ICEECE '26

International Conference on Electrical, Electronics and Communication Engineering

Theni Melapettai Hindu Nadargal Uravinmurai

NADAR SARASWATHI COLLEGE OF ENGINEERING & TECHNOLOGY

Nadar Saraswathi College of Engineering & Technology

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai
Accredited by NAAC with 'A' Grade | Recognized under Section 2(f) of the UGC Act, 1956
An ISO 9001:2015 Certified Institution
Vadapudupatti, Annanji (PO), Theni - 625 531

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Nadar Saraswathi College of Engineering & Technology

Engineering Excellence for Empowerment

Theni Melapettai Hindu Nadargal Uravinmurai

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ABOUT TMHNU

Genesis of Theni Melapettai Hindu Nadargal Uravinmurai (Since 1898)

Theni Melapettai Hindu Nadargal Uravinmurai (TMHNU) proudly proclaims its remarkable contribution to society through its commitment to quality education. Established in 1898, the pioneers of TMHNU laid the foundation for educational excellence by starting a primary school in 1919, named Nadar Saraswathi Vidhyasala, with just 38 students and 2 teachers.

What began as a small initiative has now grown into a strong and flourishing educational network. With the divine blessings of Annai Sri Bathrakaliamman, TMHNU has expanded into a group of 17 educational institutions. Today, these institutions collectively serve over 22,000 students, supported by more than 1,000 teaching staff and 1,000 non-teaching staff members.

This remarkable journey reflects TMHNU's unwavering dedication to empowering society through education and shaping future generations.

GOVERNING CELL OF TMHNU

President

Mr. A.S.G. Dharmarajan, B.A.,

It is my great pleasure to warmly welcome all participants to ICEECE'26. In this era of rapid technological advancement, such platforms play a vital role. They enable the exchange of ideas, innovations, and knowledge. This conference brings together researchers, scholars, and industry experts. It provides an excellent opportunity to explore emerging trends in technology.

I extend my heartfelt wishes to all the participants. May this gathering inspire meaningful discussions and new perspectives. Let it encourage collaboration across disciplines and domains. May innovative ideas evolve into impactful solutions for society. I wish you all a productive and enriching conference experience.

GOVERNING CELL OF TMHNU

Vice President

Mr.A.S. Jeevagan

I am pleased to extend my greetings on the occasion of the International Conference on Electricals, Electronics and Communication Engineering, organized by the Department of Electronics and Communication Engineering (ECE) and Electrical and Electronics Engineering (EEE).

This conference highlights the importance of interdisciplinary collaboration in addressing modern challenges in Electrical, Electronics, and Communication Engineering. The proceedings present a collection of high-quality research contributions that demonstrate both academic rigor and practical relevance across areas such as wireless communication, embedded systems, signal processing, IoT, power systems, renewable energy, and automation.

I congratulate all the authors, participants, and organizers for their commendable efforts. I am confident that the knowledge shared through this conference will contribute significantly to future technological advancements.

GOVERNING CELL OF TMHNU

General Secretary

Mr. M.M. Anandhavel,M.B.A.,

It is an honour to contribute to the organization of the International Conference on Electricals, Electronics and Communication Engineering, conducted by the Department of Electronics and Communication Engineering (ECE) and Electrical and Electronics Engineering (EEE).

The conference has provided an excellent platform for intellectual exchange and collaboration among researchers, academicians, and industry experts in the domains of Electrical, Electronics, and Communication Engineering. The proceedings include a collection of well-researched papers that reflect innovation, technical depth, and practical significance in areas such as wireless communication, embedded systems, signal processing, IoT, power systems, renewable energy, and automation.

I express my sincere gratitude to all contributors, reviewers, session coordinators, and volunteers whose efforts made this event possible. I am confident that this conference will have a lasting academic and professional impact.

GOVERNING CELL OF TMHNU

Treasurer

Mr. B.Ramachandran, MBA.,

I am pleased to be associated with the International Conference on Electricals, Electronics and Communication Engineering, organized by the Department of Electronics and Communication Engineering (ECE) and Electrical and Electronics Engineering (EEE).

The successful conduct of this conference reflects effective planning, coordination, and teamwork. The proceedings showcase valuable research contributions across key areas such as wireless communication, embedded systems, signal processing, IoT, power systens, renewable energy, and automation, highlighting innovation and academic excellence.

I extend my sincere thanks to all participants, sponsors, and organizing members for their support and cooperation. I am confident that this conference will contribute meaningfully to the advancement of research and innovation in Electrical, Electronics, and Communication Engineering.

ABOUT NSCET

Nadar Saraswathi College of Engineering and Technology was established in 2010 to uplift rural students and nurture them with excellence. Located on a 21-acre eco-friendly campus near Theni, the institution focuses on molding outstanding engineers as responsible citizens and professionals.

In today's world, there is a genuine need for an institute that provides quality academic and career education in a personalized atmosphere. NSCET offers programs that prepare students for successful employment through quality teaching, learning, and research. Our goal is to equip students with lifelong knowledge, skills, and credentials for professional advancement at any point in their careers.

Excellence in teaching remains our most important criterion for faculty recruitment. Our faculty are also engaged in continuous research, scholarly work, and service to the region and state. The college offers comprehensive support services to ensure student success.

PROMINENT PERSONALITIES OF NSCET

Secretary

Er.A.S.S.S. Somasundaram, B.E.,

It gives me great pleasure to present the proceedings of the International Conference on Electricals, Electronics and Communication Engineering, organized by the Department of Electronics and Communication Engineering (ECE) and Electrical and Electronics Engineering (EEE).

