and create an accurate recommendation system tailored to the needs of Sri Lankan university libraries. The methodology involved developing a collaborative filtering model using user rating data collected from Kaggle. The model was built and tested using three algorithms: K-Nearest Neighbours (KNN), a deep learning-based neural network, and Singular Value Decomposition (SVD). Rigorous evaluation and comparison of these algorithms determined the most effective approach. The results demonstrated that the KNN and neural network models outperformed the SVD algorithm in terms of accuracy. Future work includes developing a hybrid recommendation system that integrates content-based models with collaborative filtering to further enhance the recommendation system's ability to cater to diverse user preferences and improve information retrieval in university libraries.

Keywords: artificial intelligence, machine learning, recommendation system, deep learning

Introduction

The development of recommendation algorithms in libraries worldwide has brought about an important shift in the way patrons find and interact with library materials [1]. These systems improve on the traditional library

experience by utilizing cutting-edge algorithms and technology to handle the problem of information overload and offer customized recommendations based on the interests of each individual user [2]. This research focuses on developing an AI-enhanced recommendation system for libraries in Sri Lanka, aiming to optimize the process of book searching and selection for users, particularly university students [3]. Significant obstacles that affect the accuracy of recommendations include the "cold start" problem, which is characterized by biases resulting from previous user data and errors in suggesting new or unrated goods. Improving the accuracy of recommendation systems in library material requires addressing the "cold start" issue and minimizing potential biases in recommendations [4]. The scope of this research is to develop comprehensive methods that address both issues at the same time and to develop an accurate recommendation system for university libraries in Sri Lanka.

Related Works

The development of recommendation systems has seen substantial advancements across various domains, including e-commerce, streaming services, and libraries [5], [6]. Traditional information retrieval techniques in the setting of libraries mostly relied on labor-intensive manual cataloging but the shift to digital libraries necessitated more advanced methods. Previous research has explored various types of recommendation systems, including collaborative filtering, content-based filtering, and hybrid models, each with its own strengths and limitations [7]. AI-powered recommendation systems enhance user engagement by offering personalized suggestions based on reading histories and preferences, continuously improving accuracy through machine learning. Despite these advancements, current library recommendation systems face challenges like privacy issues, cold-start problems, and biases [4]. This research aims to address these gaps by developing an advanced recommendation system tailored to library needs.

Methodology

The methodology involves development of a collaborative filtering model which provides recommendations based on the ratings given by the users for the books. The dataset for this study was collected from a repository on Kaggle and underwent comprehensive pre-processing. Initially, users who had rated more than 200 books were selected, followed by selecting books that had received 50 or more ratings. After filtering, duplicates were dropped to create a clean dataset and created the final dataset for further analysis. Initially,

developed the collaborative filtering model using three different algorithms: the K-Nearest Neighbours (KNN) algorithm, a deep learning-based neural network algorithm, and the Singular Value Decomposition (SVD) algorithm. Each of these algorithms was implemented and tested rigorously. Following their development, a thorough evaluation and comparison of their accuracy levels were conducted to determine the most effective algorithm for the collaborative filtering model [8].

Results and Discussion

The results showed that accuracy was calculated for different values of k in the KNN algorithm. The accuracy varied with different k values, and the optimal k value was found to be k=5, which provided the best balance between bias and variance.
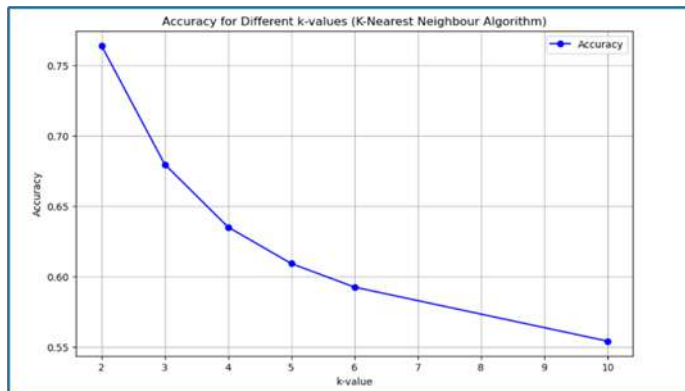
Figure 1: Accuracy of KNN algorithm for different k numbers.

For the neural network model, accuracy variation was computed by adjusting the number of epochs. By varying these values, observed how the model's learning process impacted its performance.

Table I: Metrics for Neural Network Model.

No of Epochs	Precision	Recall	F1-Score	Accuracy
10	0.246	0.357	0.291	0.570
20	0.520	0.373	0.434	0.676
50	0.683	0.370	0.479	0.759

The SVD algorithm initially showed very low accuracy, but after applying hyperparameter tuning, its performance improved, but it remained significantly lower compared to the other two algorithms.
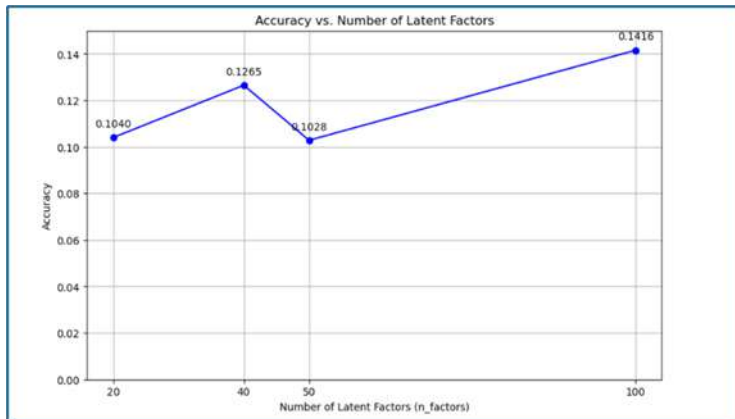
Figure 2: Accuracy of SVD algorithm for different n_factors

Table II: Metrics table for three algorithms

Algorithm	Precision	Recall	F1-Score	Accuracy
KNN (k=5)	0.359	1	0.528	0.609
SVD Algorithm	0.196	0.338	0.248	0.141
Neural Network	0.683	0.370	0.479	0.759

When comparing the three algorithms, it was evident that the KNN and neural network models outperformed the SVD algorithm in terms of accuracy and overall effectiveness. The variation in accuracy with different parameters (e.g., k values for KNN and number of epochs for the neural network) highlights the importance of tuning these models to achieve optimal performance.

Conclusion and Future work

The development of the collaborative filtering model has proven effective in enhancing the recommendation system. By leveraging user ratings for books, we implemented and evaluated three different algorithms. The KNN and neural network models demonstrated superior accuracy compared to the SVD algorithm. These results indicate that collaborative filtering can significantly improve the user experience in library systems. The accuracy of the recommendation system can be further increase by developing a content-based

model and integrating it with the existing collaborative filtering model to create a hybrid recommendation system. By implementing this hybrid model, we can obtain a significant improvement in the recommendation system's ability to cater to diverse user preferences, further optimizing the information retrieval process in university libraries.

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(#54) Sales Forecast Model for the Pharmaceutical Industry in Sri Lanka

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Abstract

This study examines the factors that affect the precise prediction of chemical and drug sales for a well-known pharmaceutical company in Sri Lanka. The article covers the theoretical framework, research design, methodology, data analysis methods, and evaluations. It deals with difficulties like the absence of structured prediction methods, insufficient acknowledgment of the significance of prediction, gaps in accountability in predicting demand, inconsistencies between sales data and real demand trends, ineffective communication among those involved in forecasting, and setting plans based on unachievable objectives. Finding these key elements is essential for enhancing the precision of demand prediction in the chemical and pharmaceutical sectors.

Keywords: Sales forecasting, pharmaceutical industry, predictive modeling, machine learning, inventory management

Introduction

This study examines the factors that affect the precise prediction of chemical and drug sales for a well-known pharmaceutical company in Sri Lanka. The article covers the theoretical framework, research design, methodology, data analysis methods, and evaluations. It deals with difficulties like the absence of structured prediction methods, insufficient acknowledgment of the significance of prediction, gaps in accountability in predicting demand, inconsistencies between sales data and real demand trends, ineffective communication among those involved in forecasting, and setting plans based on unachievable objectives. Finding these key elements is essential for enhancing the precision of demand prediction in the chemical and pharmaceutical sectors [1].

In the pharmaceutical industry, predicting sales is complicated due to various factors such as changes in regulations, evolving healthcare policies, and fluctuating market conditions. Precisely forecasting product demand is essential for maximizing inventory management, scheduling production, and

allocating resources effectively, as well as significantly influencing strategic decision-making and market positioning. Yet, conventional forecasting methods frequently fail to grasp the complexities of these diverse influences, requiring the utilization of more advanced analytical approaches and data-driven strategies [2].

Recently, the introduction of advanced technologies like artificial intelligence (AI) and big data analytics has transformed the area of sales prediction [3]. These technologies provide unique abilities to utilize large quantities of data from various sources such as sales data, demographic information, competitor insights, and economic trends. Through the utilization of AI-driven predictive models, pharmaceutical companies can access more detailed information regarding consumer behaviour, predict market trends more accurately, and adjust their strategies proactively to respond effectively to changing regulatory environments and competitive forces. This research explores the development and execution of a robust sales prediction model tailored for the pharmaceutical industry. The objective of the study is to integrate past sales data, regulatory perspectives, and market intelligence through sophisticated analytical methods to develop a comprehensive model for forecasting demand changes and enhancing resource distribution tactics. Showing through empirical validation and case studies how AI-driven forecasting techniques enhance operational efficiency and strategic planning can lead to progress in pharmaceutical sales analytics [4].

Methodology

This research utilizes a thorough approach that incorporates historical sales data, market demographics, economic indicators, and qualitative factors like regulatory changes and competitive analysis [5]. Machine learning techniques, such as time series analysis and regression models, are used to create accurate predictive models for forecasting future sales volumes [6]. The approach prioritizes checking the model's accuracy by using cross-validation methods and comparing it with actual sales data to guarantee reliability and strength.

Results and Discussion

The advanced sales forecast model shows major advancements in precision when compared to traditional methods. By adding demographic changes, policy shifts in healthcare, and analyzing the competitive landscape, the model gains a detailed understanding of market dynamics impacting pharmaceutical sales. The findings emphasize how the model can adjust to changing market

conditions and offer useful insights for stakeholders throughout the supply chain.

Conclusion

This study presents an advanced model to improve the ability to forecast sales in the pharmaceutical sector. By utilizing advanced analytics and merging various datasets, pharmaceutical companies can reduce risks, improve resource allocation, and take advantage of market opportunities. Ongoing improvement of forecasting models and adjustment to changing industry trends is crucial for staying competitive and strategically flexible in a fast-paced market.

Future Research Directions

Future research should explore how the accuracy of forecasting can be improved by integrating new technologies such as AI and big data analysis. Long-term studies can also investigate how pharmaceutical sales patterns are influenced by regulatory changes and global health trends over time. Addressing these areas will drive the field of sales forecasting forward and enable pharmaceutical companies to effectively manage future challenges with confidence.

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TECHNICAL SESSION 2

ENERGY, ELECTRICAL, AND POWER ENGINEERING

(#9) An Adaptive Control Algorithm for Electric Vehicles in A Micro-Grid Consists of Solar Photovoltaic, Battery Storage, and Grid Connectivity

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Abstract

This research proposes to modify the Particle Swarm Optimization (PSO) technique to make it compliant with the greatest power point of solar photovoltaic panels and increase its efficiency. The architecture including a boost converter will help increase the voltage of the batteries and raise overall efficiency. The proposed approach finds out the relation of connected loads with solar PV generation in a way to sustain maximized Photovoltaic (PV) efficiency. It extracts the most available power using Maximum Power Point Tracking (MPPT) and utilizes solar energy in periods of its availability at top priority. In this research study, a modified PSO will be used for MPPT in solar panels. The algorithm will be tested through experimental analysis and simulation. Performance metrics of prime interest are the efficiency of charging, the quantity of renewable energy consumed, and the availability of the system. It is shown that with the proposed modified PSO-based MPPT, an efficiency near 95% can be reached.

Keywords: *MPPT, optimization, solar photovoltaic, efficiency, particle swarm optimization*

Introduction

The rising demand for renewable energy has spurred advancements in solar photovoltaic (PV) technology. One crucial aspect of optimizing PV systems is Maximum Power Point Tracking (MPPT), which ensures that users can harness the maximum power from solar panels regardless of environmental changes [1]. During the review of the most used MPPT techniques, important disadvantages have been noticed: the convergence speed is quite slow, and big oscillations around the MPPT in cases where there is partial shade [2]. PSO is one of the nature-inspired metaheuristic algorithms, which has received a lot of attention in MPPT research, due to its simplicity and robustness. Even though PSO is an efficient and highly adaptable algorithm it still has its

drawbacks when it is needed for scenarios that need rapid changes, precise adaptation, and swift convergence [2], [3], [4], [5].

The research presented an innovative method that uses a customized particle swarm optimization (PSO) to obtain the maximum power point tracking (MPPT) in photovoltaic (PV) solar systems [6]. This customized PSO should be able to maximize the power production while minimizing the loss and improving the MPPT efficiency even when the environmental conditions change such as different temperatures or changes in brightness due to the sunlight availability. Moreover, there are changes in its mode of operation by integrating an adaptive control strategy as well as improved methods which make it more robust and resilient than before [7] [8] [9].

Methodology

The methodology used in this research deals with the development of a strong adaptive control algorithm for an electric vehicle in a microgrid. This will integrate seamlessly into each other, having critical stages which are solar photovoltaic, storage batteries, and grid connectivity. First, it collects data on solar radiation and temperature normally encountered at different times of the day. This information is used in the construction of a solar PV system model in MATLAB Simulink to study the power fluctuations in the PV output. In MATLAB Simulink, the MPPT (Maximum Power Tracking) block is designed to work with the extracted power fluctuating information to find the optimum duty cycle. The extracted duty cycle is fed through to a boost converter block connected to the battery system. The battery is also connected to a grid via a bidirectional inverter, which acts as a stable interface with the grid.

Results

It was clearly shown by the system simulations that the power output was stable for changing irradiance and temperature over the day. The MPPT system correctly determined the exact duty cycle corresponding to the maximum extracted power and was able to supply that to the boost converter. For an output power requirement of 10 kW, the boost converter efficiently doubled the input voltage of about 400V with great efficiency.

Conclusion

The results show that a PSO-based MPPT mechanism increases the efficiency of PV panels by a significant margin creating a combined maximum efficiency of 94.7%. Accordingly, the integration of the PSO algorithm into MPPT

controllers is a milestone in advancing solar PV technology by improving energy harvesting capabilities and manifesting a practical possibility of renewable energy. Further research in future works could therefore be oriented toward additional investigation and synergies between the algorithm and other emerging technologies.

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(#15) Voltage Sag and Swell Improvement in Sri Lankan Power System Adopting Superconducting Magnetic Energy Storage (SMES) Based Dynamic Voltage Restorer (DVR)

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Abstract

This paper explores the application of Superconducting Magnetic Energy Storage (SMES) based Dynamic Voltage Restorer (DVR) systems to improve voltage sag and swell issues in Sri Lanka's low voltage three-phase power system. Voltage sags and swells are critical power quality problems that can cause significant disruptions in both residential and industrial sectors. Voltage sags, often caused by short circuits, motor startups, or sudden increases in load, and voltage swells, typically resulting from abrupt load drops or capacitor bank switching, are common in industrial settings. The integration of SMES with DVR technology offers a promising solution by providing rapid and precise voltage correction. This study analyses the operation principle of the SMES-based DVR and designs the DVR output voltage control method using MATLAB SIMULINK [1]. Voltage sags and swells are detected using a power quality analyzer connected to the low-voltage three-phase power system. The collected data are used to simulate voltage sags and swells in MATLAB. The models of the SMES-based DVR are established, and simulation tests are performed to evaluate system performance. The results demonstrate significant improvements in voltage regulation, highlighting the feasibility and effectiveness of SMES-based DVR systems in enhancing power quality and reliability in Sri Lanka's low-voltage distribution network [2].

Keywords: MATLAB, SMES-DVR, Voltage Sag, Swell, Power Quality

Introduction

The Sri Lankan low-voltage (400V) power system faced significant challenges in maintaining power quality due to frequent voltage sags, and swells caused by natural disasters, aging infrastructure, and increasing demand. These issues result in substantial economic losses and affect electricity reliability, necessitating advanced solutions [3].

Superconducting magnetic energy storage (SMES) systems, known for their rapid response and high efficiency, offer a promising technology for enhancing power quality. When integrated with Dynamic Voltage Restorers (DVR), SMES systems can effectively mitigate voltage disturbances, improving power system stability and reliability. However, the application of SMES-based DVRs in Sri Lanka remains underexplored, creating a critical research gap [4]. This study aims to investigate the implementation of SMES-based DVRs for power quality improvement in Sri Lanka. It will evaluate the system's performance in mitigating voltage sags and swells and analyze its economic feasibility and benefits [5]. The study includes a detailed simulation of the SMES-DVR system in the low-voltage power system (400V) using MATLAB software, performance analysis under various disturbances, and an economic assessment. Limitations include potential performance variability and the need for empirical validation.

Methodology

This work employs a novel approach to investigating phenomena and practices using numerical algorithms to determine the causes and effects of voltage sag and swell in three-phase low-voltage power systems in Sri Lanka. These are the preferred methods for this study, as they help in precise measurement, analysis, and interpretation of numerical power quality concerns. The initial data collection method involves is made through capturing voltage levels using a power quality analyzer within the power system. The device records actual voltage information during an observing period, which highlights under voltages and over-voltages. Through measuring these disturbances, it is possible to establish a reference understanding of how often, long lasting periods and strength of variations occur from those baselines. Once the raw data is collected, then the next process is data analysis. The collected data is used for pattern and trend analysis, for instance, the frequency or circumstances when voltage sags or voltage swells prevail. The importance of this analysis is to provide insights into the causes of the above power quality problems and their effects, especially on electrical equipment and the systems.

To analyze this, the research uses MATLAB simulations in order to make an in-depth analysis of the issue possible. Using MATLAB, this sort of system can be described realistically with regards to these conditions. The last stage under the methodology is establishing and modeling an SMES-based DVR (Superconducting Magnetic Energy Storage). The SMES also tackle voltage sag and swell problems together with regulation of normal voltage for the

delicate equipment's within the power system. Hence, using data and ideas gathered earlier, this work develops a MATLAB model of the SMES-based DVR and evaluates its performance with an actual power system.

Data Collection and Analysis

The initial phase of this research involves the collection and analysis of data on voltage sags and swells from various substations and industrial units within the Sri Lankan low-voltage three-phase power system. A power quality analyzer will be deployed to record voltage disturbances over a specified period. Historical data from the past five years will be obtained from utility companies to identify patterns and the frequency of these events. Statistical analysis will be conducted to determine the most affected areas and the severity of voltage sags and swells [6].

System Design and Simulation

The design of the Superconducting Magnetic Energy Storage (SMES) based Dynamic Voltage Restorer (DVR) will be carried out using MATLAB/Simulink. The system design will include the SMES coil, power electronic converters, control systems, and voltage injection. The control strategy will focus on the rapid detection of voltage sags and swells and the immediate response of the DVR system to mitigate these disturbances [6].

Simulation Scenarios

Simulate the performance of the SMES-based DVR in mitigating voltage sags and swells under various operating conditions, such as:

- Different fault types (single-line-to-ground, three-phase, etc.)
- Varying load conditions (light load, heavy load, inductive/capacitive loads)

Assess the effectiveness of the SMES-based DVR in improving the voltage profile, power quality, and system stability during these disturbances.

Analyze the response time, reactive power injection/absorption capabilities, and overall performance of the SMES-based DVR in compensating for the voltage sags and swells [7].

Results and Discussions

The simulation results are expected to demonstrate the efficacy of the SMES-based DVR in improving the voltage profile and power quality of the three-phase low-voltage power system. The SMES-based DVR's rapid response and ability to inject or absorb reactive power are likely to significantly reduce the magnitude and duration of voltage sags and swells, thereby enhancing the overall system stability and reliability. According to the IEEE standard, voltage sag is typically considered when the voltage drops below 90% of the nominal voltage, and voltage swell is considered when the voltage rises up to 110% of the nominal voltage.

Voltage Sag Mitigation: Before the implementation of the SMES-based DVR, the system experienced voltage sags dropping to 75% of the nominal voltage for a duration of 0.5 seconds. With the SMES-based DVR in place, the voltage sag was mitigated to 92% of the nominal voltage, well within the acceptable range defined by the IEEE standard (below 90%) [6].

Voltage Swell Mitigation: Initially, the system exhibited voltage swells up to 115% of the nominal voltage for a duration of 0.3 seconds. Post-implementation, the SMES-based DVR successfully reduced the voltage swell to 108% of the nominal voltage, again adhering to the IEEE standard (up to 110%) [2]. Furthermore, the study will analyze the technical and economic feasibility of implementing SMES-based DVR technology in the Sri Lankan context. This will include an assessment of the capital and operational costs, as well as the potential benefits in terms of reduced equipment damage, production losses, and energy efficiency improvements.

Conclusion

The integration of SMES-based DVRs presents a promising solution for improving power quality in low-voltage three-phase power systems in Sri Lanka. The enhanced voltage regulation capabilities and rapid response times of the SMES-based system ensure better protection for industrial operations against voltage Sag and Swells. This research contributes to the existing body of knowledge by demonstrating the feasibility and effectiveness of advanced energy storage solutions in power quality management. Future research should focus on the economic analysis of large-scale deployment, potential impacts on grid stability, and the development of hybrid systems combining SMES with other renewable energy sources for sustainable power quality improvement.

Directions for Future Research

Future studies should aim to explore the scalability of SMES-based DVR systems for widespread applications. To validate the simulation results, the study will compare the performance of the proposed system with existing data and models from previous research. This will include reviewing case studies of SMES-DVR implementations in other regions and validating the MATLAB Simulink models against real-world scenarios. The goal is to ensure the accuracy and reliability of the simulation outcomes, and investigating the integration of SMES with renewable energy sources like solar and wind could provide sustainable and resilient solutions to power quality issues. This includes designing hybrid systems that can see excess renewable energy and use it to mitigate voltage disturbances.