The conference received an encouraging response from researchers and professionals across various regions. The selected papers included in these proceedings cover emerging areas such as Wireless Communication & 5G/6G Technologies, VLSI Design & Embedded Systems, Signal and Image Processing, Internet of Things (IoT), Power Systems & Smart Grids, Renewable Energy Systems, Electric Vehicles, Control Systems & Automation, Robotics, and Industrial Electronics.

Each paper has undergone a rigorous peer-review process to ensure quality, originality, and relevance. I sincerely thank the reviewers, authors, and organizing team for their valuable contributions and commitment. I believe these proceedings will serve as a valuable resource for researchers, academicians, and practitioners in the field of Electricals, Electronics, and Communication Engineering.

PROMINENT PERSONALITIES OF NSCET

Joint Secretary

Mr.T.Subramani, BCA., MBA.,

It is a privilege to be associated with the International Conference on Electricals, Electronics and Communication Engineering, organized by the Department of Electronics and Communication Engineering (ECE) and Electrical and Electronics Engineering (EEE).

This conference has brought together a diverse community of researchers and professionals, providing a platform to share innovative ideas and discuss recent advancements in Electrical, Electronics, and Communication Engineering. The proceedings reflect the collective efforts of contributors who have presented insightful and impactful research in areas such as wireless communication, embedded systems, signal processing, IoT, power systems, renewable energy, and automation.

I extend my sincere appreciation to all authors, reviewers, and organizing members for their dedication and support. I hope that these proceedings will inspire continued research and collaboration in emerging domains of ECE and EEE.

PROMINENT PERSONALITIES OF NSCET

Principal

Dr. C. Mathalai Sundaram, M.E., M.B.A., Ph.D., PG(IoT)

It is my immense pleasure to welcome all participants, academicians, and industry experts to ICEECE'26. Our institution has always strived to bridge the gap between theoretical knowledge and practical innovation in the fields of Electrical, Electronics, and Communication Engineering.

The theme, Recent Trends in Electricals, Electronics and Communication Engineering, aligns perfectly with this vision. I am confident that the discussions and deliberations held during this conference will create a lasting impact and contribute meaningfully to the advancement of global technological knowledge.

ICEECE '26

International Conference on Electrical, Electronics and Communication Engineering

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Mr. Bener Kim Sam

Founder and Director,
Al Aiqaa FZE, Dubai

It is a great honour to deliver the keynote address at ICEECE'26. The theme, Recent Trends in Electricals, Electronics and Communication Engineering, truly reflects the transformative era we are living in. Innovation today is not optional—it is the driving force behind progress.

This conference offers a dynamic platform where ideas are exchanged, perspectives are challenged, and the future is shaped collaboratively. I encourage all participants to think beyond boundaries, embrace emerging technologies, and contribute meaningfully to the advancement of Electrical, Electronics, and Communication Engineering.

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TerraDefender: A Deep Learning Approach to Disaster Response

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ABSTRACT:

Accurate extraction of building footprints from high-resolution satellite and UAV imagery is a critical component of modern geospatial intelligence systems, particularly in military and strategic environments. Manual interpretation of such imagery is time-consuming, error-prone, and not scalable for large datasets. This report presents the TerraScan system, an automated building extraction framework that leverages deep learning techniques to efficiently identify and delineate building structures from geospatial images. The proposed system integrates preprocessing, gridwise classification, and pixelwise segmentation using a U-Net architecture to achieve precise and reliable results. The preprocessing stage ensures data normalization and enhancement, while the gridwise classifier filters regions of interest to reduce computational complexity. The pixelwise segmentation model then performs fine-grained analysis to generate accurate building masks. Post-processing and fusion techniques are applied to refine the outputs and improve boundary accuracy. The system is designed to support both centralized and edge deployment, enabling real-time processing and analysis in operational environments. Experimental evaluation demonstrates that the proposed approach achieves high segmentation accuracy while maintaining computational efficiency. The extracted building footprints provide valuable insights for applications such as urban terrain analysis, mission planning, and infrastructure assessment.

KEYWORDS:

Building Footprint Extraction, High-Resolution Imagery, UAV, Satellite Images, Deep Learning

U-Net Architecture, Image Segmentation, Geospatial Intelligence, Edge Deployment, Urban Analysis

Raspberry PI–Based Brain Tumor Detection using Brain MRI and CT Scan Images and Deep Learning

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ABSTRACT:

A Raspberry Pi-based brain tumor detection system using deep learning is presented for automated analysis of brain MRI and CT scan images. A convolutional neural network (CNN) is used to identify spatial features and classify images as tumor or non-tumor. The model consists of convolutional, pooling, and fully connected layers to learn patterns from the medical images. Before training, images are preprocessed through resizing, normalization, and noise reduction to improve the image quality and classification accuracy. To enable deployment on embedded software, the model is optimized using pruning, quantization, and hardware-aware inference, reducing model size and computational cost. It is then implemented on a Raspberry Pi for low-power edge computing without cloud dependency. The system is evaluated using metrics such as accuracy, precision, recall, F1-score, inference time, and power efficiency, showing promising results for portable and cost-effective early diagnosis.

KEYWORDS:

Brain Tumor Detection, Raspberry Pi, Deep Learning, Edge Computing, MRI/CT scans

Smart Safety System in Crackers Factory Using IoT

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ABSTRACT:

The safety of workers in crackers factories is a critical concern due to the risk of fire accidents caused by heat, friction, and hazardous chemicals. This project proposes an IoT-based smart safety system designed to enhance the early detection of fire hazards and ensure the safety of factory personnel. The system integrates multiple sensors, including an MQ-2 gas sensor for hazardous gas detection, a fire sensor, vibration sensor, LDR (Light Dependent Resistor) sensor, and a DHT11 sensor for monitoring temperature and humidity. These sensors work in real-time, providing continuous data to a central controller, such as an Arduino or Raspberry Pi, which processes the information and triggers necessary actions. The system utilizes a Wi-Fi module to send alerts and sensor data to the cloud, enabling remote monitoring and timely intervention. In case of abnormal conditions, such as fire, gas leaks, or dangerous vibrations, the system sends immediate alerts and notifications to the relevant personnel. By leveraging real-time monitoring and cloud-based data access, this IoT solution ensures faster response times, improved worker safety, and reduced risk of fire-related accidents in crackers factories.

KEYWORDS:

Internet of Things, Arduino, Vibration sensor, Inert gas system

Design of AI-Based Smart Energy Management System for Microgrids

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ABSTRACT:

The rapid growth in electricity demand, coupled with the increasing integration of renewable energy sources,has accelerated the development of microgrids as a reliable and sustainable solution for modern power systems. However, the intermittent nature of renewable energy sources such as solar and wind, along with dynamic load variations, poses significant challenges in maintaining energy balance, system stability, and cost efficiency. To address these challenges, this paper proposes the design and implementation of an Artificial Intelligence (AI)-based Smart Energy Management System (SEMS) for microgrids. The proposed system integrates distributed energy resources, including solar photovoltaic (PV) systems, wind energy conversion systems, and a Battery Energy Storage System (BESS), within a unified microgrid framework. An intelligent control strategy is developed using machine learning techniques such as Artificial Neural Networks (ANN) and Long Short-Term Memory (LSTM) networks to accurately forecast load demand and renewable energy generation based on real-time and historical data. The AI-based controller processes inputs such as load demand, generation levels, battery state of charge (SOC), and grid conditions to make optimal energy management decisions. The SEMS prioritizes the utilization of renewable energy sources, followed by efficient battery charging and discharging, and finally grid interaction when necessary. An optimization algorithm is incorporated to minimize operational cost, reduce power losses, and improve overall system efficiency while ensuring uninterrupted power supply. The system also employs IoT-based monitoring for real-time data acquisition, enabling adaptive and autonomous decision-making.

KEYWORDS:

Microgrid, Artificial Intelligence (AI), Smart Energy Management, Renewable Energy, Battery Energy Storage (BESS), Load Forecasting, IoT Monitoring.

E-Tongue Based Intelligent System for Ayurvedic Dravya Identification using Machine Learning and IoT

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ABSTRACT:

The E-Tongue for Dravya Identification system is designed to develop a sensor-based electronic tongue capable of identifying Ayurvedic herbs through their taste (Rasa) characteristics. Using an array of taste-sensitive chemical sensors, the system captures complex flavor profiles of herbal samples and converts them into measurable electrical signals. These signals are processed with machine learning algorithms to enable real-time classification of herbs and detection of adulteration or substitution. By integrating mobile and cloud connectivity, the platform supports seamless data access, remote monitoring, and secure logging for researchers, practitioners, and quality control authorities. A central objective is to scientifically validate Ayurvedic Rasa classification by correlating sensor-derived taste patterns with traditional knowledge through data-driven models. This approach enhances standardization, strengthens authenticity verification, and supports evidence-based validation of herbal medicines, contributing to improved safety, reliability, and modernization of Ayurvedic drug identification systems.

KEYWORDS:

Electronic tongue, Ayurvedic herbs, Rasa classification, Taste sensors, Machine learning, Adulteration detection, Authenticity verification, Cloud connectivity, Quality control, Herbal medicine standardization

A Comprehensive Review of Machine Learning Techniques for Heart Disease Prediction and Diagnosis

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ABSTRACT:

During the whole cardiac cycle, heart sounds are created, and blood enters the heart chambers as the cardiac regulators open and close. Blood flow produces aural noises; the more turbulent the blood flow, the more ambiances are created. Two common cardiac sounds occur in sequence with each heartbeat in healthy adults. These are the first heart sound (S1) and second heart sound (S2), which are caused by the closure of the atrioventricular and semilunar valves, respectively. The current systematic review depends on "The Preferred Reporting Items for Systematic reviews and Meta-Analysis statement" and 40 appropriate studies. The search of the literature employed search engines similar to: IEEE Xplore, Google Scholar, Hindawi, PubMed, SCOPUS, Wiley Online, Web of Science, Taylor and Francis, ScienceDirect, and Ebscohost. This study concentrated on four characteristics: Algorithms of Machine and Deep Learning, best-algorithm performance, datasets, and application used in cardiovascular diseases predictions. The experimental articles did not use Reinforcement Learning, Semi-supervised learning, promising aspects of Deep and Machine Learning. Algorithms based on ensemble technique exhibited sensible rates of accuracy nonetheless were not frequent, whereas Convolutional Neural Network (CNN) were well epitomized. A few studies smeared main dataset. Recurrent Neural Network (RNN), boosting algorithms, Support Vector Machine (SVM) and K-Nearest Neighbors (KNN), were the best performing algorithms. This review will be beneficial for investigators predicting cardiovascular diseases using machine and deep learning methods.