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(#24) An AI-based Solar PV Power Generation Forecasting Model for Variable Sky Conditions and Critical Weather Parameters

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Abstract

The reliability and efficiency of solar PV power generation are heavily influenced by various weather conditions, which induce randomness, volatility, and intermittency in power output. Accurately forecasting solar power output is crucial for minimizing the impact of these fluctuations on the stability and operational efficiency of the power grid system. This not only aids in balanced grid operation and optimized dispatch but also significantly reduces operating costs. Given the growing interest in reducing the uncertainties associated with short-term solar PV power predictions, this study develops and evaluates an AI-based forecasting model tailored to these needs. Utilizing a comprehensive dataset collected from a rooftop solar installation in Kadawatha, Sri Lanka, which includes parameters like temperature, relative humidity, and global solar radiation, this research applies advanced machine learning techniques specifically artificial neural networks (ANN), Support Vector Machine (SVM) and gradient boosting. The models are trained to recognize and predict power output fluctuations under diverse weather scenarios, aiming to enhance forecasting accuracy. Initial results confirm the potential of AI models to significantly improve the predictability of solar power generation, thereby supporting more sustainable and efficient energy management practices.

Keywords: *solar PV power intermittency, power forecasting, grid integration, forecasting model, artificial intelligence techniques*

Introduction

Solar photovoltaic (PV) power generation has seen significant growth in recent years, favoured for its sustainability and low environmental impact. Despite its benefits, the accurate prediction of solar PV power output remains a substantial challenge, exacerbated by variable sky conditions and critical weather parameters. This research introduces a novel AI-based forecasting model designed to enhance the accuracy and reliability of solar PV power generation predictions. The novelty of the research lies in the full-scale

application and evaluation of modern machine learning techniques, in particular Artificial Neural Networks (ANN), Support Vector Machines (SVM), and Gradient Boosting Machines (GBM), in solar power forecasting under the specific climatic conditions of Sri Lanka. Utilizing these AI techniques, this model sets itself apart by its ability to precisely analyze and learn from historical PV generation data alongside meteorological variables. This novel approach offers a distinct improvement by providing more precise predictions compared to existing models, thus paving the way for more effective integration into power grid systems and enhancing operational decision-making [1], [2].

Methodology

The methodology involves utilizing a comprehensive dataset comprising historical PV power generation data and corresponding meteorological variables. Data collection is conducted from Samson Manufacturer Pvt Ltd, a rooftop solar PV power plant in Kadawatha with an installed capacity of 480 kWp. This dataset is enriched with historical PV power generation data paired with detailed meteorological variables sourced from reliable web resources. The primary weather parameters considered in this study include global horizontal irradiance, ambient temperature, cloud opacity, humidity, and direct normal irradiance. These parameters are pivotal in influencing solar power output and are therefore meticulously analyzed for their predictive significance. To ensure high data quality and consistency, the dataset undergoes several preprocessing steps. These include managing missing values, removing statistical outliers, and normalizing data values to ensure uniformity. During the feature engineering phase, exploratory data analysis and correlation analysis are utilized to pinpoint the most influential meteorological variables affecting PV power generation. This analytical process aids in selecting the most relevant features for the forecasting model, thereby enhancing the model's accuracy and reliability in predicting solar power generation under variable weather conditions.

The AI-based model captures intricate dependencies between weather parameters and solar PV power generation. Artificial Neural Networks (ANN) analyze nonlinear relationships, while Support Vector Machines and Gradient Boosting to optimize predictive performance. The model undergoes iterative training, validation, and testing to ensure accuracy and reliability. The process involves data division into training, validation, and testing sets, model training to learn the intricate relationships between weather parameters and PV power

outputs, and performance evaluation using Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and correlation coefficient to assess predictive accuracy [5], [6].

Results and Discussion

Evaluation of AI models demonstrates strong performance with lower Mean Squared Error (MSE) and higher correlation coefficients, confirming effective predictive accuracy [7], [8], [9]. In Table 1, ANN shows the lowest MSE at 0.126317 and RMSE at 0.355375, indicating the highest accuracy with the least deviation. SVM and GBM have slightly higher errors, but SVM has a marginally better correlation than GBM. All models exhibit high correlation coefficients, with ANN leading at 0.786651. Post-refinement results show robust adaptability to variable weather conditions, optimizing solar power forecasting. The research anticipates the AI-based model's effectiveness in overcoming traditional forecasting limitations and providing accurate predictions under variable sky conditions. Capturing the impact of cloud cover, atmospheric conditions, and other weather variables enhances forecast accuracy, benefiting stakeholders with better resource management, improved grid stability, and informed decision-making [10], [11]. Overall, the ANN model demonstrates superior performance, closely followed by SVM and GBM.

Table I: Performance Comparison AI Models

Model	MSE (Mean Squared Error)	MAE (Mean Absolute Error)	Root Mean Square Error (RMSE)	Correlation Coefficient
ANN	0.1263	0.203515	0.3554	0.786651
GBM	0.1646	0.238683	0.4057	0.717048
SVM	0.1401	0.20524	0.3742	0.761894

Future Work

The scope for enhancing this AI-based solar PV power forecasting model is extensive. Future studies could explore deploying this model across multiple geographic locations, which would allow for an assessment of its robustness and adaptability to different environmental conditions. Such expansion could

significantly validate the model's utility on a broader scale and facilitate more generalized applications in solar power forecasting.

Additionally, integrating real-time data and expanding the range of meteorological parameters considered could refine the model's predictions, making it more dynamic and responsive to immediate weather changes. Further enhancement of the model's performance can be achieved by fine-tuning hyperparameters and employing advanced validation techniques such as cross-validation and grid search.

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(#38) Enhance the Resilience of Islanding Microgrid Operation by Adopting Fuzzy Logic Controller-Based Battery Energy Storage System

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Abstract

Enhancing the resilience of microgrids involves implementing strategies and technologies that improve their robustness and reliability. Islanded microgrids, operating independently from the main utility grid, face significant challenges in maintaining a stable power supply, especially with the integration of intermittent renewable energy sources. This research proposes the implementation of a Fuzzy Logic Controller driven Battery Energy Storage System to enhance the resilience of such microgrids. By employing an advanced FLC, the study aims to dynamically adjust the operational modes of the microgrid based on real-time assessments of energy availability and demand. The methodology incorporates a Mixed Integer Linear Programming model to optimize the sizing and management of the BESS, facilitating improved energy distribution and reduced reliance on diesel generators. This approach is expected to enable more sustainable management of energy resources, significantly lower operational costs, and improve the environmental footprint of islanded microgrid systems. The integration of FLC with BESS represents a forward-thinking solution to the operational challenges faced by less infrastructure or independent energy systems, aiming to establish a more reliable, efficient, and adaptable energy management framework.

Keywords: *Microgrid Resilience, Battery Energy Storage System, Hybrid AC/DC Microgrid, Fuzzy Logic*

Introduction

Enhancing the resilience of microgrids involves implementing strategies and technologies that improve their robustness and reliability. Islanded microgrids, operating independently from the main utility grid, face significant challenges in maintaining a stable power supply, especially with the integration of intermittent renewable energy sources. This research focuses on enhancing the

resilience of microgrids through the adoption of a Fuzzy Logic Controller driven Battery Energy Storage System. The study proposes a novel control strategy that dynamically adjusts the operation modes of the microgrid based on real-time energy assessments, thereby optimizing the integration of RES and minimizing reliance on diesel generators. Existing literature on microgrid resilience is primarily discussed in terms of utilizing microgrids as a resilience resource [1] and algorithms for improving the resiliency of the microgrid itself are limited. These algorithms primarily focus on balancing the feeding of less critical loads with energy storage for future use [2],[3]. Typically, they prioritize supplying critical loads during disturbance events by operating microgrids in normal and resilient modes. In resilient mode, initiated by disturbance events, the algorithms emphasize continuous power supply to critical loads by categorizing loads into critical and non-critical [4]. The need for dynamic and adaptable control systems in response to real-time environments by better managing the variability of renewable sources and the capacity of energy storage systems has been underexplored. This study aims to fill these gaps by implementing a Fuzzy Logic-based energy management system. Focusing benefit of AC/DC hybrid microgrid is considered in this study is consist with wind turbines, PV, and BESS on the DC side and the Diesel Generator on the AC side. Islanded microgrids, many of which rely upon diesel generators for unexpected generation losses, encounter fuel limits and high operational costs. This work seeks to minimize diesel dependency through RES and BESS, defining high-penetration energy management strategies capable of countering generation discontinuity but maintaining a secure supply for critical periods in an extended time horizon.

Methodology

This system can make real-time decisions using a Fuzzy Logic Controller [5], and focuses on three modes, normal, resilience, and emergency. For proper operations for microgrid in resilient mode, use Mixed Integer Linear Programming for optimal sizing of BESSs [6], considering both the normal and event operation conditions while analyzing the critical minimum BESS energy for the transition from the normal condition to an unpredictable event situation. The proposed microgrid model can operate in normal, resilient, and emergency modes with the respective objective functions and scheduling horizons as Figure 1, according to the Fuzzy controller output.
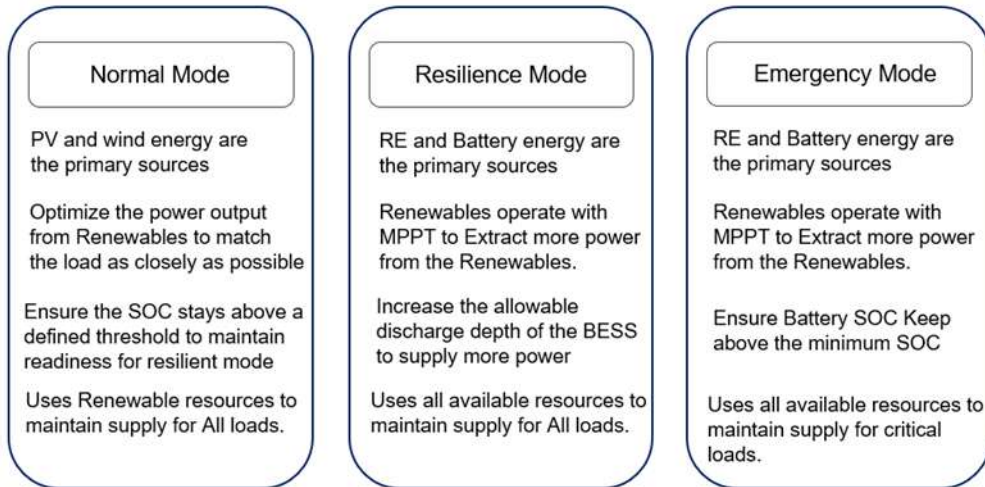
Figure 1: Three Operation Modes

BESS state-of-charge, Size of Disturbance, and Duration of Disturbance are taken as crisp input for the fuzzy logic controller. After assessing the membership levels of all three inputs decide the capable operation mode of the microgrid. The membership function of the fuzzy set is defined in Figure 2, and it uses a rule-based approach to derive fuzzy output.

	State of Charge	Disturbance size	Restoration Period
Low	Below 40%	Minimal impact	Less than 1 hour
Medium	40%-80%	Moderate impact	1 hour to 3 hours
High	Above 80%	Significant impact	More than 3 hours

Figure 2: Membership Levels for Fuzzy Logic

Results

The implementation of the FLC within the BESS demonstrated that there has been a significant enhancement of the operational robustness and reliability of the islanded microgrid during various generation loss scenarios. Through the strategic management of stored energy and the optimized integration of RES, the system minimized the use of diesel generators. In this study, three generation loss conditions were analyzed: 500 kW, 750 kW, and 1 MW, each occurring when the battery State of Charge SOC is at 50%. When a 500 kW loss occurs, the proposed system extends supply hours by 3.9375 hours compared to the conventional system. Under a 750 kW loss, it enhances supply

by 3.656 hours, and under a 1 MW loss, by 3.375 hours. Overall, the proposed system increases supply duration by 25% over the conventional system, demonstrating significant resilience improvements.

Discussion

The implementation of the Fuzzy Logic Controller within the Battery Energy Storage System has proven to be a highly effective strategy for enhancing the resilience of islanded microgrids. The innovative use of Mixed Integer Linear Programming for the sizing of BESS further ensures optimal energy storage, facilitating a continuous power supply even during unpredictable, extreme events.

These findings underscore the substantial operational advantages of the proposed system, which overall, increased the supply duration by 25% compared to the conventional approach. When sizing the battery in this study, only technical aspects were considered, without factoring in economic aspects. The system was created using 24-hour wind, irradiance, and demand profiles. To obtain accurate results, it is important to refer to more extensive profiles over longer periods and adjust parameters accordingly. This study only considers a single 24-hour scenario for practical implementation, a more accurate system would require a broader dataset and refined parameter adjustments.

Conclusions

This research significantly advances the field of microgrid resilience by demonstrating the effectiveness of a Fuzzy Logic-controlled BESS in enhancing the operational capabilities of islanded microgrids. Overall, the proposed system increased supply duration by 25%, demonstrating significant enhancements in microgrid resilience.

This kind of system proves to be a viable solution for areas frequently affected by grid interruptions, whether due to natural disasters, climatic changes, or the increasing occurrence of extreme weather events such as whirlwinds. The ability of the proposed system to maintain power supply despite losses in photovoltaic (PV) and wind energy generation demonstrates its resilience and adaptability under varying and challenging conditions.

Furthermore, by reducing reliance on diesel generators and optimizing the use of renewable energy sources, this approach supports sustainability goals while ensuring continuous power supply in critical situations. Future research will

focus on integrating more diverse energy sources, improving the scalability of the system, and exploring the potential of machine learning algorithms to further optimize the decision-making process further.

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(#47) Analysis of the Impact of Vehicle-To-Microgrid (V2MG) Technology on Island Mode Microgrid

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Abstract

With the innovation of V2G technology, it facilitates energy change in both directions between electric vehicles and conventional power grids. It aims to improve the efficiency, reliability, and sustainability of energy systems. There are benefits as well as challenges for smooth implementation and operation. So, this research focuses on addressing the challenges and assessing the technical feasibility of integrating V2G technology in island-mode microgrids using MATLAB simulations. Then, analyze the impact of V2G technology on the operational dynamics and stability of the island-mode microgrid. Island-mode microgrids are independent of the main power grid, and their electricity demand is fulfilled by the localized energy sources of the microgrid. The simulated city is powered by renewable sources, and EVs are used in critical situations. EVs store energy in batteries and supply it to the grid, as it enables bidirectional energy flow between EVs and the grid. Though traditional microgrids face challenges in balancing demand and supply, ensuring continued power supply while maintaining stable frequency and voltage levels, V2G technology offers a better solution for those challenges. The significance of the study is the technical feasibility of V2G technology in the simulated city. It consists of an island-mode microgrid of renewable energy sources with a battery management system to power up the city. By analyzing the impact of V2MG technology on island-mode microgrids, this research aims to depict the improvement in grid stability and reliability of microgrids compared to traditional microgrids. This study focuses on different conditions and scenarios of EV charging and discharging to supply power to the city and analyzes the impact of V2G technology.

Keywords: *V2G Technology, Island mode microgrid, renewable energy, bidirectional power flow, EV battery*

Introduction

With the innovation of V2G technology, it facilitates the energy change in both directions between electric vehicles and conventional power grids [1]. It aims to improve the efficiency, reliability, and sustainability of energy systems. There are benefits as well as challenges for smooth implementation and operation [2]. So, this research focuses on addressing the challenges and assessing the technical feasibility of integrating V2G technology in island-mode microgrids using MATLAB simulations. Then, analyze the impact of V2G technology on the operational dynamics and stability of the island-mode microgrid. Island-mode microgrids are independent of the main power grid, and their electricity demand is fulfilled by the localized energy sources of the microgrid [3].

The simulated city is powered by renewable sources, and EVs are used in critical situations. EVs store energy in batteries and supply it to the grid, as it enables bidirectional energy flow between EVs and the grid. Though traditional microgrids face challenges in balancing demand and supply, ensuring continued power supply while maintaining stable frequency and voltage levels, V2G technology offers a better solution for those challenges. The significance of the study is the technical feasibility of V2G technology in the simulated city. It consists of an island-mode microgrid of renewable energy sources with a battery management system to power up the city [4]. By analyzing the impact of V2MG technology on island-mode microgrids, this research aims to depict the improvement in grid stability and reliability of microgrids compared to traditional microgrids [5].

This study focuses on different conditions and scenarios of EV charging and discharging to supply power to the city and analyzes the impact of V2G technology.

Methodology

In its methodology, it outlines the technical feasibility and impacts of integrating V2MG technology into island-mode microgrids [6]. A simulation model is developed using MATLAB software to represent the components and dynamics of a V2G-enabled island-mode microgrid system. The model incorporates electric vehicles, charging infrastructure, renewable energy sources, and energy storage systems [5]. While considering grid stability, energy efficiency, and other key performances, optimize the model to

maximize the benefits of V2MG integration in microgrid operation. Finally, validate the simulation models and make a feasibility comparison with the V2G microgrid simulation.

Results

The scope of the research encompasses a broader range of factors influencing the performance of V2G technology integrated into a simulated island-mode microgrid [7]. This includes the technical feasibility of the V2G technology integration with Island mode microgrid, implementing and validating MATLAB simulations to analyse the impact of V2G on Island mode microgrid performance under different operating conditions and proposing optimized control strategies and operational frameworks for effective utilization of V2G technology within Island mode microgrid systems [8].

By studying different scenarios like change the no. of vehicle charging and discharging power to the system [5], the system aims to understand the capabilities and limitations of V2G technology integration in island-mode microgrid systems.

Discussion

It highlights the role of simulation in explaining the dynamic interaction between V2G-enabled electric vehicles and microgrid components, providing valuable perspectives for future research to develop resilient and sustainable microgrid systems [9]. In this simulation model, though it provides the valuable information for analyse the impact on island mode microgrid by V2G system, it also has some limitations. It may not capture all uncertainties. It may not cover all possible operating conditions and various scenarios.

Conclusion

In conclusion, this research aims to provide a detailed analysis of the impact of V2MG technology on island-mode microgrids, focusing on the feasibility of enhancing grid stability, reduce generation costs, and improve the reliability of the system. With the use of MATLAB simulation, this research finds how V2G technology can be integrated into island-mode microgrids effectively and promote sustainable energy solutions [9].

Directions for future research

Future research should focus on large-scale pilot projects and real-world data to determine the impact of V2G integration. With advances in battery technology and smart grid systems, it is critical to investigate consumer behaviour patterns and tariff structures that promote V2G integration. In addition, new perspectives should be explored to further improve V2G adoption and efficiency. This comprehensive approach will help uncover the potential benefits and challenges of V2G integration in modern energy systems.

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(#55) Dynamic Peak Load Management with Vehicle-to-Grid Technology

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Abstract

The rapid increase in electricity demand has led to innovative peak demand control processes, notably Vehicle-to-Grid (V2G) technology. V2G enables electric vehicles (EVs) to both draw power from and release stored energy back to the grid, making EVs mobile energy storage units. Traditional peak load management strategies are insufficient for modern energy demands, requiring comprehensive methodologies for effective dynamic peak load management using EVs in island mode microgrids. Integrating renewable energy sources enhances grid stability and sustainability. V2G technology's bidirectional power exchange allows EVs to balance demand and supply while supporting grid stability. This research focuses on maximizing efficiency, managing peak load demand, and improving grid stability with V2G technology, transforming EVs into energy management assets. By using EV batteries to meet peak demand, reduce fossil fuel-based power plant expenses, and lower generation costs, the study aims to optimize energy utilization and island-mode microgrid stability in a simulated city under various conditions.

Keywords: *Vehicle-to- Micro Grid (V2MG) technology, Electrical vehicles (EVs), dynamic peak load management, renewable energy integration, grid infrastructure*

Introduction

The rapid increase in electricity demand has led to innovative peak demand control processes, notably Vehicle-to-Grid (V2G) technology. V2G enables electric vehicles (EVs) to both draw power from and release stored energy back to the grid, making EVs mobile energy storage units [1]. Traditional peak load management strategies such as time of use pricing [2], load shaping methods [3], and curtailment programs [4] are insufficient for modern energy demands, requiring comprehensive methodologies for effective dynamic peak load management using EVs in island mode microgrids. Integrating renewable energy sources with electrical vehicles having V2G technology enhances grid

flexibility [5] and power quality [6]. V2G technology's bidirectional power exchange allows EVs to balance demand and supply while supporting grid stability. This research focuses on maximizing efficiency, managing peak load demand, and improving grid stability with V2G technology, transforming EVs into energy management assets. By using EV batteries to meet peak demand, reduce fossil fuel-based power plant expenses, and lower generation costs, the study aims to optimize energy utilization and island-mode microgrid stability in a simulated city under various conditions.

Methodology

The methodology adopted in this research included both simulation and algorithms. Data Collection had been done on demand in the microgrid and supply of energy from the renewable energy sources. In addition, EV usage patterns were monitored to collect data on the state of charge (SOC), availability of EVs, charging and discharging patterns of EVs, and driving schedules. The Load profiles were taken from the CEBcare website. Then, the values were scaled down for the analysis Identification of the microgrid components such as renewable energy sources (solar, wind), energy storage systems (batteries), and electric vehicles (EVs) equipped with V2G technology had been important. Next, a centralized control system had been developed for monitoring and managing energy flow within the microgrid [7]. Then, optimization algorithms had been developed to dynamically manage the charging and discharging cycles of EVs. The goal of this research had been to shift the EV charging during the off-peak periods and discharge stored energy during peak periods to manage the dynamic load. In the implementation, control strategies were used for dynamic peak load management to prioritize critical loads such as hospitals and supply energy stably during peak demand periods. Robust communication protocols had been established between the control system, EVs, and other renewable systems of the microgrid for seamless data exchange and coordination. Simulation models were created to test the effectiveness of the developed algorithms and control strategies under various scenarios in a controlled environment to validate the performance of the system and make the necessary adjustments. The performance of the microgrid, such as energy efficiency, cost savings, and system reliability, had been tested and analysed with the collected data to evaluate the effectiveness of the dynamic peak load management system. Next, the results had been

compared with baseline scenarios without V2G technology. By using data analysis, simulation, and algorithm formation, the research had targeted finding better solutions for integrating more renewable energy sources and implementing V2G technology for dynamic peak load management.

Results

The main focus of this research had been to effectively implement the dynamic peak load management with V2G technology within the simulated city context to install grid stability and maximize renewable energy utilization [5]. The result of the research included load shifting, energy efficiency, cost saving, system reliability, and behavioural changes in the EV owners. It had paved the way to a sustainable energy solution for dynamic peak load demand for simulated city by integrating V2G technology [8] into the island mode microgrid. The regulatory and economic challenges had limited the V2G technology integration to the island mode microgrid. As well, it had been impossible to conduct all real-world operating conditions and scenarios such as changes in the peak load duration and the peak load value in a simulated city to identify the productiveness of V2G technology.