KEYWORDS:

Cardiac cycle, heart sounds (S1, S2), blood flow turbulence, cardiovascular diseases, Machine learning, deep learning, CNN, RNN, SVM, KNN, ensemble methods, predictive analytics

IoT-Based Energy Efficient Solar Air Quality Monitoring System with Intelligent Control Actions

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ABSTRACT:

Air pollution is a major environmental issue affecting human health globally.Traditional monitoring systems are expensive and lack real-time accessibility.This paper proposes a detailed design of an IoT-based solar-powered air quality monitoring system using ESP32. The system monitors gases such as CO, NO2, VOCs, and particulate matter (PM2.5), along with temperature and humidity.The collected data is transmitted to cloud platforms such as ThingSpeak for real-time visualization and analysis. Intelligent control actions such as automatic activation of exhaust fans and air purifiers are implemented when pollution levels exceed thresholds.The integration of renewable solar energy ensures sustainability and uninterrupted operation. The system is cost-effective, portable, and suitable for smart city and rural applications.

KEYWORDS:

Air Quality Monitoring, Internet of Things (IoT), ESP32, Solar Power, Gas Sensors, Cloud Monitoring (ThingSpeak), Smart Environment

Design of Pipelined RTL Architecture for Biomedical Image Processing Applications

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ABSTRACT:

This paper presents the design and verification of a pipelined Register Transfer Level (RTL) architecture for real-time biomedical image processing using Verilog HDL. The proposed design adopts a streaming pixel-per-clock dataflow model, enabling continuous processing of image data with high throughput and deterministic latency. Unlike conventional software-based implementations, which process pixels sequentially and incur significant computational overhead, the proposed architecture leverages hardware-level parallelism through pipelining to achieve real-time performance. The architecture is implemented as a 14-stage pipeline, where each stage performs a specific image processing operation and is mapped to dedicated registers to ensure synchronized data propagation and timing stability. The processing stages include filtering, enhancement, gradient computation, adaptive thresholding, and morphological operations. Each stage in the pipeline operates concurrently, and intermediate outputs are registered and propagated forward every clock cycle. This design ensures that, after initial pipeline filling, the system produces one output pixel per clock cycle, achieving high throughput. Furthermore, the RTL implementation provides stage-wise output visibility, enabling detailed waveform-level verification and simplifying debugging during simulation. Functional validation of the architecture is carried out using a dedicated Verilog testbench, where input image data is supplied in a streaming manner and output responses are monitored across all pipeline stages.

Key Words:

Simulation-Driven VLSI Modeling, Biomedical Image Processing, Streaming RTL Architecture, ASIC Design Flow, OpenLane , Deterministic Latency, Verilog HDL

AI-Driven Predictive Maintenance for Critical Systems Using Machine Learning

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ABSTRACT:

In modern industries and healthcare environments, unexpected equipment failures can lead to severe financial losses and risk to human life. This paper proposes an AI-based predictive maintenance system that leverages machine learning algorithms to monitor equipment performance in real time and predict potential failures before they occur. The system utilizes sensor data such as temperature, vibration, and operational metrics to train models like Random Forest and LSTM networks. By analyzing patterns and anomalies, the proposed solution ensures early fault detection and reduces downtime. Compared to traditional reactive maintenance strategies, this approach significantly improves efficiency, safety, and cost-effectiveness. The study demonstrates how integrating AI into maintenance systems can revolutionize operational reliability across industries.

KEYWORDS:

Artificial Intelligence, Machine Learning, Student Dropout Prediction, Predictive Analytics, Early Warning Systems, Educational Data Mining, Student Retention

Intelligent Li-Fi/Wi-Fi Integrated System for Vehicle-To-Vehicle Communication

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ABSTRACT:

With the increase in number of vehicles traffic control and road safety are becoming Major problems in Modern Street situations. In order to facilitate vehicle–vehicle (V2V) and vehicle–infrastructure (V2I) communication the paper propose an intelligent hybrid communications system that combines Li-Fi and RF technology. The smart system continuously evaluates the geolocation of vehicle conditions in real time from parameters like speed and ultrasonic. An ATmega328P microcontroller is used to read the sensor data existing short distance or overspeed cases are being identified by it. Long-distant communication is done via RF module while short-distance for high-speed data transfer among vehicles is done via Li-Fi. Cloud Monitoring and data logging is implemented with IoT integrating ESP8266. Giving Alert regards this to driver will create them aware and reduce the scope of an accident. The system implements facilitates better communication making most reliable. Scientific Journal Impact Factor 3.617. Stop our waste. Let' s Traffic speak it out loudly.

KEYWORDS:

Li-Fi, RF Module, IoT, Road Safety, V2V Communication, V2I Communication.

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Defect Detection in Printed Circuit Board Using Image Processing and Yolov8

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ABSTRACT:

This work presents an intelligent and automated Printed Circuit Board (PCB) defect detection system using image processing and deep learning techniques to improve inspection accuracy and efficiency. The system is designed to detect and classify major defects such as missing holes, open circuits, and short circuits by analyzing PCB images. The methodology includes preprocessing steps such as grayscale conversion, noise removal, thresholding, and image enhancement, followed by segmentation to extract important defect regions. The segmented images are then used to train a YOLOv8 model, which learns features and performs accurate defect detection and classification. The system performance is evaluated using metrics such as precision,recall, F1-score, and confusion matrix. This approach reduces manual inspection errors and improves detection speed and accuracy. The proposed system can be applied in automated inspection systems and supports real-time PCB defect detection in industrial environments.

KEYWORDS:

Printed Circuit Board (PCB) defect detection, image processing, deep learning, YOLOv8, computer vision, image segmentation, automated inspection, real-time detection.

NanoVolt Detect: Electrochemical Intelligence for Pollution Analysis

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ABSTRACT:

This study presents the development of a nanomaterial-based electrochemical sensing platform for the detection of organic pollutants and heavy metal ions in vegetables and water. The synthesized nanomaterial was systematically characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA) to evaluate its structural integrity, functional groups, and thermal stability. Electrochemical measurements were conducted using a conventional three-electrode configuration coupled with an electrochemical analyzer. Cyclic voltammetry (CV) was employed in the presence of potassium chloride (KCl) as a supporting electrolyte to examine the redox behavior of dopamine as a model analyte. The sensor exhibited well-defined oxidation peaks and stable electrochemical responses, indicating efficient electron transfer and favorable sensing characteristics. Furthermore, the developed sensing platform demonstrated a sensitivity of approximately 0.1 μA/μM, along with high analytical accuracy and excellent signal reproducibility. These results highlight the potential applicability of the proposed sensor for sensitive and reliable detection of biomolecules in advanced analytical and environmental monitoring systems.

KEYWORDS:

Nanomaterial-Based Sensor, Electrochemical Sensing, Organic Pollutants, Heavy Metal Ions, Environmental Monitoring**,** Cyclic Voltammetry, Dopamine Detection, XRD, FTIR, TGA, Sensitivity, Analytical Accuracy

A Smart Health Monitoring System Integrating Internet of Things

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ABSTRACT:

Real-time, continuous monitoring of Intensive Care Unit (ICU) patients is clinically indispensable but financially out of reach for small hospitals and rural clinics in India, where commercial monitoring units' cost is too high. This paper presents a IoT-based ICU patient monitoring system built around the ESP32 microcontroller at a lower hardware cost. The system simultaneously tracks ten physiological and environmental parameters - heart rate (BPM), blood oxygen saturation (SpO_2), and estimated blood pressure via the MAX30102 optical sensor; body temperature via DS18B20; ambient temperature and humidity via DHT11; gas and smoke via MQ-2; flame via KY-026; patient motion and bed exit via HC-SR501 PIR; patient fall via SW-420 vibration; and IV saline or urine bag level via HW-038 conductivity sensor. All sensor readings are pushed to the ThingSpeak cloud platform. An web dashboard, hosted directly on the ESP32 and accessible from any browser on the local WiFi network.

KEYWORDS:

IoT, ICU monitoring, ESP32, MAX30102, SpO_2, DHT11, ThingSpeak, WiFi

Smart Load and Source Management System

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ABSTRACT:

Effective power management systems are required due to the increasing demand for electricity and the incorporation of renewable energy sources. This paper describes an Internet of Things (IoT)-based Smart Load and Source Management System that distributes electrical loads according to real-time demand and automatically chooses the best power source. The system ensures dependable and effective energy use by integrating various energy sources, such as solar power, battery storage, and the utility grid. It dynamically switches between sources based on load requirements and source conditions while continuously monitoring each source's availability and status. The system makes use of IoT technology to provide remote access to system data as well as real-time monitoring and control. This clever strategy lessens reliance on a single source and improves power distribution efficiency. The system works well in residential buildings, distribution centers. This smart solution eliminates dependency on a single source and improves power distribution efficiency. Distribution centers, homes, and businesses can all use the system. Sustainable energy management is supported by experimental results that show increased energy efficiency, optimized source usage, and decreased energy waste.

KEYWORDS:

IoT, Smart Energy Management, Load Management, Renewable Energy Integration, Power Source Optimization, Smart Grid, Energy Efficiency, Real-Time Monitoring, Sustainable Energy

Predictive Analysis of Employee Attrition using Machine Learning

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ABSTRACT:

Goal: By examining the interactions between work-life balance, career stress, growth prospects, and general job satisfaction, this study explores the major factors that contribute to workplace turnover. Methodology: The study uses a dual-phase analytical approach using a dataset of 110 employee samples. Initially, correlations between workplace characteristics were determined using statistical analysis. In order to estimate the likelihood of employee turnover, the study created and assessed five machine learning models: Logistic Regression, Decision Tree Classifier, Random Forest Classifier, Support Vector Machine (SVM), and Gradient Boosting (XGBoost). The dataset was partitioned into a 70% training set and a 30% testing set, with hyperparameter tweaking conducted to optimise predicted accuracy.

Findings: The main causes of attrition are found to be work-life balance, a lack of career advancement, and increased stress. High work frequency and satisfaction with work-life balance were found to be significantly correlated negatively. On the other hand, employee satisfaction and organisational support for stress management were found to be positively correlated.
The results indicate that machine learning methods are capable of accurately predicting turnover risks. To increase retention rates and promote organisational stability, HR professionals should give priority to improving work-life integration and stress management measures.

KEYWORDS:

Employee Turnover, Work-Life Balance, Career Stress, Job Satisfaction, Employee Retention Machine Learning, Predictive Analytics, Logistic Regression, Random Forest, Support Vector Machine, XGBoost

Self-Healing Digital Logic Circuits Using AI-Based Fault Prediction

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ABSTRACT:

Ensuring hardware reliability is critical for mission-critical industrial applications where unexpected downtime leads to severe consequences. This project presents a self-healing digital logic circuit system utilizing artificial intelligence for proactive fault prediction and dynamic recovery. Prioritizing physical hardware-software integration over virtual simulation, the system continuously monitors real-time operational parameters to detect early anomalies before catastrophic failures occur. A Python-based machine learning model analyzes this hardware data to identify predictive fault patterns with high accuracy. Upon forecasting a potential failure, the physical logic circuits, implemented using Verilog, execute autonomous reconfiguration to seamlessly bypass compromised nodes. This cohesive hardware- software co-design ensures uninterrupted and robust fault tolerance. By enabling real-time detection and automated structural recovery, the proposed architecture significantly improves the reliability, safety, and operational lifespan of complex digital systems.