Discussion

The information collected from the research indicate that the integration of V2G technology microgrid can manage the peak load effectively [9]. This system encourages the renewable energy future and reduces the carbon footprint. However, the findings identify some limitations of this project as regulatory support, advanced grid management system, and consumer support to promote V2G integration. The EV usage in dynamic peak load management is economical and sustainable instead of expensive infrastructure.

Conclusion

This research shows that V2G technology integration has a big impact on the dynamic peak load management. Due to the bidirectional flow of energy of the EVs, it can be flexible to supply power to the grid when needed. Then it enhances the grid stability and promotes renewable energy sources integration into the system. However, the study demonstrates both the capabilities and the challenges of V2G integration in island mode microgrid.

Directions for future research

Future research should focus on large-scale pilot projects as well as real-world data to find out the V2G integration impact. Studying consumer behaviour patterns, tariff structures that promote V2G integration, advancement in battery technology, and smart grid systems are also new perspectives to focus on in this research.

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TECHNICAL SESSION 3

MECHATRONICS AND CONTROL ENGINEERING

(#8) Headgear for Impact Monitoring and Location Detection

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Abstract

Head trauma is a major health concern worldwide, resulting in death or permanent disability. 1.7 to 3.8 million traumatic brain injuries are reported in the United States every year [1]. 10% of these injuries occur during sports and recreational activities. This poses a significant risk factor to solo travelers and extreme sports enthusiasts, who are more likely to be in remote locations with reduced access to healthcare. Timely medical intervention can prevent the escalation of secondary complications, which could potentially lead to more severe neurological deficits and life-threatening conditions. This research presents an innovative choice of headgear, which precisely pinpoints the area of impact facilitating the efficient administration of first aid, prior to thorough examination through advanced medical equipment. This ensures reactive safety whilst minimizing interference with proactive safety headgear.

Keywords: impact detection, head impact, sport injury, head trauma

Methodology

A comprehensive evaluation was performed in selecting the most suitable mechanism for impact detection and subsequent data processing. According to research conducted on head impact incidents associated with football players [2], there is a higher probability of impact to the front and the back of the head. Hence, to guarantee the wearer's safety, the design was created to cover the entire scalp. Based on the findings, the most comfortable safety headwear is in the form of a band, which does not cover every touch point on the scalp. The optimum solution was selected as a beanie, which provides total coverage of the scalp for impact monitoring. As the design calls for a fabric material, T-PEPS (Textile Piezoelectric Pressure Sensor) [3] based on ZnO nanorods array for wearable application was selected as the sensor of choice. In addition to the above requirements, ZnO nanorod arrays have the ability to detect a pressure up to 2.25kPa, with a sensitivity of 0.62V/kPa, covering the

minimum pressure level(85g) with the potential to cause a brain concussion. In addition to the above method, another mechanism for impact detection would be utilized with the help of an MV60 accelerometer to provide an enhanced detection capability. Its rugged design which can withstand up to 5000g's of shock offers precision and superior reliability, whilst further increasing the accuracy of impact detection, setting this design a notch above the rest of the impact monitoring solutions in the market.

Since this is a wearable headgear, the device should be upgradable to integrate new features that further enable emergency responders to provide timely medical treatment, such as impact magnitude analysis and identification of possible injuries that may occur as a consequence. STM32 microcontroller was shortlisted based on these requirements. Furthermore, its features such as high performance, low power consumption, efficiency and flexibility makes it an ideal solution for medical purposes of this sort. In addition to this, a built-in GPS module SIM808 will be incorporated into the headgear to identify and pinpoint the exact coordinates of the user to make it easy to reach out and provide necessary attention if needed while making the system more compact to favor the desired features of wearable devices. To identify the injured person's position in an emergency, based on the conceptual design, the headgear would facilitate the connection of removable LED strips.

To optimize the device uptime, priority was given to lower power consumption when choosing the above given components. Moreover, the compactness of the elements was also favored to reduce the weight and bulkiness and improve non-interference from the device with daily tasks.

Results and Discussion

The beanie design was modeled using SOLIDWORKS.

Figure 1: Headgear Design View 1   Figure 2: Headgear Design View 2

To check the functionality of impact detection, simulations were carried out in the MATLAB Simulink environment with a Raspberry Pi development kit instead of STM32 based on the availability of resources [4]. The tests were carried out with respect to a known force to check if the desired output was achieved. With this, the anticipated LED output and the function of IOT incorporation were successfully given.
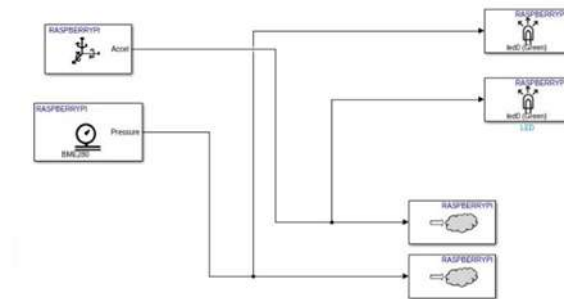

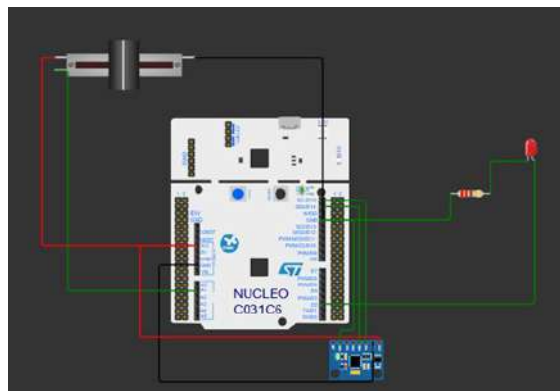Figure 3: Impact Detection Block Diagram

Figure 4: Simulation on Wokwi

Directions for Future Research

The headgear thus developed has the ability to detect any mechanical impact on the wearer. The detection capabilities could be increased by integrating multi-sensor fusion techniques. This would improve the accuracy of impact detection and provide further insights into its magnitude as well. IoT integration of the system, whilst utilizing a machine learning model for real-time impact classification and severity measurement, would further enhance the device. This would also enable storing a history of impact-related data, which would be useful in analyzing motions resulting in injury. This data would be helpful to arrive at preventive strategies and improve the overall performance of sportsmen. The long-term effects of repetitive impacts could also be evaluated through an enhanced version of this device, and protective measures too could be integrated into it.

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(#32) Review: Real-Time Drivable Area Detection Using LiDAR Camera Fusion for Autonomous Vehicles

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Abstract

Autonomous driving technology has advanced significantly in recent years, increasing how vehicles perceive and traverse complicated settings. Lane identification is critical for self-driving cars to understand their surroundings, as is recognizing drivable areas for safe road planning and collision avoidance. This research study looks at how merging YOLOv8s (You Only Look Once version 8) with LiDAR and video data can increase autonomous vehicle identification skills. We will examine the methodologies, results, and future directions in this sector to better grasp the present advancements and obstacles. Our research has multiple key objectives. First, we collect data by correctly locating sensors and cameras. Using this data, we next create a model for detecting drivable areas and test it under various scenarios. We next train the model to accurately differentiate between drivable and non-drivable zones. Finally, we test, validate, and deploy the drivable area detection system to guarantee it performs well in real-world circumstances. These measures aim to increase autonomous cars' safety and efficiency by increasing their ability to sense their surroundings.

Keywords: *autonomous vehicles, drivable area detection, sensor fusion, real-time processing, multi-task model*

Introduction

Autonomous driving technology has advanced significantly in recent years, increasing how vehicles perceive and traverse complicated settings. Lane identification is critical for self-driving cars to understand their surroundings, as is recognizing drivable areas for safe road planning and collision avoidance. This research study looks at how merging YOLOv8s (You Only Look Once version 8) with LiDAR and video data can increase autonomous vehicle identification skills [1]. We will examine the methodologies, results, and

future directions in this sector to better grasp the present advancements and obstacles.

Research has multiple key objectives. Collect data by correctly locating sensors and cameras. Using this data, next, create a model for detecting drivable areas and test it under various scenarios [2], [3]. Next train the model to accurately differentiate between drivable and non-drivable zones. Finally, the drivable area detection system is tested, validated, and deployed for good results in real-world conditions.

Methodology

A full literature review comprising LiDAR–camera fusion real-time detection of a drivable area is presented, focusing on sensor fusion approaches, data processing techniques, and deep learning models. This review is conducted to consider several approaches associated with the integration of LiDAR and camera data towards the development of real-time detection of a drivable area, with particular emphasis to the results of the sensor calibration for good alignment of LiDAR point clouds with camera images.

It is observed that the KITTI dataset is one of the most crucial datasets for training and testing how the models respond to a variety of driving scenarios [4], [5], [6]. This includes analyzing various techniques of data augmentation and model tuning regarding their effects on the YOLOv8s model's performance [1], [7]. It further presents training procedures, data augmentation, and model tuning enabling an improvement in accuracy and reliability of detection while addressing trade-offs with respect to accuracy and computational efficiency crucial for real-time detection mechanisms in autonomous driving. The main goal is to overview and introduce the state-of-the-art research that has been done on sensor fusion and to indicate directions for further work.

Results and Discussion

This paper focuses on a real-time drivable zone detection system using LiDAR and camera data from the KITTI dataset. Sensor data from both units was pre-processed and then concatenated into a unique representation, which was then converted to RGB format, effectively merging depth information obtained from LiDAR with visual details obtained from the camera [2], [3], [8]. This

fused RGB data is what the YOLOv8 model used in drivable area detection, constituting strengths from both sensors and increasing the accuracy and reliability of this approach.

Finally, state-of-the-art evaluation metrics such as precision, recall, F1-score, intersection over union (IoU), mean average precision (mAP), and false positive rate (FPR) were used to be able to assess system performance over different driving conditions [5], [6]. Results showed that LiDAR and camera data integrated after being processed by YOLOv8 highly improved detection performance under hard conditions, such as low lighting or partial occlusions. Spatial accuracy was guaranteed with high IoU and mAP scores, while a low FPR showed the system's ability to minimize false detections. Therefore, these results back up the efficacy of the proposed method for real-world applications of autonomous vehicles by showcasing the potential of this method to improve drivable zone detection [4].

Future Works

Future research will have to be directed towards improving sensor robustness in bad weather and refining techniques of sensor fusion for further improving the accuracy of detection. There is a need to search through into the integration of multi-task learning models, which can handle multiple perception tasks lane detection, object recognition, and drivable area identification simultaneously. Extensive testing in the real world will be required to validate such advancements to ensure the robustness of systems across many different scenarios. Collaborative efforts from research and industry could then drive innovation, leading to practical adoption in commercial autonomous vehicles.

Conclusion

In this research, the fusion of LiDAR and camera sensors with deep learning models such as YOLOv8s will provide a strong approach to enhance the detection of a driveable area for an autonomous vehicle. Although methodologies currently under operation seem promising, continuous further research is required to eliminate existing hurdles and make system performance better. The future challenge for sensor technology within the automotive sector is expected in further development, together with fusion techniques, to navigate through complicated environments with assured safety and efficiency.

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(#37) Path Planning for Resource-Constrained Autonomous Vehicles in a University Environment

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Abstract

This study explores the implementation of path-planning algorithms in resource-constrained autonomous vehicles within a university environment, specifically NSBM Green University. Unlike most studies that assume abundant resources, this research focuses on cost-effective solutions suitable for environments with limited financial and computational capabilities. The methodology involved an extensive review and analysis of existing path-planning algorithms and localization methods, followed by simulations using MATLAB. The selected algorithm, Hybrid A*, was optimized to balance computational efficiency, path accuracy, path length, and obstacle avoidance. The results confirmed that reliable autonomous navigation is achievable even under resource constraints. Future work will involve creating a more detailed map of the university and testing more complex algorithms to further enhance the robustness of the path planning system. Additionally, the optimized algorithm could be tested in real-world scenarios to validate its practical feasibility for autonomous navigation.

Keywords: Autonomous Vehicles, Path Planning Algorithms, Localization, Resource-Constrained, University Environment

Introduction

Autonomous vehicles are very common in modern society and promise to transform transportation into safer, more efficient, and more accessible mobility solutions. One of the critical facets of AV technology is path planning, which assures safe and efficient navigation of the vehicle in a complex environment. Path planning ensures that a vehicle moves from a starting point to a target or destination while avoiding obstacles in the way and following all traffic rules. The problem researched in this paper is how to efficiently and reliably navigate an AV with financial and computational

resource constraints. This research is important because most other studies assume abundant resources; this one, however, focuses on cost-effective solutions designed to be implemented in resource-constrained environments. This means the AVs in question lack the capacity to use high-cost sensors like LiDAR's and do not have access to proper testing environments and advanced processing components needed for heavy computational tasks. The research focuses on finding an appropriate localization technique, then on selecting a path planning algorithm which will be optimized and implemented in a university environment, with a specific emphasis on NSBM Green University. The selected algorithm is carefully chosen to balance computational efficiency, path accuracy, path length, and obstacle avoidance. Results also show that reliable autonomous navigation can be attained even in such resource-constrained conditions by carefully choosing and optimizing the path planning algorithms and the localization methods [1], [2].

Methodology

The methodology for the research primarily entailed an extensive review and analysis of existing path planning algorithms and localization methods that would best fit in environments like NSBM Green University. The data collection process involved extracting information from existing literature on path planning algorithms and localization methods, with a focus on papers from trusted sources such as the IEEE Xplore Digital Library. After identifying and selecting the most relevant algorithms, simulations were done using the MATLAB software. The simulations were conducted using the algorithms available in the MATLAB robotics toolbox on a binary occupancy grid map of the NSBM Green University. This map was processed from real-world road map data and then converted into a binary occupancy grid map. Next, the best fitting path planning algorithm was selected from these results and was then optimized to get better results for our use case scenario. Optimizations are supposed to increase the computational efficiency and accuracy of the algorithm in handling navigation through the university environment. The final implementation was evaluated based on its ability to handle dynamic and static obstacles, ensuring that the algorithm met the necessary criteria for reliable autonomous navigation within the university setting.

Discussion and Results

The analysis process of the localization methods led to an informed choice of a fusion of GPS and IMU as the best technology to be used for the purpose of the research given the resource constraints [3]. The analysis process done for the path planning algorithm resulted in the choosing of 5 algorithms RRT, RRT*, Bi-RRT, Planner PRM, and Hybrid A* [4]. A benchmarking process then evaluated the path planning capabilities of the algorithms on the university road map using standard benchmarking criteria commonly found in path planning literature, such as path validity, smoothness, clearance, path length, and execution/initialization times. The results obtained in accordance with these criteria are shown in Figures 1,2,3,4 and 5. These results indicate that the hybrid A* algorithm was by far the best path-planning algorithm in terms of smoothness, clearance, and path length. After the hybrid A* algorithm was chosen and optimized we managed to get an outcome that was smoother and better in almost all criteria as shown in Figures 6 and 7.
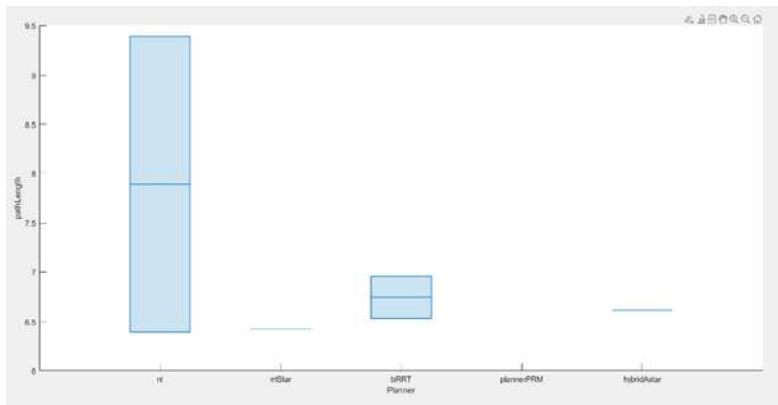

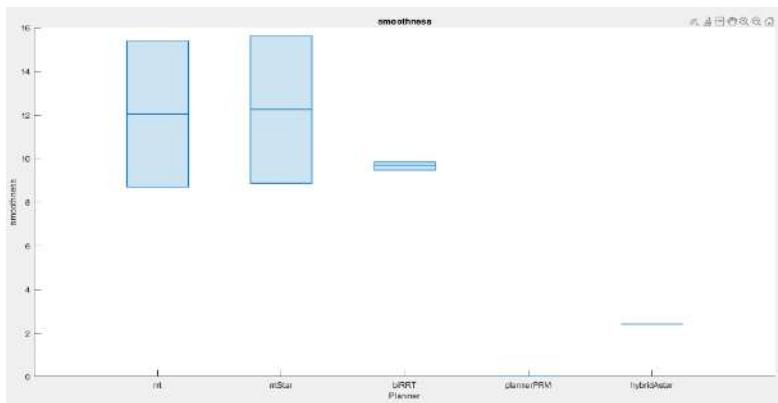Figure 1: Comparison of Maximum Path Length

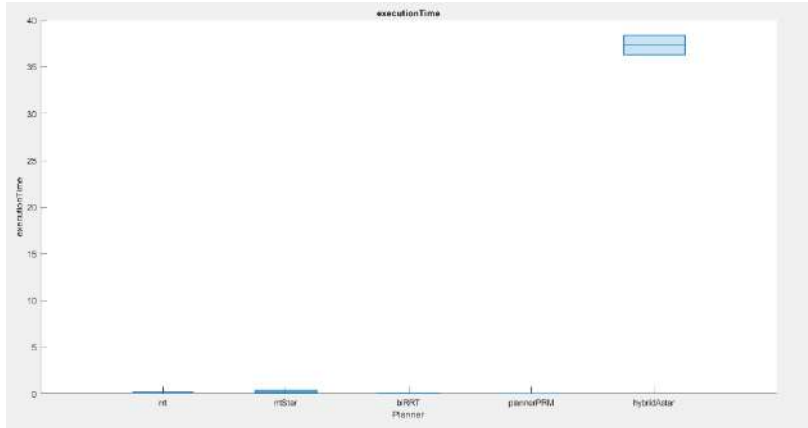Figure 5: Comparison of Path Smoothness

Figure 6: Comparison of Execution Times
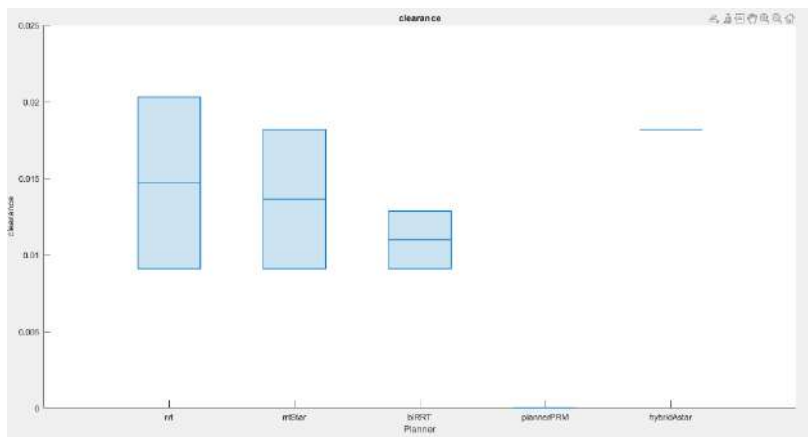
Figure 7: Comparison of Clearance
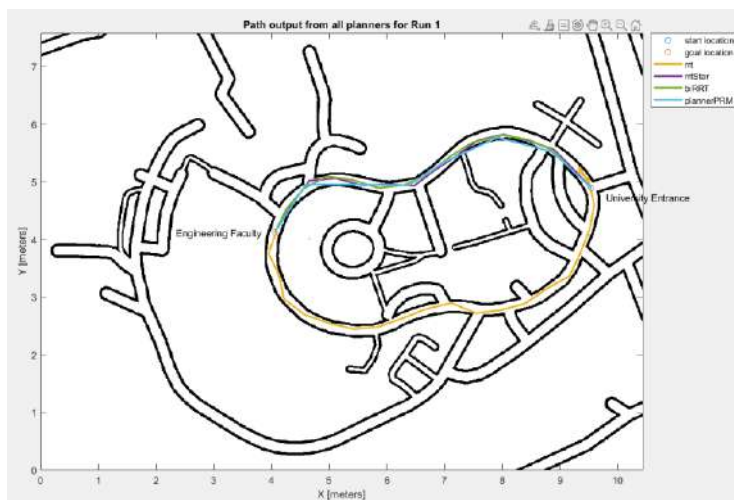
Figure 8: Visualization of Path Planning Algorithms
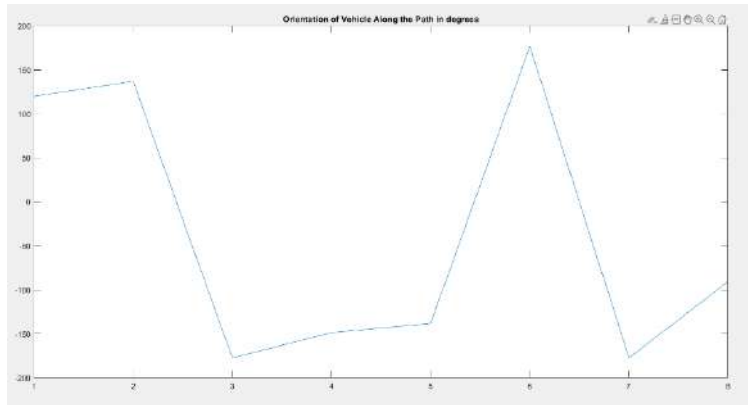
Figure 9: Orientation Data of Hybrid A* Before Optimization
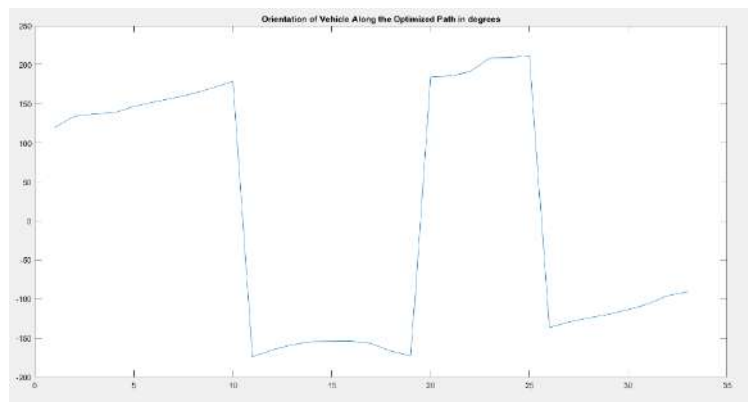
Figure 10: Orientation Data for Hybrid A* After Optimization

Conclusion and Future Work

This work proved the feasibility of cost-effective path-planning algorithms and localization methods for resource-constrained autonomous vehicles in a university environment. Only after extensive analysis, simulation, and optimization was the Hybrid A* algorithm exposed to be the best solution concerning computational efficiency, path accuracy, and obstacle avoidance. The results confirm that even with limited resources, reliable autonomous navigation can be realized. For future work, the development of a more detailed map of the university environment is recommended, allowing for the testing and deployment of more complex and robust path-planning algorithms, thereby enhancing the overall effectiveness and applicability of the research. Testing the optimized algorithm in real-life scenarios will also be beneficial so

that it validates its performance and establishes its practical feasibility for autonomous navigation in resource-constrained settings.