KEYWORDS:

Self-healing, AI fault prediction, Digital logic, Hardware integration, Verilog

Privacy-First AI Cloud Gallery for India: Semantic Search, Multilingual Captioning, and Offline Access in PhotoNest

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ABSTRACT:

India has a lot of digital photos and videos because smartphones and cheap internet are now common. But it's still hard to put them in the right order. Google Photos and iCloud are two systems that already exist that help, but they often have trouble finding the right balance between privacy, personalization, and cultural awareness. This paper is about PhotoNest, an AI-powered cloud gallery that is only available to people in India. PhotoNest uses CLIP and BLIP for semantic search, Stable Diffusion and Dream Booth for remembering events, multilingual captions, and Progressive Web Apps (PWAs) for offline access. It puts privacy first by using AES-256 encryption, watermarking, and user-controlled consent, which are all in line with India's Digital Personal Data Protection Act (DPDP, 2023). This way is not the same as the ones used by other platforms. A pilot study with people from different cities and towns showed that the app worked well without an internet connection, with people from different cultures, and in many languages. Quantitative testing showed that the accuracy of semantic retrieval went up from 72% to 86%, and the latency was acceptable. The results show that PhotoNest successfully combines personalization, privacy, and cultural adaptability to make AI ethics, digital memory systems, and human-computer interaction better in new markets.

KEYWORDS:

Cloud storage systems, generative AI, image retrieval, privacy protection, progressive web apps, and human-computer interaction are all important terms.

A Microcontroller-Based Autonomous Solar Declination Control System using the GPS Synchronization.

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ABSTRACT:

The design and implementation of a microcontroller-based autonomous solar declination control system for low-frequency radio antenna applications are presented in this work. The proposed system enables automatic RF signal path switching in a Log-Periodic Dipole Array (LPDA) antenna used for solar radio observations. A dsPIC33 microcontroller is employed and interfaced with a GPS receiver to acquire real-time date information, which is used to compute solar declination accurately based on established astronomical models. Depending on the computed declination angle, a relay-based switching network dynamically selects between delay and no-delay RF signal paths, ensuring optimal antenna configuration without manual intervention. To enhance system reliability, a fallback real-time clock (RTC) mechanism is incorporated, allowing uninterrupted operation in the absence of GPS signals—particularly important for remote and unattended observatory installations. The proposed system significantly reduces human effort, improves observational accuracy, and supports continuous long-term solar monitoring. Experimental validation confirms accurate switching performance across the full solar declination range (−23.5° to +23.5°). The compact, cost-effective, and robust design makes it suitable for deployment in field observatories and integration into global low-frequency radio astronomy networks.

KEYWORDS:

Microcontroller-based system, solar declination, dsPIC33, GPS receiver, real-time clock (RTC), LPDA antenna, RF switching, autonomous control, radio astronomy, low-frequency observation.

Early Diabetic Retinopathy Screening using Retinal Fundus Image Processing and Artificial Intelligence

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ABSTRACT:

This paper presents the design and implementation of an automated deep learning-based system for the multi-stage detection and classification of diabetic retinopathy using retinal fundus images. Unlike conventional diagnostic approaches that rely on manual examination by ophthalmologists or traditional machine learning techniques with handcrafted features, the proposed methodology focuses on robust feature learning through transfer learning and ensemble-based classification. The system is developed using the EfficientNet-B7 architecture, which provides superior feature extraction capabilities while maintaining computational efficiency. A comprehensive preprocessing pipeline is employed, including image resizing, normalization, Gaussian enhancement, removal of black borders, circular cropping, and data augmentation to improve image quality and model generalization. The model is initially pre-trained on the Diabetic Retinopathy Detection 2015 dataset and subsequently fine-tuned using the APTOS 2019 Blindness Detection dataset, enabling improved robustness across diverse imaging conditions. The proposed framework classifies retinal images into five clinically significant stages: No Diabetic Retinopathy, Mild, Moderate, Severe, and Proliferative Diabetic Retinopathy. To enhance prediction stability and reduce variance, an ensemble learning strategy is incorporated, combining the outputs of multiple trained models. Comprehensive performance evaluation is conducted using standard metrics, including accuracy, precision, recall, F1-score, and Cohen's Kappa coefficient. Experimental results demonstrate an overall accuracy of 80%, with a weighted precision of 0.77, recall of 0.80, F1-score of 0.76, and an average Kappa score of 0.8527, indicating strong agreement with expert annotations. Furthermore, the trained model is integrated into a user-friendly web-based application developed using Flask, enabling real-time retinal image analysis and instant diagnostic feedback. The proposed system provides an efficient, scalable, and accessible solution

for early diabetic retinopathy screening, supporting teleophthalmology applications and assisting clinicians in timely decision-making

KEYWORDS:

Diabetic Retinopathy Detection, Deep Learning, EfficientNetB7, Retinal Image Analysis, Convolutional Neural Networks (CNN), Transfer Learning, Medical Image Processing, Multi-Class Classification, Kappa Score Evaluation, Web-Based Prediction System

Smart Industrial Machine Health Monitoring System Using IoT

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ABSTRACT:

This paper presents an IoT-based smart industrial machine health monitoring system designed to enhance predictive maintenance and reduce unexpected failures. Unplanned outage in industry due to machine failures can lead to significant production losses and increased maintenance costs. Predictive maintenance methods use the data collected from IoT-enabled devices installed in working machines to detect incipient faults and prevent major failures. In this study, a predictive maintenance system based on machine learning algorithms, specifically AdaBoost, is presented to classify different types of machines stops in real-time with application in knitting machines. The data collected from the machines include machine speeds and steps, which were pre-processed and fed into the machine learning model to classify six types of machines stops: gate stop, feeder stop, needle stop, completed roll stop, idle stop, and lycra stop. The model is trained and optimized using a combination of hyperparameter tuning and cross-validation techniques to achieve an accuracy of 92% on the test set. The results demonstrate the potential of the proposed system to accurately classify machine stops and enable timely maintenance actions; thereby, improving the overall efficiency and productivity of the textile industry.