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(#40) In-Situ Pipeline Inspection with A Soft Robotic Manipulator Using PneuNet and SMA Springs

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Abstract

Soft robotics has emerged as a trending field recently due to the traditional rigid robotics failure in their applications requiring flexibility and adaptability in constrained environments. One of the crucial parameters that defines a soft robot is its material and the redundant degrees of freedom. The use of soft materials allows for continuous deformation which in turn, enables structures with ranges of motion limited only by the properties of the material [1]. Such materials that are used for the fabrication of the soft manipulators are Silicone Rubber, Elastomers (PDMS), SMAs, Thermoplastic Elastomers, etc. Among the applications that require flexibility one significant scenario is the inspection of pipelines in water sprinkler systems, which often involves navigating through pipelines with diameters as narrow as 4-8 inches. This research aims to design and analyse a soft robotic manipulator specifically for in-situ operations within these confined spaces. The manipulator incorporates a Shape Memory Alloy (SMA) spring, actuated by voltage, and a pneumatically actuated PneuNet structure to facilitate precise and flexible movements. The main focus of this research is on detailing the design process of the manipulator and highlighting the customization of the SMA spring. The manufacturability and material selection for the PneuNet structure are also discussed, alongside simulations are also performed using Abaqus CAE to ensure the validity of the manipulator design.

Keywords: *soft robotics, bio-inspirations, confined space, continuum robots, manipulators*

Introduction

Soft robotics has emerged as a trending field since recently due the traditional rigid robotics failed in their applications requiring flexibility and adaptability in constrained environments. One of the crucial parameters that defines a soft robot is its material and the redundant degrees of freedom. The use of soft

materials allows for continuous deformation which in turn, enables structures with ranges of motion limited only by the properties of the material [1]. Such material that are used for the fabrication of the soft manipulators are Silicone Rubber, Elastomers (PDMS), SMAs, Thermoplastic Elastomers, etc. Among the applications which require flexibility one significant scenario is the inspection of pipelines in water sprinkler systems, which often involves navigating through pipelines with diameters as narrow as 4-8 inches. These inspections are mostly done as in-situ inspections where the system is isolated and then the pipelines are cut through from the welding seems to check for the damages. This research aims to design and analyse a soft robotic manipulator specifically for in-situ operations within these confined spaces. The manipulator incorporates a Shape Memory Alloy (SMA) spring, actuated by voltage, and a pneumatically actuated PneuNet structure to facilitate precise and flexible movements. The manipulator designed thus would be able to extend lengthwise utilizing the SMA spring properties and then bent to inspect the inside of the pipeline using the pneumatic bending rib. The main focus of this research is on detailing the design process of the manipulator and highlighting the customization of the SMA spring. The manufacturability and material selection for the PneuNet structure are also discussed, alongside simulations are also performed using Abaqus CAE to ensure the validity of the manipulator design. The novelty of this research is though the Pneumatic rib incorporated manipulators are extensively explored this scientific study incorporates two basic actuation principles Shape Memory Alloy and Pneunets which are still nearly unexplored, in the same design for a successful operation of the manipulator.

Methodology

The design inspiration for the manipulator comes from the tentacle of a jellyfish, which is bendable at the end for precise operations. The design process began by selecting Nitinol (NiTi) for the spring due to its superior shape memory properties and its widespread acceptance in the industry. The initial and most crucial step involved determining the operating state of the SMA coil, as the phase transition of SMA significantly impacts the design calculations; 100% Austenite state or 100% Martensite state. A summary of the designing process of the SMA spring is carried out as explained in [2]. The design process of the SMA spring involved obtaining properties like shear

modulus in both austenite and martensite states, maximum residual stress, and critical stresses. The desired maximum shear stresses were then obtained for both states so that the values are not too close to the marginal stresses as the second step. These values were considered for 100% martensitic and 100% austenitic states as constant loading condition and constant deflection condition where in this research we considered both cases in the calculations. As the third step some of the calculation parameters were preselected and they were the initial pitch angle to be 0º and the coil index to be 9. And thus, all the other parameters were calculated accordingly and reselected for industry manufacturable standards. The final pitch angle and the maximum stroke was calculated as the next step and finally, the no. of active coils and the total number of coils were calculated. After verifying manufacturability, the process was finalized.

The next step involved designing the PneuNet structure, consisting of 10 units of two different sizes with hollow chambers to facilitate air passage. This structure was simulated using Keyence AR G1L, Reynolds Ecoflex 00-10, and Ninjaflex, chosen for their flexibility and manufacturability.It should also be specified that according to [3] the softness of the material for soft robotics cannot be described with the classical concept of modulus of elasticity except it must be considered a primary finding when selecting a material and must have a Young's modulus of greater than 100Pa for structural support, controlled deformation and to be compatible with traditional manufacturing processes. Also, the tangent modulus of the material must be less than 1000 MPa to offer greater flexibility and the strain capacity to undergo deformation must be within the range of 10% to 100%. The PneuNet structure is attached to the SMA spring via a custom-designed holder, enabling it to reach and inspect local points within the pipeline effectively. The components were designed in SOLIDWORKS and assembled, with each part validated through simulations in Abaqus CAE.

Simulation and Results

The following Table 1 depicts the results obtained through the mathematical modeling of the Shape Memory Alloy coil spring (SMA spring). This spring is a tension spring which is a very compact spring and will actuate lengthwise only when given a tensile force.

Table I: SMA numerical data

		Martensite	Austenite
G	Shear Modulus	8×10^9 Pa	25×10^9 Pa
d	Wire diameter	0.75mm	0.75mm
α_i	Initial pitch angle	0º	0º
D	Spring diameter	6.75mm	6.75mm
n_a	Active no. of coils	21	21
N_t	Total no. of coils	23	23
F_R	Required force	2.45N	2.45N
v	Poisson's ratio	0.33	0.33
δ_{max}	Maximum stroke	8.16mm	8.16mm
D_m	Mean diameter	6mm	6mm
α_f	Final pitch angle	1.07º	0.02º
C	Coil index	9	9
$\varepsilon_{s\tau}$	Detwinning martensitic factor	1	1

To confirm the reliability and effectiveness of the design, simulations were conducted using Abaqus CAE. The simulations involved setting up appropriate boundary conditions and parameters to mimic the operation of the manipulator under different loading conditions.

PneuNet simulations involve the bending of the actuator under gravity while having one end of the rib fixed under Encastre boundary condition as shown in Figure 1. The spring was simulated for tension under loads. The primary focus was on the mechanical behaviour of the spring and the simulation results provided critical insights into the performance of both the components guiding necessary adjustments such as the wire diameter of the spring, diameter of the wire, and parameters of the PneuNet such as the length and the chamber occupancy.
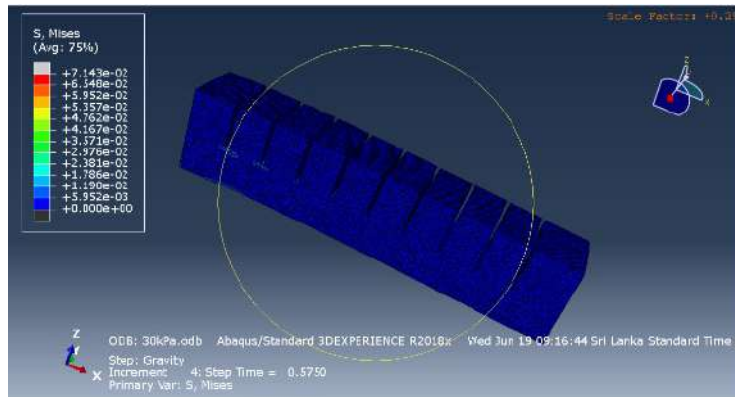
Figure 11: PneuNet structure simulation bending under 30kPa pressure
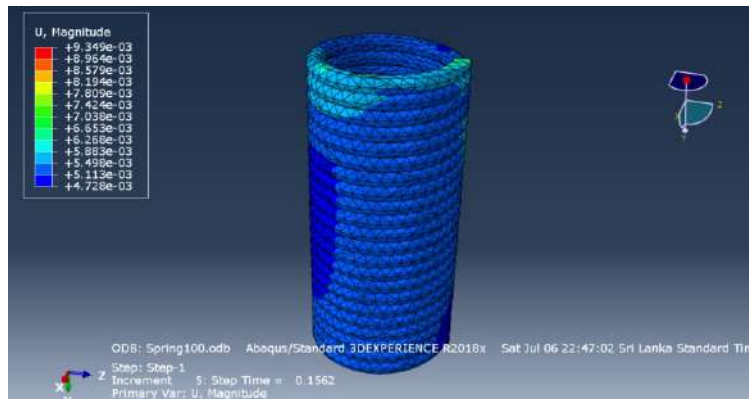
Figure 12: SMA Spring under 100N load

Discussion

The design process of the soft robotic manipulator highlights the importance of material selection and parametric decision-making for precise actuation of the SMA spring and the PneuNet structure. While the manipulator components met most of the expectations to be feasible to employ it in a confined space of a pipeline further research should be carried out to simulate the complete manipulator via a suitable simulation tool and to explore alternative materials to address the limitations.

Conclusion

This research was focused on designing a soft robotic manipulator for in-situ operations within pipelines of water sprinkler systems; integrating an SMA spring and PneuNet structure for effective movements. The simulations

performed in Abaqus CAE provided insights into the design and limitations that must be addressed. Future work will explore further enhancements to the manipulator's performance and broader the application of the manipulator.

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(#51) Review: Obstacle Detection and Localization in an Autonomous Vehicle

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Abstract

This paper analyses the revolutionary impact of artificial intelligence (AI) technologies on the fast-changing landscape of vehicle automation within the automobile industry. AI software for automobiles is expected to generate USD 6.6 billion by 2025, fuelling a revolutionary transformation, particularly in the realm of autonomous driving systems. Object detection, a cornerstone of self-driving vehicles, is examined through the lenses of two-stage and single-stage approaches, stressing its vital role in allowing vehicles to observe and classify their surroundings. The analysis goes deeply into the complexities of obstacle avoidance, emphasizing its critical role in real-time path planning and assuring human and vehicle safety. Object localization, a critical component of this process, requires precise distance determination and justified coordinates to overcome obstacles given by changing environmental conditions. Current research highlights the dominance of deep learning algorithms, with the YOLO approach and several R-CNN variations taking the lead in object identification and avoidance systems. The problems of sensor integration are examined, with a focus on cameras and LIDARs, which are judged appropriate for 3D modeling. The review also addresses sensor position issues and provides an ideal solution that uses cameras for object recognition and LIDARs for depth perception. The literature study continues by identifying relevant studies with approaches that are closely matched with the suggested methodology, underlining the importance of continuous research to accelerate developments in autonomous driving capabilities.

Keywords: autonomous vehicles, object detection, deep learning, lidar, sensor fusion

Introduction

Autonomous Vehicles (AVs), which once seemed futuristic, are now a practical reality prepared to transform transportation. With a focus on improving safety, lowering labor costs, and providing mobility solutions, AVs

use sensing, perception, decision-making, and control as essential elements. Efficient object detection algorithms are critical, replicating the human visual system and allowing computers to navigate without specialized sensors. The Society of Automotive Engineers defines these categories as totally manual (level 0) through fully autonomous (level 5). Self-driving vehicles integrate observed data from cameras and sensors to simulate human behavior in obstacle avoidance, resulting in a full environment model for informed decision-making.

In relevance to the current state of research conducted, the objective of this review is to find an efficient and accurate method for accurately identifying and tracking objects. I hope to provide a detailed overview of current solutions, from intricate sensor integration to cameras and LIDARs. This in-depth review of current methodologies illustrates advantages and disadvantages which will give me an understanding of current system architecture and help me formulate a solution to advance how object detection and tracking can be developed.

Methodology

This review systematically examines the use of Deep Learning for Obstacle detection in an Autonomous Vehicle. We searched peer-reviewed articles from IEEE Xplore, PubMed, and Google Scholar, focusing on studies published between 2010 and 2024. Our search used keywords such as "Object Detection," "Deep Learning," "Sensor Fusion," and "Obstacle Avoidance" guided our search.

Obstacle avoidance is a basic tool for local path planning and an enabling technology for ensuring the safety of humans and vehicles. Decades of research have been conducted into the study of this subject, leading to the design of numerous methods, some of which have been used in real applications. At this regard, the system must be able to computationally identify what the object is, whether it's a person or vehicle, and identify how far the object is relative to the vehicle.

Current research was studied to identify the current progress in object detection systems. Sensor fusion is a new concept in obstacle detection systems and is being tested and implemented, one such was the KITTI vehicle [1], which is a benchmark dataset for sensor fusion systems. Sensor fusion was

studied starting with recent surveys and review papers [2] [3] giving the basic idea of where the research should focus on to conclude with the research gap. With the process of screening using inclusion and exclusion criteria relevant papers were selected [4].

Discussion

Current object detection systems often struggle with accurately identifying objects in diverse and complex environments due to limitations in individual sensor technologies [5]. Monocular image-based sensing can lack depth information [6], while LIDAR provides accurate depth but can miss finer details in the object's texture and colour [7]. This is where sensor fusion becomes crucial. By integrating multiple sensor types, such as combining LIDAR with cameras, systems can leverage the strengths of each sensor, leading to more robust and reliable object detection and identification. Sensor fusion enhances the overall accuracy, efficiency, and situational awareness of the system, making it better suited to handle real-world variability and challenges [8].

The best approach for the integration of sensors would be to use a camera for object identification through deep learning and use a subordinate sensor such as LIDAR for the depth perception of the system [2]. This integration could also allow us to reduce the training time of the deep learning model by merging the inputs and outputs [9]. This library with the datasets of completed research would also support my development of the system [10]. The research gap identified is to run the pre-processed data through a fusion pipeline, a model to concatenate the lidar and camera data. Use the output of that data as an input for a pre-trained model to run the detection of the obstacle.
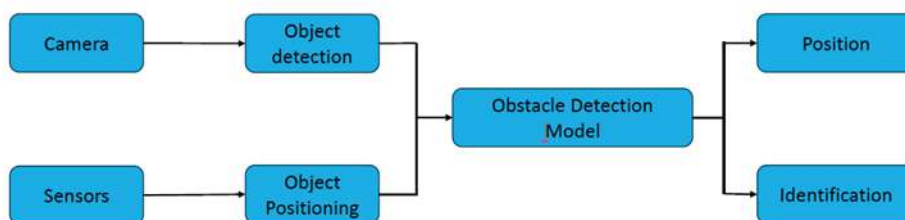

Figure 1: Basic Breakdown of System

Conclusion & Future Research

In conclusion, this review highlights the significant potential of sensor fusion in addressing the limitations of traditional object detection systems. Sensor fusion techniques offer promising solutions to improve accuracy, reliability, and efficiency in object detection and identification operations. Our systematic review of recent advancements reveals a growing trend toward integrating multiple sensor types, such as LIDAR, cameras, and point cloud sensors, to enhance detection capabilities and reduce error rates.

Future work dives into developing a real-time solution integrating the system. Additionally, exploring the integration of advanced AI models such as single-stage detectors (YOLO, Retinanet) and deep learning techniques to improve the efficiency and quality of the sensor fusion and LIDAR data processing. By continuing to advance the application of sensor fusion and using different techniques to improve the object detection model [11], we can achieve more accurate, reliable, and efficient detection strategies that can be implemented in the real environment to detect, process, and output data in real time.

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(#52) Development of A Durable Cutting Technology for Enhanced Efficiency in Textile Manufacturing

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Abstract

This study focuses on the development of durable cutting technology to improve efficiency in textile manufacturing, specifically for cutting thin fabric straps like shoulder straps for female undergarments. The research aims to design a cutting blade and mechanism actuated by a pneumatic actuator and controlled by an HMI-based system. It addresses the need for a durable cutting edge and proposes a method to model and design an effective cutting process. The study involves examining the mechanical properties of fabrics, frictional coefficients, and cutting mechanisms. It also explores the selection of actuation techniques and control systems, including the development of a ladder program to operate the mechanism. The methodology includes designing the blade using parametric curves, calculating cutting forces, and determining the wedge angle and blade thickness. Simulations ensure the blade's strength meets the requirements for cutting force. The research identifies factors affecting cutting tool effectiveness, such as wedge angle, curvature of the edge, and blade thickness, which influence the cutting force needed for different fabric piles. The study contributes a solution that can be applied in the textile industry for productive and cost-effective cutting strategies.

Keywords: *Fabric, blade, parametric, pneumatic*

Introduction

The research is based on developing technology for fabric cutting. The technology is based on cutting edge and a mechanism. The study is based on designing a cutting blade along with a cutting mechanism which the blade can be driven and actuating the mechanism using a pneumatic actuator and designing an HMI-based control system to control the cutting mechanism. The study mainly focuses on the cutting geometry and the cutting mechanism. Overall design concepts that are brought through this study can be applied in the textile industry to productive and cost-effective cutting strategies. This

study mainly focuses on cutting thin fabric straps mainly shoulder straps of female undergarments which are single-pile clothing. The force required for the shearing of these fabrics is much less.

The research gap identified in this study is developing a durable cutting-edge technology to minimize the drawbacks of existing cutting methods, proposing a suitable method to model the cutting edge using parametric curves, and designing the system to ensure an effective cutting process. This research provides a better solution for the industry.

The novelty of this research is that the design of the blade starts with mathematical curves called parametric curves. The cutting edge of the blade is modeled and designed using mathematical curves. The cutting mechanism is designed to drive the blade, and the controlling strategies are designed to suit the cutting mechanism. Providing overall cutting solutions to the industry.

Several fields should be studied before this study, Some of them are the mechanical properties of fabrics [1], [2], frictional coefficient of the fabrics[3], [4]. Fabric cutting mechanisms and important parameters. Selecting a proper actuation technique for the cutting mechanism and selecting a suitable HMI and a PLC for the control process. The study also focused on developing a ladder program to drive the mechanism.

Methodology

The first approach of this study is to study the parametric curves and model an effective curvature. Several parametric curves have been studied and factors affecting the cutting tool effectiveness have been studied. The major parametric curves that have been used are based on mathematical curves. The blade design is the first step of this study. As mentioned earlier parametric curves are used for modeling the curved edge. Then after that the cutting forces are calculated after the wedge angle and the blade thickness are calculated. Fabric is most likely considered as a soft solid. So, suitable wedge angle degrees are used for experimental designs [5]. After designing the blade, the next step is to design the cutting mechanism. The cutting mechanism is designed to drive the cutting blade smoothly and deliver the required shear force to make a clean cut in the fabric. The mechanism is actuated by a pneumatic actuator which is a spring returned single acting cylinder. The reason for using pneumatics in this aspect is it can deliver a higher force within a short period of time. After the CAD model the necessary simulations for the blade were done to ensure its strength characteristics were met to withstand

the cutting force [6], [7]. For this SolidWorks simulation tool is used along with Ansys software. The blade was modeled using its finite element model [8]then after that the simulations were carried out to make sure the blade met its strength requirement. After the simulation stage the next step is to design the pneumatic system [9], [10]. The pneumatic system is composed of a two-by-three directional valve which is solenoid-operated. And a spring-retuned pneumatic piston. The pneumatic system was designed using Festo fluid Sim software. The piston drives with a 10mm stroke. Control system development will be done [11], [12].

Results

There are number of parametric curves that can be used to model the cutting edge among then several parametric curves are used to design the blades and do the simulations. Some met the required strength characteristics, and some did not. The effect of the curvature and the nature of the sharp edge can be studied separately. The result of the overall system's performance is to be analyzed. Factors affecting the cutting tool are the wedge angle and the curvature of the edge. The blade thickness is also an important parameter thickness when it comes to the cutting force. When the thickness is higher the blade can undergo higher cutting forces. If the thickness is reduced, the cutting force it can withstand is lower. Another important factor in the cutting edge is the wedge angle. Higher wedge angles are used for large cloth piles while smaller wedge angles are used for small cloth piles. Ultrasonic cutting is an existing cutting technology that has several drawbacks of tool wear and cutting defects the blade is frequently replaced because of impacts and cracks of the horn. And the cutting performance is less because when the crack of the horn develops with time the fabric is more likely to get struck between that crack and less likely to be cut efficiently. Overall, 5 parametric curve designs are used for the study. The ecliptic-based parametric curve gives a good result of strength characteristics. Further tests and studies should be carried out to determine what is the best elliptic curve variation. Advanced technologies are required for further optimization of the design. The outcomes that come from this study is beneficial for many industries.

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(#57) Enhanced Object Localization via Neural Network Integration with Newton's Method

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Abstract

Machine vision is crucial in autonomous vehicles and robotics, demanding precise object localization and environmental perception. Enhancing the baseline between cameras can improve accuracy and range but introduces challenges in stereo synchronization. This research presents a novel system that integrates neural networks with Newton's method to enhance object localization accuracy while reducing computational costs. Utilizing three cameras with known baselines, the system combines Convolutional Neural Network (CNN) models, such as YOLO, for critical component identification, with Newton's method for refining initial location estimates provided by machine learning algorithms. This integration ensures high accuracy by double-checking neural network outputs with mathematical models, avoiding local minima, and enhancing computational efficiency. Experimental results demonstrated successful camera calibration, accurate object detection, and significant improvements in point estimation accuracy using Newton's method. This approach promises advancements in 3D reconstruction and real-time object localization for autonomous systems.

Keywords: Multiview Stereo (MVS), Stereo Matching, Object Localization, Newtonian Solvers

Introduction

Machine vision plays a crucial role in autonomous vehicles and robotics, where precise object localization and environmental perception are vital. Increasing the baseline between cameras can enhance the accuracy and range of these systems [2], but it also introduces challenges related to stereo synchronization due to mechanical constraints. While modern research often relies on machine learning-based estimates [1], [3], [4], these approaches may lack the precision required in certain high-accuracy scenarios.