KEYWORDS:

IoT-based Monitoring, Predictive Maintenance, Machine Learning (AdaBoost), Machine Fault Classification, Textile Industry Automation

Airmatrix: Edge-Based Air Quality Monitoring System

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ABSTRACT:

The proposed vehicle cabin air monitoring system ensures passenger safety by continuously detecting harmful gases such as CO, NO_2, and NH_3 using the MICS-6814 sensor and Arduino- based processing. It identifies hazardous conditions like exhaust leakage, fuel vapour emission, coolant combustion, and oil fumes, displays real-time readings on an LCD, and automatically activates ventilation when unsafe levels are detected. This cost-effective and reliable system enhances in-vehicle air quality management and supports the development of smarter automotive safety solutions.

KEYWORDS:

In-vehicle air monitoring, Cabin air quality assessment, Hazardous gas identification, MICS- 6814 gas sensor, Embedded system implementation.

AI-Driven Multi-Sensor Vehicle Safety & Autonomous Emergency Parking System

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ABSTRACT:

Road accidents due to driver drowsiness, health emergencies, and loss of control remain major causes of fatalities worldwide. Traditional safety systems emphasize vehicle dynamics but overlook the driver's physical and cognitive state. This work proposes an AI based multisensor vehicle safety system integrating drowsiness detection, health monitoring, and autonomous emergency parking. A Raspberry Pi 4 runs computer vision models to analyze facial cues such as eye closure, blinking, and yawning, enabling robust fatigue detection under varied conditions. An ESP32 subsystem with a MAX30102 sensor monitors heart rate and SpO_2, while capacitive touch sensing ensures steering wheel interaction. By combining behavioural and physiological indicators, the system achieves reliable multimodal decision making. Upon detecting sustained impairment—drowsiness, abnormal vitals, or hands off steering—the vehicle initiates autonomous roadside parking using lane detection and controlled motor actuation. This unified platform enhances driver safety by reducing accident severity when manual operation becomes ineffective.

KEYWORDS:

Driver Drowsiness Detection, Vehicle Safety System, Health Monitoring, Autonomous Emergency Parking, Multisensor Integration, Computer Vision, Raspberry Pi 4, ESP32, MAX30102 Sensor, SpO_2 Monitoring, Lane

GNN-Based Prediction on Static voltage drop in Digital Circuits

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ABSTRACT:

As transistor densities increase, Static IR Drop analysis has become a critical computational bottleneck in the VLSI physical design flow. While Machine Learning (ML) techniques offer accelerated prediction, representing complex 2D physical layouts in a format suitable for AI remains a significant challenge. This paper presents an end-to-end, spatially-aware framework utilizing Graph Neural Networks (GNNs) for the prediction of static IR drop in integrated circuits. Using standard benchmark circuits (e.g., c432) processed through an industry-standard Cadence sign-off flow (Genus, Innovis, Voltus), we developed a custom parsing pipeline that translates raw physical design files directly into spatial graphs. This formulation allows the GNN to utilize message-passing architectures to dynamically learn the physics of the power delivery network without relying on manual spatial feature engineering. Furthermore, to combat the mathematical illusion of high overall accuracy in heavily imbalanced power grids, our model was strictly evaluated on its ability to isolate the top 10% worst-case critical gates. Our empirical results validate that spatial graph representations successfully capture the complex routing dependencies inherent in microchip layouts. We conclude that the end-to-end architecture of GNNs provides a robust, highly automated foundation for AI-driven EDA tools, offering the necessary structural awareness to scale to complex, industrial-grade designs.

KEYWORDS:

IR drop prediction, Graph Neural Networks, VLSI physical design, power delivery network, electronic design automation, machine learning, spatial graph representation.

Adaptive API Gateway for Secure, Reliable Data Exchange in IoT Ecosystems

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ABSTRACT:

The rapid expansion of APIs in IoT application packages presents serious security, usability, and lifecycle management issues. Because they lack the intelligence to handle dynamic endpoints or proactively resolve vulnerabilities, traditional API gateways function reactively. In order to automate security and administration inside IoT ecosystems, this article presents a revolutionary framework called the Intelligent API Gateway. Four key features are integrated into our proactive model: dynamic re-authentication of vulnerable endpoints; continuous authentication optimality and usability testing; automated API discovery and inventory to maintain a real-time census of endpoints; and a context-aware recommendation engine to direct developers toward secure usage practices. Through the implementation of a proof-of-concept, we show how effective the framework is at independently locating and protecting API endpoints while giving users useful information. The findings show that IoT apps have a stronger security posture and a considerable decrease in manual oversight. A fundamental change from reactive API administration to an intelligent, automated, and comprehensive paradigm is provided by this study.