This research seeks to enhance accuracy without escalating computational costs. The proposed system employs three cameras with a

known baseline and integrates algebraic equations for localization with Newton's method to solve these equations. A neural network is used to generate the initial guesses required for Newton's solver. This approach continuously re-evaluates the output of the machine learning algorithm against the mathematical model, yielding significantly more accurate results. The neural network plays a critical role in avoiding local minima, while the Newtonian solver improves accuracy with minimal computational overhead. Additionally, the mathematical solver employed here has broad applicability to various complex mathematical challenges.

Related Work

Recent advancements in MVS include MVSNet, which uses deep learning to predict depth maps from multiple views, enhancing accuracy and efficiency [1]. AA-RMVSNet further improves this with adaptive aggregation and refinement strategies, achieving state-of-the-art 3D reconstruction [3]. Additionally, using a CNN model like YOLO for key component identification before stereo matching improves accuracy and reduces computational costs [4]. Employing CNNs early in the process enhances overall accuracy and workflow efficiency [5]. A neural network for computing Cartesian coordinates simplifies complex calculations and reduces computational load [6].

Method

As illustrated in Figure 1, the process begins by saving the feeds from all three cameras simultaneously to eliminate artifacts caused by time delays. Next, the cameras are calibrated using their intrinsic properties to remove lens distortions and warping effects. For critical component analysis, a Convolutional Neural Network (CNN) model, such as YOLO, is employed to identify essential objects in the images, such as vehicles, humans, and obstacles.
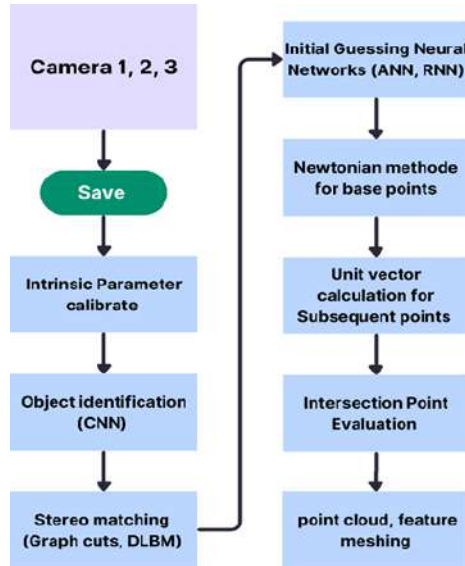
Figure 1: Flow chart

Once these critical components are identified, stereo matching is performed to determine stereo correspondence. Points on these critical components with high confidence in stereo matching are designated as base points (A, B, C). The angular disparity between these base points is then calculated, providing essential data for initial location estimates, which are generated using a machine learning algorithm such as an Artificial Neural Network (ANN) or a Recurrent Neural Network (RNN). To enhance the accuracy of these initial estimates, a Newtonian method is subsequently applied. After refinement, the mathematical model is applied specifically to the evaluation of the base points, as they carry the most critical information, with other points being assessed relative to these base points.

Subsequent points (P_p) are evaluated relative to the base points by calculating unit vectors relative to camera coordinates (O_i) using the angular disparity between the base points and the subsequent points (AO_iP_p). These unit vectors are then used to determine intersection points, thereby creating a point cloud. Finally, a mesh algorithm is applied to the point cloud to reduce noise in the measurements and improve the overall data quality.

To train the neural network for initial guessing, start by creating a virtual environment in a 3D Cartesian space, ensuring the workspace is sufficiently large to accommodate the X, Y, and Z range, which defines the system's field of range. This virtual workspace is then divided into X_R, Y_R, and Z_R segments, forming a point cloud, where the resolution ($X_R * Y_R * Z_R$) can

be adjusted based on application requirements. Cameras are placed outside the point cloud, and angular disparities are calculated from 4 or more randomly selected points to each camera location. For the training process, camera locations and angular disparity data are fed to the neural network as input, while the Cartesian coordinates of the selected points are provided as output.

Results

The intrinsic camera calibration process was successfully completed, demonstrating a high level of accuracy in removing lens distortions and warping effects. Critical object identification using the YOLO CNN model was also achieved, enabling the system to accurately detect and classify various objects such as cars, buses, humans, and animals with high precision.

$$\theta, \beta, \Upsilon = Mesured\ angles\ using\ camera\ view\ (AOB, AOC, BOC)$$

$$A, B, C = Initial\ guess\ for\ the\ base\ points$$

$$O_i = Camera\ location$$

$$AO_i = (X_{O_i} - X_A, \quad Y_{O_i} - Y_A, \quad Z_{O_i} - Z_A)$$

$$BO_i = (X_{O_i} - X_B, \quad Y_{O_i} - Y_B, \quad Z_{O_i} - Z_B)$$

$$AO_i = (X_{O_i} - X_C, \quad Y_{O_i} - Y_C, \quad Z_{O_i} - Z_C)$$

$$i = Selected\ camera\ [\,1, 2, 3\,]$$

$$0 = \theta - \arccos\left(\frac{AO_i \cdot BO_i}{|AO_i| \times |BO_i|}\right)$$

$$0 = \beta - \arccos\left(\frac{AO_i \cdot CO_i}{|AO_i| \times |CO_i|}\right)$$

$$0 = \Upsilon - \arccos\left(\frac{BO_i \cdot CO_i}{|BO_i| \times |CO_i|}\right)$$

Figure 2: Equations for solver

The Newtonian method, developed using the SciPy library, was rigorously tested and found to significantly improve the accuracy of point estimations, falling well within acceptable error margins. The equations for the Newton's method are provided in Figure 2. The procedures for calculating unit vectors and evaluating intersection points were successfully implemented and rigorously tested within a Python environment. These equations detail the specific calculations used for determining unit vectors as shown in Figure 3.

$$P_p = \begin{pmatrix} Pix_1 & Pix_2 & \cdots & Pix_n \\ Piy_1 & Piy_2 & \cdots & Piy_n \\ Piz_1 & Piz_2 & \cdots & Piz_n \end{pmatrix} = \begin{pmatrix} A_{xi} & A_{Yi} & A_{zi} \\ B_{xi} & B_{Yi} & B_{zi} \\ C_{xi} & C_{Yi} & C_{zi} \end{pmatrix}^{-1} \cdot \begin{pmatrix} \cos(AO_iP_1) & \cos(AO_iP_2) & \cdots & \cos(AO_iP_n) \\ \cos(BO_iP_1) & \cos(BO_iP_2) & \cdots & \cos(BO_iP_n) \\ \cos(CO_iP_1) & \cos(CO_iP_2) & \cdots & \cos(CO_iP_n) \end{pmatrix}$$

$$P_p = Subsequent\ points, P \in [1, 2 \ldots\ldots n]$$

$$Pix_n = Unit\ vector\ of\ point\ P_n\ seen\ from\ O_i - X\ component$$

$$A_{xi} = Unit\ vector\ of\ point\ A\ seen\ from\ O_i - X\ component$$

$$AO_iP_n = Angle\ between\ AO_i\ and\ P_nO_i$$

Figure 3: Unit vector calculation

The virtual point cloud has been generated as shown in Figure 4 with a 120-degree field of view and a range extending to 250 times the baseline between the cameras. Within this region, 100,000 points have been uniformly distributed. From this point cloud, four points are randomly selected and processed by another algorithm as shown in figure 05 to evaluate the angles between them (AOiB, AOiC, AOiD, BOiC, BOiD, COiD). These are four base points and 18 relative angles between them (with each image frame generating six angles across three frames). The resulting data, comprising 25,000 data points generated from the above-mentioned method, is then stored in a file for use in the neural network training process.
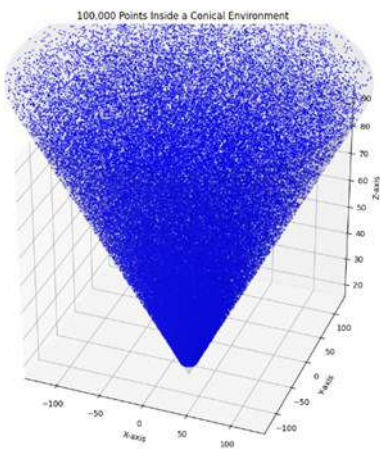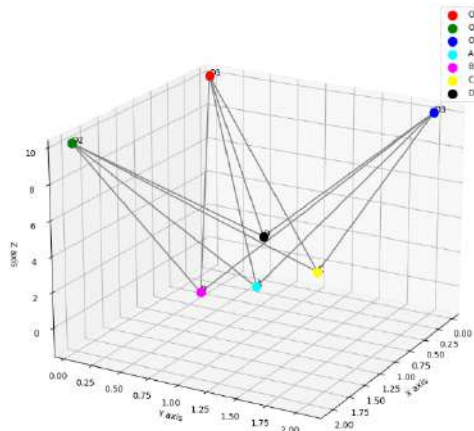

Figure 4: virtual point cloud   Figure 5: virtual point cloud

Both RNN and ANN neural networks have been developed and rigorously tested. However, despite thorough evaluation, the LSTM neural network is demonstrating the highest learning potential, even though it is currently experiencing significant underfitting, as demonstrated in Figure 6.
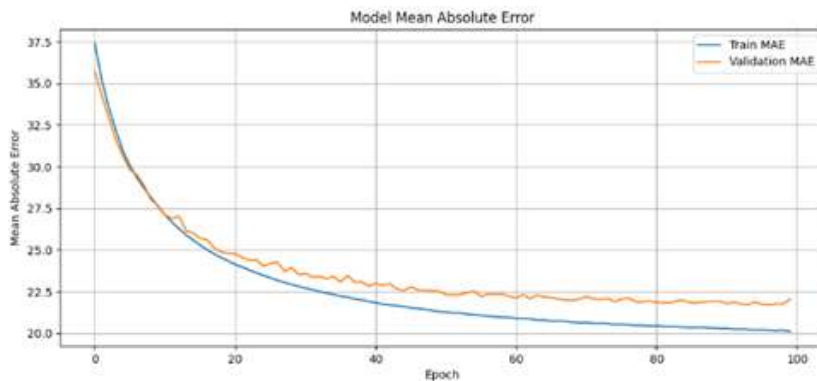
Figure 6: LSTM - Mean Absolute Error

Future Work

Future work will focus on several key areas to enhance system accuracy without increasing computational costs. This includes testing various stereo meshing algorithms and refining them to reduce noise and improve data extraction. Additionally, the initial guessing neural network will undergo further evaluation, with different architectures being tested to determine the optimal accuracy. Keras Tuner and hyperparameter tuning will also be incorporated into the system to fine-tune the neural network for better performance. Exploring the implementation of a feed-forward algorithm is suggested. Since the CNN algorithm identifies critical components, it can also be used for algorithm optimization. Implementing a feed-forward loop could create a more intelligent system capable of adapting to different environments, thereby optimizing performance for each specific scenario.

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TECHNICAL SESSION 4

CIVIL ENGINEERING, DESIGN, AND QUANTITY SURVEYING

(#1) Evaluating Construction Cost Impacts of Building Parameters Using Artificial Neural Networks

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Abstract

The accurate estimation of construction costs is a critical, yet complex task influenced by numerous variables. Traditional methods often fail to provide reliable early-stage cost estimates, leading to budget overruns and project delays. This research addresses this gap by focusing on identifying and ranking the most significant factors affecting the construction costs of residential buildings with less than four stories. Specifically, the study leverages Artificial Neural Networks (ANN) to enhance the accuracy of cost predictions by considering multiple building parameters. This approach is aimed at improving budgeting processes and resource allocation in the construction industry.

Keywords: *Artificial Neural Networks (ANN), Building Parameters, Cost Estimation, Construction Costs*

Introduction

The accurate estimation of construction costs is a critical, yet complex task influenced by numerous variables [1]. Traditional methods often fail to provide reliable early-stage cost estimates, leading to budget overruns and project delays [2]. This research addresses this gap by focusing on identifying and ranking the most significant factors affecting the construction costs of residential buildings with less than four stories. Specifically, the study leverages Artificial Neural Networks (ANN) to enhance the accuracy of cost predictions by considering multiple building parameters. This approach is aimed at improving budgeting processes and resource allocation in the construction industry. Consequently, the scope of the research is narrowed down to investigating the impact of building parameters on construction cost using Artificial Neural Networks, with a particular focus on low-rise residential buildings in Sri Lanka.

Methodology

Initially, a comprehensive literature review was conducted to identify 21 factors and 24 building parameters that significantly influence construction costs. To validate these findings, a quantitative approach was adopted, with survey and case study serving as the two main strategies for further proceedings. A structured questionnaire was distributed to 32 construction professionals, aiming to pinpoint the most critical factors and parameters specific to low-rise residential buildings. The survey responses were analyzed to select the input variables for the ANN models. Subsequently, twelve case studies of low-rise residential building projects from the Sri Lankan construction industry were selected to train the cost prediction models. These case studies provided real-world data, ensuring the models' accuracy and relevance. The parameters chosen for each building element served as independent variables in the ANN models, influencing the construction cost predictions.

Findings and Discussion

The ANN model demonstrated its effectiveness in predicting the construction costs of building elements, emphasizing the significance of specific inputs. The research identified ten factors as highly significant in influencing construction costs, including Gross Internal Floor Area (GIFA), the number of floors, height between floors, and external wall area. Additionally, nine other factors were categorized as significant, further refining the cost estimation process. The findings revealed that ANN-based models could provide more accurate cost predictions compared to traditional estimation methods. The model's ability to process multiple parameters and consider their combined effects resulted in enhanced prediction accuracy and reliability. This highlights the potential of ANN in revolutionizing cost estimation practices in the construction industry.

Conclusion

This study underscores the efficacy of Artificial Neural Networks in predicting construction costs based on various building parameters. By offering a more precise and reliable estimation method, the research contributes to the improvement of budgeting processes in construction projects. The ability to accurately predict costs at the early stages of a project can significantly impact its successful completion within budget constraints. The study also emphasizes the importance of considering specific building parameters in cost

estimation models. The identified significant factors and parameters can serve as a foundation for further research and development of advanced cost prediction models. Ultimately, the integration of ANN into construction cost estimation practices can lead to more efficient resource allocation and project management, benefiting the construction industry as a whole.

Directions for Further Research

Below are a few ways this research could be further developed.

- Expanding the research context by incorporating additional factors or parameters along with more detailed project information.
- Extending the study to cover various types of buildings as well as civil engineering projects.
- Currently, this study evaluates the cost implications for 12 main building elements. Further research could include additional elements, if applicable.

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(#14) The Impact of Green Building Interior Design, with a Focus on "Look and Feel," on Employee Satisfaction-In LEED Certified Office Buildings in Sri Lanka

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Abstract

This study investigates the impact of green building interior design, focusing on "look and feel," on employee satisfaction. Utilizing a mixed-methods approach, data were collected from 210 employees through surveys and semi-structured interviews with key stakeholders at MAS Thurulie, a LEED Platinum-certified building in Sri Lanka. Quantitative analysis via SPSS revealed significant correlations between design elements and satisfaction. Qualitative thematic analysis underscored the importance of ergonomic, aesthetic, and natural elements in enhancing well-being. Findings suggest that thoughtful interior design in green buildings significantly boosts employee satisfaction.

Keywords: Green building, Interior, look and feel, Employee satisfaction

Introduction

Green buildings are designed to minimize environmental impact and enhance human health by efficiently using energy, water, and resources while protecting occupant well-being. They incorporate sustainable materials, renewable energy, and efficient waste management throughout their lifecycle, from design and construction to operation and maintenance [1][2]. While green buildings' role in promoting sustainability is well established, the impact of green interior design on employee satisfaction, particularly in terms of "look and feel," is less understood. Existing research primarily addresses broader benefits like energy efficiency and environmental impact, leaving a gap in understanding how the aesthetic and sensory elements of green interiors affect employee well-being and satisfaction [3-10]. This research is conducted to explore this unexplored dimension, focusing specifically on the subjective experiences of employees within green buildings. To investigate this research

has selected MAS Thurulie as a case study. Thurulie represents LEED-certified green buildings in Sri Lanka, being the first in the country to achieve LEED Platinum certification [11].

Methodology

This study used a mixed methods approach to explore how green building aesthetics impact employee satisfaction at MAS Thurulie. The quantitative component involves a detailed questionnaire assessing Employee satisfaction through metrics such as eNPS (Employee Net Promoter Score) [12], JSS (Job Satisfaction Survey) [13], and Look and Feel Satisfaction Scale, with data analysed using SPSS. This quantitative component involves a representative sample of 210 employees, including both office and factory workers with diverse job positions and tenures. The sample size was determined through statistical power analysis, ensuring the reliability and generalizability of the results to the broader population within the company. The qualitative component consists of semi-structured interviews with 15 employees, 3 supervisors, 3 nominated individuals, and the design team, focusing on personal experiences and suggestions related to Look and Feel. Thematic analysis is used for qualitative data. Ethical considerations include informed consent and confidentiality. Limitations include limited access to company data and potential self-report bias and restricted generalizability.

Discussion and Findings

The "look and feel" of green buildings, encompassing design, materials, space planning, and nature integration, significantly impacts occupants' psychological and emotional well-being [14]. Studies highlight that organic shapes, natural materials, and nature-inspired designs enhance visual appeal, promote harmony, foster a unique character in buildings, and positive effect on Employee satisfaction [15-17]. At MAS Thurulie, the interior design emphasizes worker comfort, functionality, and satisfaction, using materials like stabilized earth blocks, bamboo blinds, and natural colours to create a comfortable, aesthetically pleasing environment. Large windows bring in natural light, connecting employees to the lush greenery outside, and the thoughtful use of shapes and colours fosters tranquillity, order, and focus. This well-rounded design approach has significantly boosted employee satisfaction and visual experience.
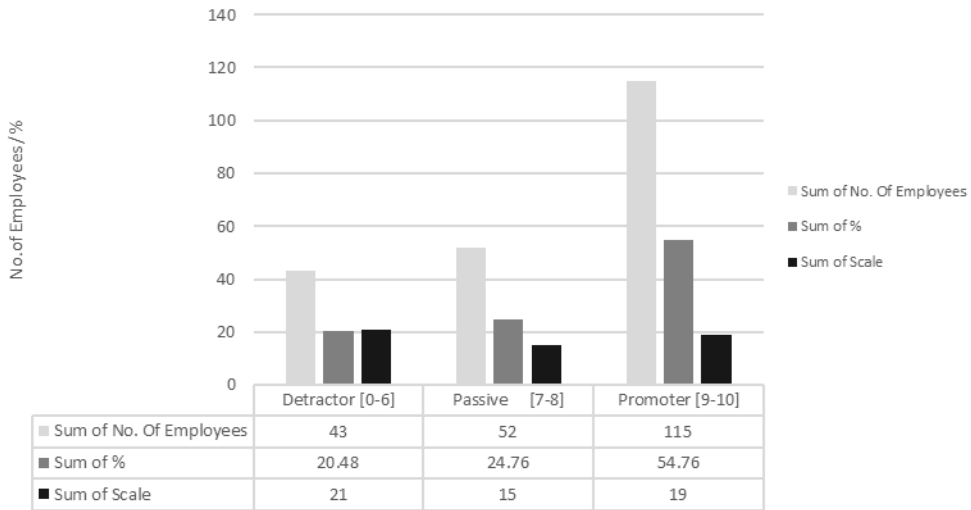
Figure 1: eNPS, Source: Survey Data

Table 01: Look and Feel Satisfaction [*Source: Survey Data*]

Scale	Mean	SD	r	β
Visually appealing	4.2	0.8	0.785	0.794
Materials used in the workplace	4.1	0.9	0.825	0.711
Layout and space planning with Ergonomics	4.3	0.7	0.784	0.752
Design elements used	4.2	0.8	0.779	0.725
Integration of natural elements	4.4	0.7	0.743	0.811
Overall satisfaction with Look and Feel	4.3	0.6	0.784	0.797

Table 2: Job Satisfaction [*Source: Survey Data*]

Scale	Mean	SD
Overall Job Satisfaction	4.4	0.7
Work Environment Satisfaction	4.1	0.6
Productivity at Work	4.3	0.7
Work-Life Balance Satisfaction	4.1	0.8
Likelihood to Recommend Workplace	4.2	0.6

The survey respondents expressed high satisfaction with the "look and feel" of their workspace, with mean scores ranging from M=4.1 to M=4.4 across various dimensions. For instance, the integration of natural elements, scoring a mean of M=4.4, was particularly appreciated for its positive impact on employee well-being, as highlighted by qualitative feedback emphasizing

the refreshing and serene environment. Furthermore, the Employee Net Promoter Score (eNPS) was calculated at 34.28, indicating a strong positive sentiment towards the workplace, with 54.76% of employees categorized as promoters. This suggests a significant likelihood of employees recommending MAS Thurulie as a workplace, reflecting the overall favorable perceptions of the work environment. Job satisfaction measures also indicated high satisfaction, with an overall mean score of M=4.4, while specific aspects like work environment satisfaction and work-life balance scored M=4.1. The survey results, backed by thematic analysis, underscore the critical role of a satisfied work environment and the emphasis on work-life balance in enhancing employee satisfaction. The high reliability of the Job Satisfaction Scale (Cronbach's alpha of 0.85) and the good model fit indices further validate these findings, suggesting that the look and feel at MAS Thurulie significantly contribute to employee comfort and satisfaction, ultimately supporting higher job satisfaction levels.

Conclusion

In conclusion, this research at MAS Thurulie highlights that green building interiors significantly enhance employee job satisfaction through improved visual appeal, material quality, ergonomically designed layout, and the integration of natural elements. The high Employee Net Promoter Score (eNPS) and strong correlations between look and feel scales emphasize the positive impact of Green building "Look and Feel" into Employee Satisfaction. These findings underscore the importance of investing in green building features to boost employee satisfaction in the Office environment. Future research should explore the long-term effects of green building interiors on job satisfaction to assess the sustainability of these benefits over time. Additionally, comparing different green building certifications and their specific impacts on various aspects of employee experience could provide a more nuanced understanding of how different standards influence workplace satisfaction.

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(#64) An Investigation on Consumer Preferences In Cane With Wood Blend Furniture; Special Reference To Wewaldeniya Cane Industry

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Abstract

Consumer preferences play a pivotal role in the success of any industry, and the Wewaldeniya Cane Industry is no exception. This research aimed to comprehensively investigate consumer preferences for cane with wood blend furniture within this industry, identifying key influencing factors and providing recommendations. Through a qualitative approach involving photographic documentation, observational studies, and a consumer preferences questionnaire, valuable insights were uncovered. The photographic study provided an overview of the availability and variety of cane with wood blend furniture in the Wewaldeniya context. The questionnaire's analysis highlighted aesthetics, functionality, durability, sustainability, cultural significance, and price as critical factors shaping consumer choices. Design, comfort, quality, natural materials, craftsmanship, and affordability emerged as top priorities. Based on these findings, recommendations were formulated, including offering diverse aesthetic options, enhancing ergonomics and comfort, maintaining stringent quality standards, promoting sustainable practices, leveraging cultural heritage, and implementing competitive pricing strategies. By aligning product offerings with these consumer preferences, the Wewaldeniya Cane Industry can strengthen its market position, foster product innovation, and contribute to the sustainable growth of this culturally significant industry.

Keywords: *Consumer Preferences, Cane with Wood Blend Furniture, Wewaldeniya Cane Industry*

Introduction

The furniture industry is currently undergoing a shift in consumer preferences, with more individuals expressing a desire for unique, sustainable, and visually appealing options for their living spaces. One particular trend that has gained traction is the use of cane and wood blend furniture, which is favoured for its natural charm, long-lasting quality, and environmentally friendly attributes. Given this evolving landscape, it is essential for manufacturers to gain insights into consumer preferences for such furniture to adapt their product offerings and remain competitive in the market.

Research Background

Understanding the dynamic factors that influence consumer preferences for cane with wood blend furniture is essential for the *Wewaldeniya* Cane Industry to adapt and thrive in the changing market. By delving deeper into these influences, local manufacturers can gain valuable insights to improve their product offerings and effectively compete in the industry.

Furthermore, through a thorough examination of specific consumer preferences and influential factors, the *Wewaldeniya* Cane Industry can harness these insights to develop precise and targeted marketing strategies. This approach can be complemented by enhancements in product design and development, effectively aligning with the evolving needs and expectations of their discerning target consumers.

Research Question

What are the key factors influencing consumer preferences for cane with wood blend furniture in the Wewaldeniya Cane Industry, and how can these insights be leveraged to better cater to consumer demands?

Aims and objective

The aim of this research is to comprehensively investigate and understand consumer preferences for cane with wood blend furniture within the Wewaldeniya Cane Industry, with the goal of identifying the key factors that influence these preferences and providing actionable recommendations to local manufacturers to better align their products with consumer demands.

Objectives

1. To Identify the types of cane with wood blend furniture
2. To investigate the factors influencing consumer preferences for cane with wood blend furniture
3. To provide recommendations for the *Wewaldeniya* cane industry to better meet consumer demands based on identified preferences and influencing factors.

Methodology

A qualitative research approach was employed, involving photographic documentation, observational studies, and consumer preference questionnaires. Photographic studies were conducted at six cane manufacturing shops in *Wewaldeniya* to document the available furniture types. Additionally, close-ended questionnaires were administered to 50 consumers to gather insights on preferences, perceptions, and purchasing behavior regarding cane with wood blend furniture.

Research Strategy

The research strategy for this study will employ a qualitative approach to gain a deep, contextual understanding of consumer preferences for cane with wood blend furniture within the Wewaldeniya Cane Industry. This Strategy involves Photographic Studies, and qualitative questionnaires to gather rich, detailed data from various stakeholders.

Research Design

The research design outlines a systematic approach for collecting, analyzing, and interpreting qualitative data to address the research objectives. It begins with a comprehensive literature review to build a theoretical foundation and understand the context of the cane industry, cane furniture, and consumer preferences. This review identifies gaps in existing literature, guiding the formulation of research questions and themes.

Following the literature review, a photographic study documents the types and styles of cane with wood blend furniture in Wewaldeniya. This involves photographing furniture from six manufacturing shops, accompanied by descriptive notes for visual analysis.

The next step involves administering qualitative questionnaires to 50 participants, including consumers and retailers, both in person and via Google Forms. The collected data undergoes content analysis to interpret preferences, perceptions, and influencing factors, providing insights into consumer and retailer preferences and decision-making factors regarding cane with wood blend furniture.

Data Collection

The data collection process for this study involves a multi-faceted approach to gather comprehensive qualitative data on consumer preferences for cane with wood blend furniture within the *Wewaldeniya* Cane Industry. The primary data collection methods include photographic documentation and qualitative questionnaires, ensuring a thorough examination of both the physical products and consumer perspectives.

Results and discussion

The photographic study revealed a diverse range of cane with wood blend furniture types, including cane-back chairs, cane-seated chairs, cane-top tables, cane-framed sofas, and cane-panel cabinets. The questionnaire analysis highlighted aesthetics, functionality, durability, sustainability, cultural significance, and price as critical factors shaping consumer choices. Consumers prioritized design, comfort, quality, natural materials, craftsmanship, and affordability. Recommendations were formulated, including offering diverse aesthetic options, enhancing ergonomics and comfort, maintaining stringent quality standards, promoting sustainable practices, leveraging cultural heritage, and implementing competitive pricing strategies.

Table I: Photographic Study Findings

Furniture Type	Description	Images
Cane-back chairs	These chairs featured intricately woven cane backs combined with wooden frames and legs,	

	offering a unique blend of natural textures and structural stability.	
Cane-seated chairs	In addition to cane-back chairs, the artisans also crafted chairs with woven cane seats mounted on sturdy wooden frames and legs.	
Cane-top tables	Tables with cane woven tabletops and wooden bases or legs were commonly found, showcasing the fusion of materials in functional and decorative pieces.	
Cane-framed sofas and lounges	While less prevalent, some artisans also produced sofas and lounges with cane woven frames supported by wooden legs, creating a seamless integration of natural materials.	

Cane-panel cabinets and storage units	Cabinets and storage units with cane woven panels or doors incorporated into wooden frames were observed, combining the aesthetic appeal of cane with the functionality of wood.	

Questionnaire Findings

Aesthetics
- **Design**
- Style
- Color
- Texture

⇒ Design as the primary aesthetic driver, while also showing that style, color, and texture hold considerable importance for consumers assessing this furniture type.

Functionality
- **Comfort**
- Ergonomics
- Ease of Use

⇒ while all three factors are important, comfort takes precedence for most consumers assessing the functionality of this furniture type.

Durability
- Material
- **Quality**
- Construction
- Longevity

⇒ while all four factors hold importance, quality is the primary driver influencing consumers' perceptions of this furniture type's durability.

Sustainability
— Eco-friendliness
— **Natural Materials**
— Environmental Impact

while all three factors are important, a furniture's Natural materials take slight precedence for most consumers assessing its overall sustainability.

Cultural Significance
— Tradition
— Heritage
— **Craftsmanship**

while all three factors contribute to cultural value, the quality of craftsmanship holds the highest importance for most consumers assessing this aspect.

Price
— Affordability
— **Value for Money**
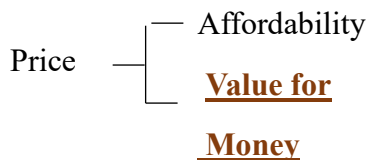
while these two factors are important, Value for money takes priority for most consumers assessing the Price of this furniture type.

The findings highlighted the significance of aesthetics, functionality, durability, sustainability, cultural significance, and price in shaping consumer choices. Factors such as visually appealing designs, comfort, material quality, natural materials, craftsmanship, and affordability emerged as top priorities for consumers.

Through the photographic study, provided an overview of the availability and variety of cane with wood blend furniture in the *Wewaldeniya* context.

Recommendations

Based on the findings and consumer preferences for cane with wood blend furniture within the *Wewaldeniya* Cane Industry, the following recommendations can be made;

1. Prioritize Aesthetic Considerations

2. Enhance Functionality and Comfort

3. Maintain High Standards of Quality and Durability

4. Emphasize Sustainable and Eco-Friendly Practices

5. Leverage Cultural Heritage and Craftsmanship

6. Maintain Competitive Pricing and Value Proposition

By implementing these recommendations, the Wewaldeniya Cane Industry can effectively cater to consumer preferences, enhance their product offerings, and maintain a competitive edge in the market.

Conclusion

This research provides valuable insights into consumer preferences for cane with wood blend furniture within the Wewaldeniya Cane Industry. By understanding and addressing these preferences, the industry can better cater to evolving consumer demands, foster product innovation, and maintain a competitive edge while preserving cultural heritage and sustainable practices. Future research could explore cross-cultural comparisons, emerging trends, and the integration of technology and innovation in traditional crafts.

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(#76) An Evaluation of the Artificial Lighting Approaches on Users in an Ayurveda Treatment Room

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Abstract

This research aims to explore the effect of artificial lighting on patients within 5 parameters in Ayurvedic treatment rooms. case studies, observational studies with photographs, and patient surveys are used to examine current lighting strategies and identify gaps. The study highlights the importance of lighting in improving patients' visual comfort, relaxation, stress reduction, and sleep-wake cycle, recommending advanced LEDs and tunable white light for optimal results.

Keywords: *ayurveda treatment room, artificial lighting, user approaches*

Introduction

The objective of this research is to evaluate the effect of different artificial lighting approaches on users in an Ayurvedic treatment room.

Ayurveda, a traditional medicine system that originated in India, emphasizes health through balancing the three doshas (Vata, Pitta, Kapha) created by the five elements: earth, water, fire, air, and ether (Sugathapala, M.A.S.H., 2023). In Ayurveda, there are Various treatments with distinct processes and demand-specific facilities. Some are relaxing while some focus on concentration. This is why they have different types of treatment rooms with different environments available. (G.S. Lavekar, M.M.Padhi, O.Sarada, M.M.Sharma,2010) The physical environment in which a patient receives affects patient outcomes, patient satisfaction, and the safety of patients. The use of lighting design may support a positive atmosphere, and potentially also support the health and well-being of users that are in these environments.

The quality of light in a space is dependent not only on the properties of the light but also on how that light is delivered to space. The quality of lighting is measured according to these few parameters. (Illuminance level, Glare, color rendering, light distribution, color temperature)

The research is limited to examining the Shirodhara, Snehana, and Swedana treatment units, which are commonly featured in Sri Lankan Ayurveda resorts and centers. These specialized rooms include the Shirodhara unit for stress relief and relaxation, the Snehana unit for oil-based body therapies, and the Swedana unit for herbal steam treatments that promote detoxification.

The intersection of modern lighting technology and ancient Ayurvedic principles has been explored only to a limited extent. Studying these effects can guide the creation of effective lighting in Ayurvedic settings, promote patient well-being, and conform to Ayurvedic principles across diverse environments.

Scope of the Study

Research focuses on assessing how different lighting strategies affect user attention and therapeutic outcomes in Ayurvedic settings. It aims to improve visual comfort, relaxation, stress reduction, sleep-wake cycles, and reduce visual fatigue through tactical lighting design and recommends optimal solutions following Ayurvedic principles. Ultimately, it aims to improve overall treatment efficiency and user experience in healthcare environments.

Aims and Objectives

The research aims to explore a way to enhance the overall quality and effectiveness of Ayurveda treatments by evaluating artificial lighting strategies in treatment rooms to maximize treatment results, user comfort, and therapeutic efficiency.

Objectives

1. To evaluate the artificial lighting strategies used in treatment rooms to get maximum treatment results.
2. To examine the influence of artificial lighting approaches on users' comfort and purposefulness during Ayurveda treatments in treatment rooms.
3. To evaluate the strengths and weaknesses of existing lighting strategies in a treatment room and propose an optimal lighting strategy for enhanced user experience and therapeutic efficacy according to Ayurveda principles.

Research Methodology

The literature review examines 4 main areas: Ayurvedic treatment units, treatment processes, lighting strategies, the effect of artificial lighting on users, and the role of natural lighting in Ayurveda. According to that 3 detailed photographic case studies independently assess specific artificial lighting methods across five parameters: brightness level, luminance, color rendering, light distribution, and color temperature. Additionally, questionnaire-based evaluations focus on users' cognitive responses to visual comfort, relaxation, stress reduction, sleep-wake cycles, and visual fatigue with the aim of optimizing lighting strategies for enhanced therapeutic environments in Ayurvedic healthcare settings.

Result and Discussion

The study assessed lighting strategies in Ayurvedic treatment centers and noted positive effects such as improved relaxation with adjustable lighting and warm light tones. However, issues such as glare from direct ceiling lighting and inadequate lighting conditions have been identified as adversely affecting visual comfort and fatigue levels. Survey results showed a preference among visitors for morning sessions with soft, warm lighting.

Conclusion

Research highlights the critical impact of thoughtful lighting design on treatment spaces, improving patient comfort, relaxation, and overall treatment efficacy. It recommends advanced technologies such as Tunable White lighting to mimic natural daylight while promoting a healthy environment in accordance with Ayurvedic principles. By addressing issues such as glare and optimizing lighting conditions, the study suggests that Ayurvedic centers can significantly improve patient outcomes and satisfaction. Future efforts should focus on integrating these innovative lighting solutions into treatments tailored to individual needs, thereby enhancing the holistic healing experience.

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(#79) Investigate the Potential of Iluk Plant for The Development of Particle Boards for Interior Applications

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Abstract

The deforestation associated with the production of traditional wood-based particleboards requires the exploration of sustainable alternatives. This research investigates the potential use of *Imperata cylindrica (Iluk),* a fast-growing and readily available perennial grass, as a viable raw material for particleboard specifically designed for interior applications. The study explores the feasibility of substituting the *Iluk* plant for wood in particleboard production. It analyses the mechanical properties (strength, durability, moisture resistance) of *Iluk*-based particleboard compared to conventional alternatives. In addition, a life cycle assessment is conducted to quantify the environmental benefits of using *Iluk*. This research aims to Assess the feasibility of using *Iluk* particles to develop a functional particle board suitable for interior use. Evaluation of performance characteristics of *Iluk*-based particle board compared to conventional particle board. Investigate the environmental benefits associated with using *Iluk* as a sustainable alternative. The findings of this research contribute to the development of sustainable alternatives in the construction and furniture industry. Successful results may lead to a reduced dependence on traditional wood resources and a more environmentally friendly approach to particleboard production.

Keywords: *particle board, Imperata cylindrica (Iluk), sustainability, deforestation, indoor applications, life cycle assessment, Dry leaves*

Introduction

The construction and furniture industry heavily relies on wood-based materials like particleboard. However, concerns regarding deforestation highlight the need for exploring sustainable alternatives. This research investigates the potential of Imperata cylindrica (*Iluk)* as a viable raw material for particleboard specifically designed for interior applications.

Justification for Using *Iluk,*

- *Iluk* is a fast-growing perennial grass native to tropical and subtropical regions. This rapid growth rate offers a readily available and renewable resource compared to traditional wood sources.

- *Iluk* possesses a high cellulose content (around 40-50%) within its stems, a crucial component for binding particles in particleboard.

- Using *Iluk* for particleboard production can provide additional benefits to Sri Lankan farmers in some areas.

- *Iluk* is considered an invasive weed due to its rapid spread. By providing a sustainable economic use for *Iluk*, this research can contribute to managing its invasive tendencies and reducing its negative impact on agricultural land.

- Cultivating and harvesting *Iluk* for particleboard production can create a new source of income for farmers.

Aims and Objective

- To investigate the composition and production processes of existing particleboards.

- To characterize the physical, and mechanical properties of *Iluk* for particle board applications.

- To investigate the available binding agents used in particle boards in the local market.

- To investigate the potential of clay as a sustainable binding agent for *Iluk* particleboard

- To develop and optimize production processes for *Iluk* particle board.

Methodology

This research will explore the potential of *Iluk (Imperata cylindrica)* as a sustainable raw material for particleboard production, focusing on its suitability for Sri Lankan interior applications.
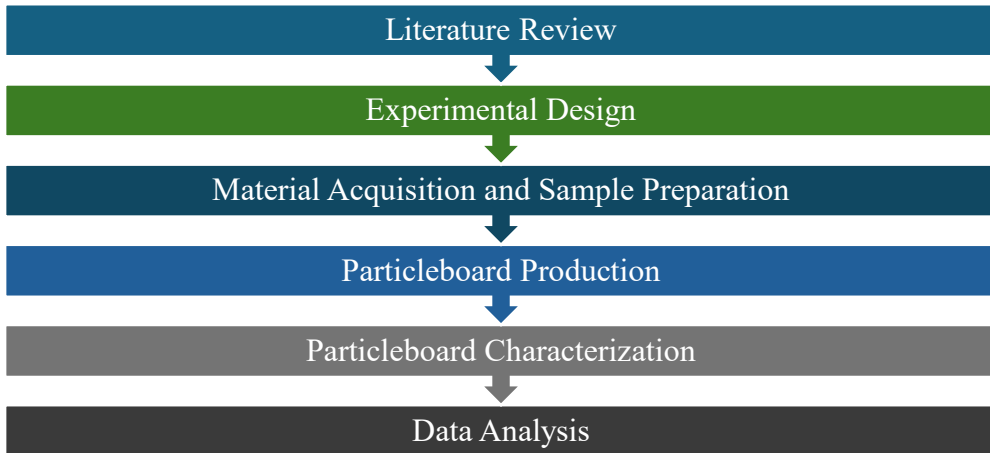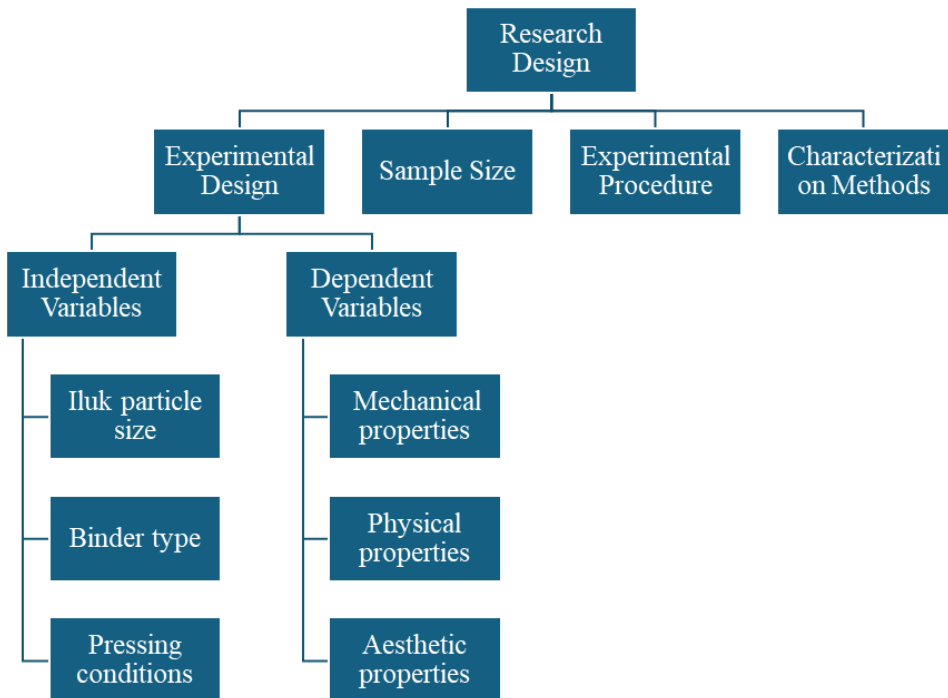
Figure 1: Research Strategy
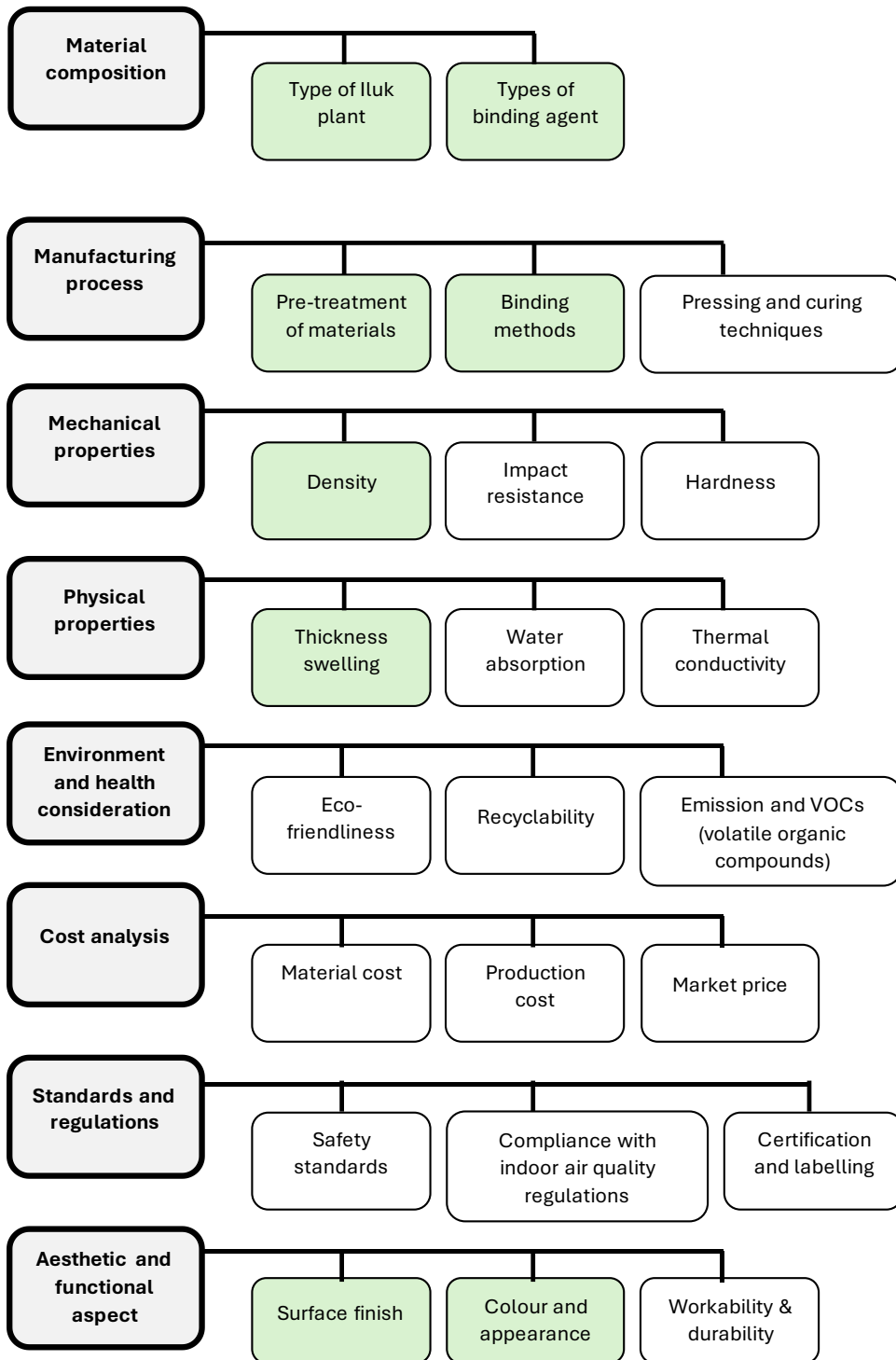

Figure 2: Research Design

Figure 3: Theoretical Framework

Result And Discussion

Cut and collect Iluk plants. → Cut the Iluk plants into small pieces. → Wet Iluk particles

Dried particles in first day | Dried particles in second day | Dried particles in third day
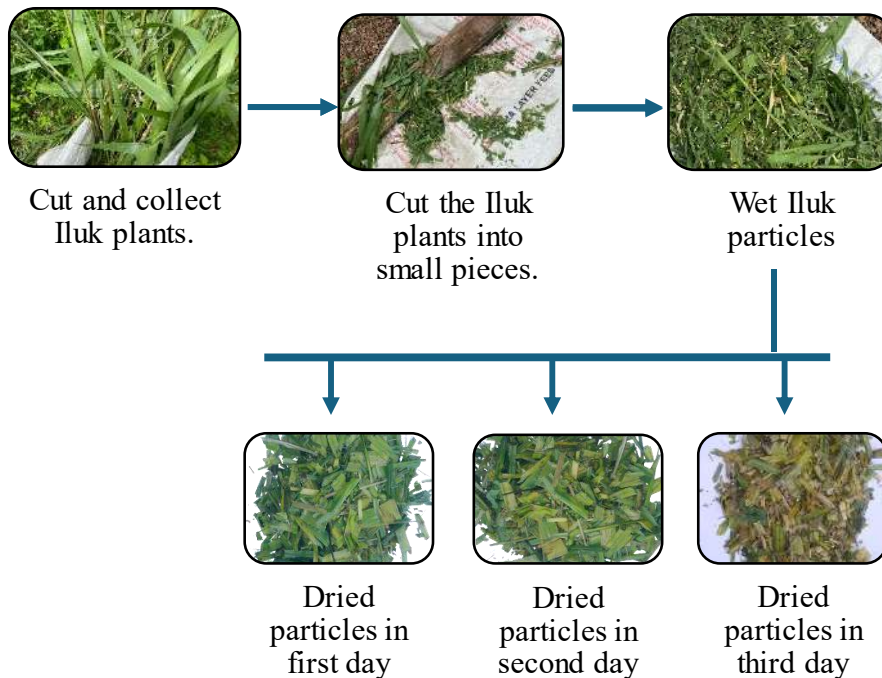
Figure 4: Process of sampling

Experimental steps

- First the clay is seasoned well

  o Clay is often soaked in water for a specific period to hydrate it and improve its plasticity. This can help ensure better distribution and adhesion within the particleboard.

- Mixing with dried *Iluk* particles

  o The mixing of dried *Iluk* particles with the seasoned clay binder is a critical step in the particleboard manufacturing process. This step involves combining the two components to form a mixture that will serve as the particleboard.

- Put the prepared mixture into the mold.

  o The mold is prepared to ensure smooth and even distribution of the mixture.

o The prepared mixture is carefully pressed into the mold. The mixture was evenly distributed to avoid voids or inconsistencies in the final product.

- compress it well using a hydraulic compression tool.

  o Compressing the particleboard mixture using a hydraulic compression tool is essential to enhance its physical and mechanical properties. This process increases the density of the material, improves its strength, and reduces its porosity.

- Remove the panel from the mold and dry it again.

Test 01

This particle board was made using polymer bind and *Iluk* particles. Here, the plant parts were well dried and mixed with polymer gum, put into the mold, and compressed. After two days in the mold, there was no fixation. From the third day, something like mold was seen on the board. On the fourth and fifth days, the mold spread all over the board. Because of this, this board must be named a failure.

Test 02

This particle board is made from dried *Iluk* plant particles and polyethylene. Heat polythene in a bowl and stir until the polythene melts. Then polyethylene and Iluk are mixed. Then this mixer is put into the mould and compressed

Test 03

This particle board is made using dried *Iluk* particles and seasoned clay. Here, this mixture is made in a ratio of 1:2 of *Iluk* particles and clay. This is allowed to compact for a day at normal ambient temperature and then removed from the mould to dry.

Test 04

This particle board is made using dried *Iluk* particles and seasoned clay. Here, this mixture is made in a ratio of 1:3 of *Iluk* particles and clay. This is allowed to compact for a day at normal ambient temperature and then removed from the mould to dry.

Table I: Test Results

Material	Quantity (g/ ml)	Ratio	Size/ Thickness Weight	Result	
Test 01 Sun dried Iluk plant particles Polymer binder	200 g 200g	1:1	6"x 6" x 0.5" 350g	Fail	
Test 02 Sun dried Iluk plant particles Disposable lunch sheets	75g 100g	3:4	6"x 6" x 0.2" 120g	Average	
Test 03 Sun dried Iluk plant particles Pre – Treated clay	200g 400g	1:2	6" x 6" x 1" 550	Success	
Test 04 Sun dried Iluk plant particles Pre – Treated clay	200g 600g	1:3	6" x 6" x 1" 600	Success	
Test 05 Sun dried Iluk plant particles Red clay	200g 400g	1:2	6" x 6" x 1" 500	Average	
Test 06 Sun dried Iluk plant particles Red clay	200g 600g	1:3	6" x 6" x 1" 750	Average	
Test 07 Sun dried Iluk plant particles Pre – Treated clay	200g 600g	1:3	6" x 6" x 1" 600	Success	

Test 05

The materials used here are *Iluk* particles and red clay known as brick clay. There were some cracks in this board while it was drying.

Test 06

The materials used here are *Iluk* particles and red clay known as brick clay. There were some cracks in this board while it was drying.
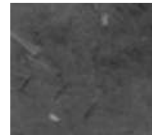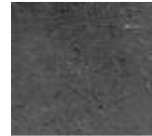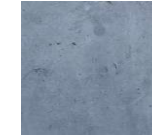
Test 04

This particle board is made using dried *Iluk* particles and seasoned clay. Here, this mixture is made in a ratio of 1:2 of *Iluk* particles and clay. This is allowed to compress for 2 days at normal ambient temperature and then removed from the mold to dry.

This research utilized pre-treated *Iluk* particles and seasoned clay as the primary materials. The *Iluk* particles were prepared to a specific size and mixed thoroughly with the clay binder. The mixture was then molded and compressed using a hydraulic press to achieve the desired density.

Conclusion

This research investigated *Iluk's* potential as a sustainable particleboard material and clay as a viable, eco-friendly binder. While *Iluk* displayed promising properties like density and tensile strength, pre-treatment was crucial for optimal use. Clay's potential as a binder is evident, but further optimization is needed to match conventional binders in strength and moisture resistance. *Iluk* particleboard prototypes using pre-treated *Iluk*, and clay showed encouraging results for some physical and mechanical properties. However, further refinement is necessary to achieve peak performance across all aspects, such as bending strength and internal bond strength, which are crucial for particleboard applications in furniture and construction.

This research demonstrates the potential to transform *Iluk*, an environmental and economic burden, into a valuable resource for the sustainable building materials industry. Utilizing *Iluk* for particleboard production offers a dual benefit – managing invasive plant growth while providing an eco-friendly alternative to wood-based materials. This approach aligns with the growing

demand for sustainable construction practices that minimize environmental impact.

Directions for Future Research

- This research on *Iluk*-based particleboard lays the groundwork for future exploration in several key areas.

- Investigating different *Iluk* species and pre-treatment methods to improve particleboard performance.

- Exploring formaldehyde-free binding agents for a more environmentally friendly product.

- Using advanced techniques to gain deeper insights into the material properties and performance of *Iluk* particleboard.

- Examining the economic feasibility of *Iluk*-based particleboard production, including production costs, market demand, and economic impact on *Iluk* cultivation and processing.

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(#82) Optimizing Railway Station Interiors: A Case Study of Tourist Destination Railway Stations on The Kandy-Ella Line in Sri Lanka

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Abstract

This study aims to optimize the interior design of railway stations along the Kandy-Ella line in Sri Lanka to enhance their appeal as tourist destinations. A pilot study was conducted at Kandy, Nanu Oya, and Ella railway stations to identify the types of public spaces available and their usage. Data was collected through interviews, and questionnaires distributed to passengers, focusing on the most frequented public spaces and their architectural attributes. Detailed observations were conducted to corroborate the survey findings. The results highlight the importance of comfort, aesthetic appeal, accessibility, and space utilization in creating an inviting atmosphere for travellers. This research provides actionable recommendations for refurbishing and enhancing the interiors of railway stations to boost tourism and passenger satisfaction.

Keywords: railway station, SLR, Sri Lanka railway, public space, customer satisfaction

Introduction

Well-designed railway stations, particularly in tourist destinations like Kandy, Nanu Oya, and Ella, can enhance the travel experience and attract more tourists due to their historical and architectural significance. This research aims to identify issues in Sri Lankan railway stations and explore key factors for successful public space utilization to improve tourist attraction and provide practical insights for policymakers and designers.

Aims and objectives

• To assess the current state of interior design at Nanu Oya, Kandy, and Ella railway stations.

> • To explore the key factors that contribute to a successful utilization of public spaces in railway stations.

> • To suggest how these factors contribute to enhancing the railway station interiors and facilities, and overall tourist experience, and position Sri Lanka as a distinctive and attractive destination for travelers.

Methodology

A pilot study was conducted at the Kandy Railway Station, Nanu Oya Railway Station, and Ella to understand the different types of public spaces available and the activities that take place in them. Then questionnaire was sent to passengers to identify the public spaces that were mostly used by passengers, which would be used to conduct the study. Collected local and foreign passenger experiences by customer reviews from Google Maps and rated pages. Collected data by observations, interviews, and photographic study with the layouts. To understand the utilizing the interior, a questionnaire was given to passengers by a QR code present at the station regarding each identified public space.

Results and discussion

The research identified several key areas for improvement in railway stations along the Kandy-Ella line. First, it recommended increasing the number and quality of seating areas and ensuring restrooms are clean and accessible. A cohesive design strategy reflecting local culture and heritage, along with consistent signage and decorative elements, was suggested to enhance the stations' aesthetic appeal. To improve accessibility, the introduction of ramps, elevators, and tactile pathways was advised. Additionally, repurposing underutilized areas for amenities like extra seating, recreational facilities, and cultural exhibits was recommended to boost passenger comfort and engagement. By addressing these issues, the stations could become more welcoming, efficient, and attractive, benefiting both daily commuters and tourists, ultimately supporting local tourism and regional development.

Conclusion

The study concluded that improving seating, waiting areas, and restrooms is essential for passenger comfort, as existing facilities are often inadequate. Enhancing the station's aesthetic quality through consistent design, better

signage, and regular maintenance can make the stations more attractive, especially to tourists. Accessibility remains a major issue, with many stations lacking essential features like ramps, elevators, and tactile guidance for individuals with disabilities. Implementing universal design principles is crucial to ensure ease of movement for all passengers. Additionally, repurposing underutilized spaces for more seating, recreational facilities, and cultural exhibits can improve both functionality and the overall travel experience

Acknowledgment

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(#88) Thermal Satisfaction of Students in Indoor Spaces at Academic Institutions

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Abstract

This paper discusses a study conducted to identify the critical factors influencing the thermal comfort of learners within a classroom. The Fanger Model is used to predict the critical factors, and a result of a questionnaire survey has also been used.

Keywords: *Thermal satisfaction, Fanger model, Temperature, Humidity, Indoor environment*

Introduction

Thermal comfort is critical to the teaching and learning nature of an academic institution [1]. Thermal comfort in a learning environment is determined by essential characteristics which include temperature, humidity, airspeed, sunlight, as well as most significantly, the location of the institution [8]. The thermal comfort of a learning environment may be improved to various degrees by including natural and mechanical ventilation techniques. Despite the fact that there are more information technology resources available nowadays, most pupils decided to have a physical education.

As a result, the academic institution's premises must be built with improved thermal comfort in accordance with international standards such as ASHRAE 55 [2] and the ISO 7730 rule for "Ergonomic Principles on Environmental Thermal Satisfaction" specifies and investigates thermal convenience statistically [4].

This study focused on identifying the thermal comfort levels in occupied classrooms with different ventilation systems according to the Fanger model calculations which are PMV (Predicted Men Vote) and PPD (Predicted Percentage Dissatisfied) with respect to international standards.

Literature Review

As per the results of a study done by Kwok [11] within academic institutions in Japan, during the summer the thermally comfortable temperature in naturally ventilated classrooms was in the range of 26.9 ^{0}C and 27.1 ^{0}C, whereas that of air-conditioned classrooms was 24.0 ^{0}C and 24.2 ^{0}C. Further, it was found that the comfortable relative humidity for occupants in a naturally ventilated learning environment was 72.8% and for an air-conditioned space this value was 50.7%. There was a significant different between the air speeds in naturally ventilated learning environment and an air-conditioned environment and those measured values were 0.27 m/s and 0.08 m/s respectively.

It was noted that the findings presented by Knok [11] are compatible with the ASHRAE 55 standard parameters. In China, the favorable temperature range was recorded as 23.5 - 27.4 ^{0}C at a relative humidity of 70% with an airspeed of 0.44 m/s, clothing insulation of 0.43, and a metabolic rate of 1.0 met [9]. A study conducted to identify the most effective ventilation types for the classrooms based on thermal satisfaction revealed that the most cost effective and thermally satisfied are the hybrid ventilated classrooms in an education institute [6].

Methodology

Thermal comfort inside a classroom is heavily influenced by the internal architectural layout and the air circulation techniques employed [5]. A mixed, qualitative, and quantitative approach was adopted in this study in order to acquire more reliable results. The study areas were selected according to the ventilation systems adopted such as AC rooms and HBMS (Hybrid Ventilation with Mechanical Systems) rooms [6] to obtain the results based on the requirement of the Fanger model.

Both indoor and outdoor temperatures, humidity, and air speeds required for the Fanger model were measured simultaneously. A questionnaire survey was conducted to obtain the thermal satisfaction level of the occupants.

The questionnaire survey was conducted on 500 students by collecting their gender, thermal preferences, thermal satisfaction level during the questionnaire survey, stress levels, the immediate past activity performed, and their clothing habits. Table I shows the specifications and accuracies of the instruments used to collect data.

Table I: Specifications of Measuring Instruments

Instrument	Parameter	Resolution	Range	Accuracy
OEM HTC-2 Hydrometer	Temperature	0.1 ^{0}C	-50 ^{0}C – 70 ^{0}C	$\pm$1.0 ^{0}C
	Humidity	1 % RH	10% - 99% RH	$\pm$5% RH
UT363 mini wind speed and temperature meter	Wind Speed	0.01 m/s	0- 30 m/s	$\pm$0.02 m/s

Results and Discussion

The main objective of the study is to identify appropriate thermal parameters for the thermal comfortability of students in an academic institute in Sri Lanka. With the outcome of the questionnaire survey, clothing insulation (Iclo) and the metabolic rate (MET) were calculated as per the Fanger model [3]. The calculated clothing insulation was 0.61 since most of the students were wearing light clothes due to the hot humid environment in Sri Lanka. The metabolic rate was also calculated according to the Fanger model, and the magnitude was 60.0 W/m2. The activities engaged by the students were taken as sitting and writing in the calculation of the rate of metabolic.

According to the equations of the Fanger model [10], the PMV and PPD percentages, thermal preferences, and stress levels were calculated by incorporating the collected data. Tables II and III show the results summary of the study.

Table II: Summary of Indoor and outdoor thermal parameters

Classroom	Session	Classroom & Type	Indoor parameters			Outdoor Parameters		
			Temp ^{0}C	RH %	Wind speed(m/s)	Temp ^{0}C	RH %	Wind speed (m/s)
U1 114	Morning	HBMS	28.89	81.3	0.05	27	86	0.15
U1 733	Morning	AC	24.08	61.8	0.15	28.5	85	0.45
U3 517	Evening	HBMS	31.23	68.6	0.1	31.2	65	0.6
Z0 725	Evening	AC	23.82	63.3	0.05	27.2	86	0.15

Table III: Summary of Results

Classroom	Session	Type	Fanger model		Thermal preferences (%)			Learning stress (%)		
			PMV	PPD %	Cold	No change	Warm	Relaxed	Neutral	Stressed
U1 733	Morning	AC	-0.41	8.49	20	70	10	17	53	30
U1 114	Morning	HBMS	5.89	100	59	32	9	15	37	47
U3 517	Evening	HBMS	3.78	100	89	7	4	4	45	51
Z0 725	Evening	AC	0.38	7.37	7	77	17	13	63	23

As per the results, it can be concluded that indoor thermal comfort mainly depends on the classroom ventilation type. It was noted that the PMV and PPD were within the acceptable range of the Fanger model [-0.5 < PMV < +0.5 and PPD < 10%] when classrooms were air-conditioned. Further, the results of the questionnaire survey are compatible with the results of the Fanger model, since students prefer a learning environment with PMV and PPD is within the acceptable range of the Fanger model.

Conclusion

Based on the results of the study, it can be concluded that the best temperature for thermal comfort in a classroom should be in the range of 23.0 0C to 25.0 0C and relative humidity in the range of 60% to 65%. When considering the AC classrooms, have fulfilled the acceptable parameter range, while HBMS classrooms need some improvements in ventilation techniques to meet the acceptable parameters [9].

It was also noted that the HBMS classrooms could easily be converted to a satisfactory level if students were wearing clothing with low insulation. This will drastically reduce the operation cost [7] of the institute by reducing the number of AC rooms.

Future Work

Following future works may be suggested,

- Further study is required to identify possible natural ventilation systems to enhance HBMS classrooms to appropriate temperature and humidity ranges specified in the Fanger model.
- Develop local standards to evaluate appropriate thermal parameters to achieve the required thermal comfortability levels.
- To develop a relationship between thermal satisfaction level with the student's residence places, since thermal comfortability may vary based on their previous lifestyle and habits.

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POSTER SESSION

(#2) Usage of Enterprise Resource Planning System for Material Management in Building Projects in Sri Lanka

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Abstract

Material management is crucial for the successful completion of construction projects. Globally, the construction sector seeks effective material management processes due to inefficiencies in conventional methods, often leading to excessive material usage and waste. Despite the potential benefits of Enterprise Resource Planning (ERP) systems in managing these issues, their application in the Sri Lankan construction industry remains underexplored. This study aims to fill this research gap by evaluating the feasibility of ERP systems for material management in Sri Lankan building projects. Prior research has highlighted the advantages of ERP systems in streamlining operations, reducing costs, and improving data security. However, this study seeks to address a lack of focused studies on their implementation within the context of Sri Lankan construction.

Keywords: Enterprise Resource Planning, Construction Industry, Material Management, Sri Lanka

(#3) Statistical Approach for the Accuracy of Gravitational Acceleration for Physical Laboratories versus Virtual Laboratories in Simple Pendulum Oscillation Experiment

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Abstract

When studying physics at any level, doing laboratory experiments is essential for understanding the theories and how those theories can be applied practically. With the enhancement of technology, virtual laboratory experiments have been introduced, with many more advantages compared with physical laboratories, such as flexibility, accessibility, cost-effectiveness, and safety. When considering these benefits, it is crucial to further recognize the accuracy of the virtual laboratories compared with the physical laboratories, in enhancing the student's education level. Hence, this study mainly aims to observe how the accuracy and quality of physical science education at NSBM Green University, Sri Lanka can be enhanced by introducing virtual laboratories. For this, the Simple Pendulum Oscillation Experiment of the Physics subject, to find the gravitational acceleration (g) was conducted for 29 Engineering Foundation students in the physical laboratory and also as a virtual experiment using the PhET platform. According to the results obtained in both physical and virtual laboratories, it was observed that the mean g values obtained in both methods are approximately equal, and the variation of the results was greater in the physical method. This concludes that virtual laboratories are more consistent compared with physical laboratories. Hence, this study illustrates that for the advancement of educational technology, the method of using virtual experiments can be further expanded for various other disciplines with different types of virtual platforms.

Keywords: *physics education, virtual laboratories, physical laboratories, oscillation experiment*

(#6) A Novel Cooling Technique for Power Electronic Circuits Through Airflow Optimization

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Abstract

This study delves into airflow optimization and cooling techniques specifically for power electronic circuits. By considering the principles of heat dissipation, airflow dynamics, and thermal management, this research aims to develop a high-performance cooling solution for power electronics. A combination of computer simulations, experimental verification, and theoretical analysis were employed to identify the most effective cooling strategies.

Keywords: *Power electronic circuit cooling, Thermoelectric coolers (TECs), Cooling techniques*

(#7) Ferrock: A Sustainable Alternative Construction Material for Modern Infrastructure

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Abstract

This study explores the potential of ferrock as an alternative construction material to traditional concrete, in terms of sustainability and performance. A comprehensive literature review analyzed ferrock's environmental benefits, carbon-negative nature, suitable applications, superior strength, flexibility, and crack resistance compared to concrete made of Ordinary Portland Cement. This review highlights the knowledge gaps and the need for further research, particularly addressing long-term performance, economic feasibility, and optimizing production. According to the review and existing research, key benefits of ferrock include its ability to absorb CO_2, thereby minimizing global warming, and its physical properties that prove superior to conventional concrete. Though a relatively new material, ferrock seems promising as an emerging construction material and could possibly replace concrete in the construction industry, without the environmentally detrimental impact concrete entails.

Keywords: *ferrock, sustainable, carbon-negative, recycled materials, emerging construction material*

(#16) Development of A Versatile Dye Concentration Measuring Device for The Fabric Manufacturing Industry Using Light Detection Technology

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Abstract

In response to a leading fabric manufacturer's need for a precise dye concentration measurement system, we developed an advanced spectrophotometric prototype to replace the current greyscale visual method. This cost-effective device features a 650nm laser module as the light source, a TEMT6000 light sensor to detect transmitted light intensity, and an Arduino Uno for data processing. The prototype's design, focused on durability and cost-efficiency, was realised using SolidWorks 2023 and wood fabrication. The system measures dye concentration by directing the laser through a copper sulphate solution and calculating absorbance using Beer-Lambert Law. Machine learning algorithms were integrated for automatic calibration, ensuring consistent and accurate readings. This solution offers enhanced accuracy, reduced waste, and improved operational efficiency, making it suitable for industrial applications.

Keywords: Dye Concentration, Light Detection, Machine Learning, Beer-Lambert's Law, Fabric Industry

(#18) Design and Development of Robust Mechanical Detection Mechanism in Textile Industry

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Abstract

The textile industry constantly seeks innovative solutions to improve the accuracy and efficiency of its manufacturing processes. One critical aspect is the measurement of strap length and thickness variations, which directly impact product quality. Traditional methods often rely on vision-based systems, which can be costly and complex. This research aims to design and develop a simple, cost-effective mechanical detection mechanism that accurately measures strap thickness and length, thereby enhancing operational efficiency. The study addresses the challenge of providing a straightforward solution that can be easily implemented in industrial settings, specifically focusing on fabric straps produced by companies like NATURUB (PVT) Ltd. and MAS UNICHELLA (PVT) Ltd.

Keywords: mechanical detection, textile industry, tape measure, thickness variation, fabric strap

(#19) A Novel Implementation Strategy for AES Algorithm on FPGA

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Abstract

Traditional methods of keeping data secure, while effective, face certain challenges. Information must be processed quickly and in real-time. This becomes a big problem during the use of the Advanced Encryption Standard (AES) algorithm. It is widely used in the modern world. encryption protocol due to the increasing complexity and volume of AES, Data acceleration requires new methods for designing and implementing encryption systems. High-performance encryption makes it difficult to integrate FPGA-based systems Programs that must work in real time. With specific optimization of FPGA architecture. The goal of AES work is to find the right balance between the use of computing resources. It also meets the need for energy-efficient and fast data processing.

Keywords: *AES Algorithm, FPGA, Encrypting, pipeline, optimizing*

(#22) AI-Enhanced Remote ICU Patient Monitoring System

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Abstract

Intensive Care Units (ICUs) are vital in healthcare, especially for patients at risk of rapid clinical deterioration. Effective monitoring is crucial for timely medical intervention and improved patient outcomes. However, in many developing countries like Sri Lanka, ICU monitoring largely relies on manual, paper-based systems. Nurses and healthcare staff manually record vital signs, which are then reviewed by medical professionals. While this method is standard, it has significant limitations, including potential human error, delays in data processing, and challenges in maintaining accurate records. To address these issues, there is a growing need for modern technological solutions that enhance the efficiency, accuracy, and security of ICU monitoring. This research focuses on developing an AI-enhanced remote ICU patient monitoring system. By transitioning from paper-based to digital platforms, this system aims to provide a robust, secure, and efficient solution for healthcare providers, improving overall care quality.

Keywords: *ICU patient monitoring, remote patient monitoring, rule-based system, AI for healthcare, cloud-based healthcare systems*

(#26) Underwater Identification of Sri Lanka's Top Exported Ornamental Diseased Fish

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Abstract

In the packing process before exporting, it is crucial to identify diseased and healthy fishes. And it is crucial to identify diseased fish early otherwise disease can spread very fast through water. Removing diseased fish from the healthy ones becomes crucial but poses a complex and time-consuming task, often requiring additional expenses when hiring labour. The scope of this research is to develop Deep Learning model which can identify healthy and diseased fish to overcome above challenges include lack of efficiency and labour cost.

Keywords: ornamental fish, computer vision, diseased fish, deep learning, image processing

(#33) Smart Powertrain Monitoring and Predictive Analysis for An Autonomous Guided Vehicle

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Abstract

Autonomous Guided Vehicles (AGVs) are essential in industrial automation, but their reliability is often compromised by powertrain failures, particularly in the battery and motor systems, leading to operational inefficiencies. Existing research typically focuses on either the battery or motor, neglecting the interdependencies crucial for effective fault detection. This research addresses these gaps by developing an IoT-based real-time monitoring system that uses the MQTT protocol to track key powertrain parameters like current, voltage, and temperature. Machine learning algorithms are employed to predict motor and battery health, with models classifying motor conditions and estimating battery State of Charge (SOC) in real time. By utilizing real-world AGV data, this study offers a more comprehensive and practical approach to enhancing AGV reliability and efficiency.

Keywords: *Autonomous Guided Vehicles, Powertrain failures, Internet of Things, Machine learning*

(#34) Use of Machine Learning for Predictive Identification: A Review

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Abstract

The review explores the transformative potential of Machine Learning (ML) techniques in predictive identification and Predictive Maintenance (PdM) within the manufacturing industry. Traditional maintenance methods, such as reactive and preventive maintenance, are limited in predicting and preventing unexpected machinery failures, leading to significant downtime and repair costs. This comprehensive review identifies current research gaps and evaluates the effectiveness of various ML algorithms in PdM applications. By systematically examining peer-reviewed articles from 2010 to 2023, the study highlights the advantages of ML in enhancing predictive accuracy. The methodology involved a rigid selection process of 50 relevant studies, focusing on ML techniques for failure prediction across different industries. The discussion emphasizes the shortcomings of conventional maintenance techniques and the use of mathematical models in PdM, advocating for the integration of scalable, flexible, and adaptive ML approaches. The paper concludes with a suggestion for further research on robust ML models tailored for PdM, the incorporation of real-time data, and IoT technologies. These advancements aim to revolutionize maintenance strategies, ensuring more efficient, reliable, and cost-effective operations in the tyre manufacturing sector.

Keywords: *predictive identification, machine learning, predictive maintenance, downtime reduction, maintenance strategies*

(#35) A Review: Night to Daytime Image Translation for Enhancing Autonomous Driving Systems

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Abstract

Navigating the challenges of low-light conditions in autonomous driving, this review focuses on the cutting-edge realm of Night to Day (N2D) image translation. Leveraging the transformative power of Generative Adversarial Networks (GANs), we explore how these advanced deep learning techniques can enhance the visual capabilities of autonomous vehicles, ensuring safety and reliability around the clock. From the pioneering Cycle GANs, which thrive without paired training data, to the precise yet data-dependent Pix2Pix models, this review synthesizes insights from a decade of research spanning 2010 to 2023. By systematically analyzing peer-reviewed articles and conference proceedings, we uncover the latest innovations, highlight persistent hurdles, and identify future directions for optimizing N2D image translation. Unsupervised GANs emerge as a promising solution, offering flexibility and performance without the need for large, paired datasets, although challenges like mode collapse and training instability remain. This review not only charts the current landscape of N2D translation techniques but also paves the way for future advancements that could revolutionize autonomous driving by identifying the limitations and gaps of the N2D image translation approaches.

Keywords: night-to-day image translation, autonomous driving, generative adversarial networks, unsupervised learning

(#43) A Review of Wireless Sensor Network-Based Indoor Positioning System Using Machine Learning

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Abstract

This review explores the advancements in wireless sensor networks-based indoor positioning systems using machine learning techniques. The review begins by highlighting the challenges faced by traditional positioning methods, such as GPS and GNSS, in indoor settings due to signal irregularities and complex structures. It then focuses on the emerging use of machine learning (ML) algorithms for achieving precise indoor positioning. Various techniques, including Fingerprinting, and Particle Filters, are discussed, which leverage data from wireless sensors. The integration of wireless sensor networks supported by advanced machine learning methods is emphasized as a promising approach for enhancing indoor positioning systems. The review further explores the use of machine learning algorithms such as Random Forest regression, Decision tree regression, support vector regression, and XGBoost algorithms. Overall, the literature review highlights the significant progress made through machine learning-based methods combined with wireless sensor networks and their potential to address the challenges and achieve effective indoor positioning.

Keywords: indoor positioning, wireless sensor networks machine learning, regression algorithms

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(#46) Mathematical Modelling and Framework for A Dynamic Reverse Osmosis Desalination Unit

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Abstract

Reverse osmosis (RO) is widely used for desalination, but traditional static control systems lack responsiveness to dynamic data. This study aims to develop an efficient control system for RO units that reacts to real-time data, optimizing freshwater production. We propose a conceptual framework for dynamic simulation using MATLAB. Key process parameters, including fluid dynamics and membrane characteristics, were extracted from existing literature to form the mathematical backbone of the simulation. The setup is categorized into Multi Input Multi Output (MIMO) compartments: the RO unit, permeate unit, and brine unit. Essential equations governing concentrations, flow rates, and pressures were established. The dynamic simulation prototype integrates a feedback control system to optimize functionality by adjusting parameters based on real-time data. The system's performance metrics include maintaining a recovery rate of 45%-75% and a salt rejection rate above 93%. Feedwater quality, particularly salinity and temperature, significantly impacts permeate quality and energy usage, highlighting the need for robust control strategies. Future work will implement the mathematical models and framework in MATLAB, incorporating a Finite Horizon Model Predictive Control algorithm into the feedback system. This dynamic simulation tool aims to enhance RO processes, boost productivity, and ensure consistent performance under varying conditions, contributing to the development of sustainable desalination technologies.

Keywords: *desalination, reverse osmosis, dynamic feedback, model predictive control, Matlab*

(#53) A Review of Intrusion Detection and Prevention Systems in IoT Networks Using Machine Learning with On-premises and Cloud Processing Techniques

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Abstract

The Internet of Things (IoT) has become increasingly relevant to modern society, impacting various aspects of daily life, industry, and governance. However, with its widespread adoption, security vulnerabilities in IoT devices, coupled with potential breaches of personal data, pose risks to user privacy and safety. Technological advancements, especially the integration of IoT with artificial intelligence, Machine, and Deep Learning (ML/DL), analytics, contribute to innovation and economic growth. One of the crucial components of securing IoT systems is early intrusion detection. Implementing robust intrusion detection mechanisms helps identify and respond to security incidents promptly. There are several methods that have been proposed by previous literature to implement these intrusion detection mechanisms such as Anomaly Detection, Behavioural Analysis, Network Monitoring, Signature-Based Detection and Machine Learning, and AI. Designing and implementing a dedicated system with hardware acceleration for Machine Learning (ML) is crucial. In this regard, we can use on-premises (edge/fog computing) Hardware Acceleration or Cloud-Based Processing both have their own advantages and drawbacks respectively. This research review aims to explore the implementation of a hybrid approach that combines both on-premises and cloud-based methods that can help optimize efficiency and costs.

Keywords: *IoT security, intrusion detection systems, machine learning, fog computing*

(#56) Control Algorithm for Battery Energy Storage Systems to Enhance Power Quality and Stability in Large-Scale Solar PV Systems

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Abstract

The rapid growth of renewable energy sources, particularly large-scale solar photovoltaic (PV) systems, has been a significant focus in Sri Lanka's efforts to diversify its energy mix and reduce reliance on fossil fuels. The integration of these intermittent and non-synchronous renewable energy sources has presented numerous challenges to the stability and power quality of the electricity grid. Voltage fluctuations, power quality issues, and grid instability, particularly frequency fluctuations, are prevalent problems that need to be addressed to ensure the reliable and efficient operation of the power system. Researchers have highlighted the importance of energy storage systems, such as battery energy storage systems (BESS) in mitigating the intermittency of solar PV generation and improving grid stability. Various BESS control strategies have been proposed, focusing on aspects like ramp rate control, frequency regulation, and voltage support. In the context of Sri Lanka, studies have identified the specific challenges faced by the country's power grid due to the integration of large-scale solar PV systems. Data for this research were collected from the DNS Wedearachchi Solar Power Plant, located in the Southern Province of Sri Lanka.

Keywords: solar PV intermittency, grid-connected solar PV, battery energy storage systems, ramp-rate control

(#59) Designing of the Dynamic Behavior of Planetary Gear System in Mini Hydro Power Plant

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Abstract

This research focuses on designing a novel planetary gear system for mini hydro power plants to enhance turbine rotation efficiency and overall transmission performance. In Sri Lanka, the mini hydro industry, with a potential of 400 MW, often encounters inefficiencies due to suboptimal turbine speeds in conventional setups, which typically utilize diversion systems, dams, and pumped storage methods. Our study proposes a 3-stage planetary gear system to address this issue by efficiently transferring power from the turbine to the generator. The methodology involves problem analysis, solution design, mathematical calculations, and dynamic analysis using software, followed by CAD simulations and prototype manufacturing based on specific material parameters. The final step includes analyzing the dynamic behavior of the prototype to ensure smooth operation and addressing challenges like wear, noise, and vibration. Results indicate that the proposed system achieves a gear ratio of 106.23, significantly enhancing speed and torque. Experimental testing shows that the system can increase speeds up to 1000 rpm, enabling generators to handle loads exceeding 1500 kW effectively. This innovative approach promises to revolutionize the mini hydropower sector by optimizing power consumption and advancing technology. The study emphasizes the importance of integrating precise parameters in the design process and suggests future research directions, including the use of advanced materials and condition monitoring strategies to further improve planetary gear systems. This groundbreaking design sets a new standard for efficiency and reliability in mini hydro power plants.

Keywords: *Hydroelectric power station, Mini Hydro plant, Planetary gear system, Turbine rotation speeds, Transmission system*

(#61) Design and Optimization of a Parallel Axis Manipulator for Drone-Based Package Handling in Logistics

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Abstract

With the rapid development of technology, UAV usage has expanded from non-contact to contact tasks. Logistics is one of the most promising applications for UAVs, with a projected market value of up to $28 billion, potentially accounting for 53% of shipping costs. Major companies are investing heavily in UAV technology for payload handling, with applications ranging from pharmaceutical deliveries to retail and e-commerce platforms. Last-mile delivery presents unique challenges for UAVs, as payload capacities vary significantly across models. While entry-level UAVs can carry only a few grams, more advanced models can transport several kilograms. However, managing additional payload beyond the UAV's empty weight remains a significant challenge, particularly in the face of unwanted disturbances. To address these challenges, Delta Parallel Arm Manipulators have been introduced for UAVs. Some designs incorporate grabbers to compensate for changes in the centre of gravity, enabling UAVs to handle various objects. However, current research often needs to integrate arm dynamics with overall UAV control, limiting the ability to compensate for external disturbances beyond the simple centre of gravity shifts in one direction. A global survey indicates that approximately 25% of all deliveries weigh between 0.2 and 0.5 kg, with another 24% falling in the 0.6 to 1 kg range. This data underscores the importance of developing UAV systems capable of reliably handling payloads within these weight ranges. This research aims to address the gaps in current UAV manipulator designs by developing a parallel arm manipulator for handling payload in logistics.

Keywords: UAV, parallel manipulator, Delta robot

(#62) A Comprehensive Review of Portable Weather Forecasting Stations Leveraging Deep Learning Techniques

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Abstract

Portable weather forecasting stations, empowered by deep learning algorithms, offer a promising solution for real-time, localized weather prediction. These systems are particularly valuable in providing precise weather data in remote and underserved areas. This review paper aims to explore the current landscape of portable weather forecasting stations utilizing deep learning, examining the methodologies, challenges, and advancements in this burgeoning field. By synthesizing peer-reviewed literature, this paper seeks to provide a comprehensive understanding of the integration of deep learning with portable weather systems and to identify future research directions. The review reveals significant advancements in the application of deep learning for portable weather forecasting stations, with deep learning algorithms, particularly Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), demonstrating superior accuracy in predicting various weather parameters compared to traditional methods. However, challenges such as data quality, hardware limitations, and the need for real-time data processing remain prevalent. Future research should focus on developing more advanced models, exploring new data sources, and enhancing the functionality and connectivity of portable weather stations through IoT integration. Interdisciplinary collaboration will be crucial in driving innovation and improving the accuracy of weather forecasting models, ultimately contributing to climate resilience.

***Keywords:** deep learning, weather forecasting, portable weather station*

(#71) Exploring the Influence of Dutch Colonial Architectural Elements on Interior Renovation Projects in Galle Fort

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Abstract

Galle Fort, a UNESCO World Heritage Site located on the southwestern coast of Sri Lanka, stands as a prominent testament to the island's rich history and the influence of Dutch colonial architecture. This research explores the influence of Dutch architectural elements on interior renovation projects within Galle Fort, focusing on how these elements shape the aesthetics, functionality, and cultural identity of contemporary spaces. The study is conducted through a multidisciplinary approach, integrating historical analysis, architectural theory, and case studies of the Galle Fort Hotel, Maritime Archaeology Museum, and Galle Fort Bazaar Hotel. The research aims to investigate the historical context of Dutch colonial architecture in Galle Fort and its impact on interior design aesthetics. It identifies key architectural elements such as gabled facades, latticework, and the use of local materials that are prevalent in renovation projects. Furthermore, it assesses the significance of these elements on the spatial organization, materials, and ornamentation of interior spaces, highlighting the balance between preserving historical integrity and meeting modern functional requirements. The findings reveal that Dutch architectural elements significantly influenced the interior renovations in Galle Fort, contributing to a unique blend of historical charm and contemporary functionality. This study underscores the importance of preserving architectural heritage while adapting to contemporary needs, offering valuable insights for architects, designers, and heritage conservationists engaged in similar projects. By documenting and analyzing the integration of Dutch colonial elements in modern interiors, the research contributes to a deeper understanding of cultural heritage preservation and innovative design practices within historical contexts.

Keywords: Dutch Colonial Architecture, Heritage Preservation, Galle Fort, Interior Renovation, Cultural Identity

(#75) Mitigating Power Quality Concerns of Sri Lankan Power Distribution Network through the Adoption of Smart Grid Solutions

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Abstract

The research explores the challenges of increasing electricity demand and the integration of distributed generation sources, particularly renewable energy, within the Sri Lankan power distribution network. These challenges include voltage deviations, frequency instability, and grid resilience issues, which are further exacerbated by bidirectional power flow, short-circuit currents, harmonic distortions, and transient stability concerns. Traditional methods currently used in Sri Lankan power networks are increasingly inadequate in addressing these issues, highlighting the need for modern smart grid solutions. The study proposes several smart grid technologies to mitigate these power quality concerns, including battery energy storage systems. Methodologically, the research employs simulation-based investigations using a multi-functional energy storage system to address power quality challenges. Tools like MATLAB Simulink, Open DSS, and Python are utilized to develop and test algorithms for frequency control, peak shaving, and power factor adjustment. Real-time data from the Wennapuwa low voltage grid substation is analyzed to evaluate reactive power control strategies under varying solar irradiation conditions. The simulations are conducted on a base network model representing an 11kV distribution network, focusing on battery charging routines by the grid and photovoltaic balance. The results demonstrate the effectiveness of the proposed reactive power control algorithms in maintaining voltage levels within acceptable limits, despite fluctuations in solar irradiation. The frequency control and peak shaving algorithms further enhance grid stability and efficiency. The study concludes that smart grid technologies offer significant potential for improving the resilience and reliability of the Sri Lankan power distribution network.

***Keywords:** battery energy storage systems, embedded generation integrations, power distribution network, reactive power control, smart grids*

(#78) A Comparative Analysis of the Productivity of Working from Home Vs Working in the Office: Interior Design Practices

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Abstract

This study investigates the productivity of interior designers working in a home-office setting. The findings, which used twenty-five interior designers, show that working from home has significant benefits, including improved physical health and lower stress levels, positively contributing to productivity. However, challenges such as maintaining motivation and separating work from personal life were also identified. On the other hand, office-based work provides a professional environment that supports face-to-face collaboration and resource access but is often hampered by unplanned interactions and noise. The research concludes that the most effective approach to maximizing productivity for interior designers is a hybrid work model combining home and office work environments.

Keywords: Interior Design Practice, Work from Home, Work in Office, Productivity

(#80) A Study on the Effectiveness of Biophilic Design in Restaurant Interiors

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Abstract

The Biophilic design encompasses more than just green-inspired design and decor - instead, it recognizes and highlights the connection between human spirits and nature, and how the natural world supports our pursuit of ultimate well-being. Biological design can most easily be understood by recognizing its changes with human impact on the environment, allowing us to remain connected to nature while still innovating. That is, biophysical design connects the natural world with industry, as well as an interior setting with natural elements included in and contributing to health and wellbeing. Restaurants that are considered biophysical should integrate activities that directly connect back to the natural world -Demonstrating how integrated activities can satisfy human desires for nature immersion. In recent years, the field of interior design has witnessed a paradigm shift, with an increasing emphasis on creating environments that not only cater to aesthetic preferences but also contribute to the well-being of individuals. One notable approach gaining traction is biophilic design, a concept rooted in the innate human connection with nature. This research endeavors to delve into the effectiveness of incorporating biophilic design principles in restaurant interiors, aiming to understand its impact on customer experience, satisfaction, and overall business success.The restaurant industry is highly competitive, with establishments constantly seeking innovative ways to distinguish themselves and create memorable experiences for their clientele. Biophilic design, with its potential to foster a sense of well-being and relaxation, may offer a unique and sustainable solution for achieving these goals. However, the extent to which biophilic design contributes to the success of restaurants remains an underexplored area of research.

Keywords: *Effectiveness, Biophilic design element, Customer satisfaction, Restaurant interior design, Biophilic design, Dining Accespiat*

(#81) A Comparative Study of BESS for Blackout Restoration and Frequency Regulation Instead of Gas Turbines

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Abstract

The reliability of electricity grids is crucial, especially for blackout restoration and frequency regulation. Traditional gas turbines, used for these purposes, have drawbacks including high costs and a substantial carbon footprint. This study explores the potential of Battery Energy Storage Systems (BESS) to replace gas turbines in Colombo, focusing on the Kelanithissa thermal power plant. BESS can provide effective frequency regulation and blackout restoration, acting as a spinning reserve with rapid response times and improved efficiency. The research uses MATLAB to design and model BESS integration into the power plant's restoration process. The control algorithm for BESS includes communication during blackouts, pre-charge sequence control, state-of-charge estimation, and incremental load connection to the grid. When a blackout is detected, the BESS pre-charge breaker activates, charging the DC link capacitor and maintaining the state of charge above 20%. Additional loads are connected at intervals to regulate frequency. The grid-forming inverter is crucial for regulating frequency and power supply, providing a more reliable response than gas turbines. Results show that BESS significantly improves response time and frequency stability during blackouts, managing incremental loads while maintaining desired frequency ranges. Key performance indicators, such as voltage stability and frequency control, demonstrate superior results with BESS compared to gas turbines. This enhanced responsiveness and reliability makes BESS a more effective solution for blackout restoration and frequency regulation. The study confirms the benefits of using BESS over gas turbines at the Kelanithissa power plant, enhancing system responsiveness, stability, and efficiency while reducing environmental impact.

Keywords: *Battery Energy Storage System, Blackout Restoration, Frequency Regulation, Kelanithissa Power Plant*

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(#85) Digital Advertising Campaign on Social Networks for the Launch of Decorative Templates

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Abstract

The present work is dedicated to proposing the structuring of a digital advertising campaign through three specific social networks with the purpose of launching digital decorative templates as an alternative design resource making known its usefulness and benefits to end users in multiple fields, including interior design and graphic design. A qualitative analysis and survey revealed that there are three preferred networks to search decorative templates in Russia, as this is the location where the study took place. The results showed that users are interested in using the decorative templates for interior and exterior design, office and personal items, and packaging. Based on these findings, the campaign was designed to promote the digital product's launch. The campaign will target Russian users on Instagram, Pinterest, and Vkontakte to increase brand awareness and drive sales.

Keywords: decorative digital templates, digital advertising campaign, social networks (sn), product presentation, exterior and interior decorations, online template design tools