KEYWORDS:

Intelligent API Gateway, IoT Security, API Management, Automated Authentication

Real-Time Heart Rate Monitoring and Cardiac Anomaly Detection System Using Raspberry Pi 4 Model B with Firebase Cloud Backend

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ABSTRACT:

The top cause of death in the world is cardiovascular diseases, which kill around 17.9 million people annually, according to the World Health Organization. Timely identification of cardiac abnormalities, such as tachycardia, bradycardia, clinically irregular rhythms, suggestive of possible myocardial infarction, are potentially helpful in improving patient outcomes. The given paper proposes the design and implementation of a cost-effective, IoT-based real-time finite heart rate monitoring and cardiac anomaly detector system with the assistance of Raspberry Pi 4 Model B to form a central processing unit, a MAX30102 optical photoplethysmography (PPG) sensor to measure and record heart rate, and blood oxygen saturation (SpO 2) as well as Google firebase as the cloud service platform to store, synchronize, and dispatch emergency alerts. The suggested system constantly gets physiological data, work with it according to the rules of a peak-detection algorithm, analysis of heart rate variability (HRV), and associates the cardiac condition with normal, warning, or critical. When a critical area is sensed, a system sends local alerts using a buzzer and LED and at the same time, sends out emergency alerts using Firebase Cloud Messaging (FCM) to registered devices of caregivers. Experimental findings shows an approximation error of heart rate of only to the tune of + 2.3 BPM to an approved pulse oximeter base, and end to endreaction time of less than 1.8 seconds with a Wi-Fi interface. In a controlled study, the sensitivity of the system is 94.7 per cent and the specificity is 91.2 per cent to detect abnormal events in the cardiac system. The solution suggested has become a less expensive, scalable and remotely accessed option to traditional cardiac monitoring devices, and would have a high degree of use in home healthcare, eldercare, and in the rural Telehealth applications.

KEYWORDS:

Internet of Things, cardiac monitoring, photoplethysmography, Raspberry Pi, Firebase, heart rate variability, anomaly detection, telemedicine, remote patient monitoring

Design and Implementation of an IoT-Enabled Smart Panic Desk for Women Safety in Educational Campuses

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ABSTRACT:

Ensuring women's safety within educational campuses is a critical concern that demands rapid and discreet emergency response mechanisms. This paper presents the design and implementation of an IoT-enabled Smart Panic Desk, a concealed emergency alert system intended for deployment in classrooms, hostels, libraries, and study areas.

The proposed system incorporates a hidden panic button installed beneath desks or tables, enabling users to trigger alerts silently during emergency situations. Upon activation, the system transmits real-time notifications, including location and timestamp, to designated authorities such as security personnel or hostel wardens. Additional features, such as automatic camera activation, warning indicators, and audible alarms, can be integrated to enhance response effectiveness.

Unlike wearable safety devices, the proposed solution offers a fixed, infrastructure-based approach that ensures constant availability and ease of access. The system is cost-effective, reliable, and scalable, making it suitable for modern smart campus environments. By enabling immediate and discreet communication during emergencies, the system significantly enhances safety and response efficiency.

KEYWORDS:

IoT, Women Safety, Smart Panic Desk, Campus Security, Emergency Alert Systems

Experimental Study of Geometrical Characteristics on Teflon with Various End Point Drill Bit Angle

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ABSTRACT

High-temperature polymers like Acetal homopolymer (Teflon) find application in various forms. In particular, they can be used in conventional parts either to reduce their weight and cost, or as per the requirement of a particular application, and so forth. Some examples of the preferred application of such polymers would be aircraft interior, wire insulation, wire coupling and fastenings, and so forth, especially at the application of high temperature. Drilling process is liable to affect the near net shape in which the finished product is made available. For conducting the experimental investigation with the purpose of finding out the minimal value of surface roughness as well as geometrical accuracy, the experiment was optimized for drilling of Teflon polymer in wet conditions. The four levels of variables like N, f, EPA, and P were considered as control parameters for response variable. It was observed from output responses that minimum average roughness of 0.43µm was achieved when the fifth parameter had been used where the speed and feed rate were low, pecking was high and end point angle was low. Of course, lower end point angle of drill bits helped in minimizing surface roughness and also in enhancing geometrical accuracy.

KEYWORDS:

Wet drilling, Taguchi method, DOE, Ra, Pecking rate.

Smart Hybrid Renewable Energy System for Residential Power Supply

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ABSTRACT:

The growing demand for reliable and sustainable energy in residential sectors has led to the development of hybrid renewable energy systems. This paper presents a smart hybrid system that integrates solar and wind energy sources to provide continuous and efficient power supply for residential applications. The system combines photovoltaic (PV) panels and a wind turbine with battery storage to overcome the intermittency of individual energy sources. A microcontroller-based energy management system (EMS) is used to monitor and optimize power flow between sources, storage, and load based on environmental conditions. Excess energy is stored during peak generation, while stored energy is utilized during low generation periods. IoT-based monitoring enables real-time data visualization of parameters such as voltage, current, power output, and battery status through cloud platforms.

The system also includes protection mechanisms to ensure safe and reliable operation. Results indicate improved energy efficiency, reduced dependency on grid power, and enhanced system reliability. The proposed solution is cost-effective, scalable, and suitable for smart residential applications, promoting sustainable energy utilization and reduced carbon emissions.

KEYWORDS:

Hybrid Renewable Energy System, Solar Energy, Wind Energy EMS, IoT, Smart Grid, Residential Power Supply

Flow-Based Forensic Attack Chain Reconstruction for Scalable Analysis of Multi-Stage Cyber Attacks in Enterprise Wired Networks

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ABSTRACT:

Enterprise wired networks serve as the critical infrastructure for organizational communication and data exchange, generating vast volumes of network traffic that pose significant challenges for effective forensic analysis. Traditional packet-level inspection methods are increasingly impractical due to scalability constraints and the widespread adoption of encryption, which limits payload visibility. Moreover, modern cyber-attacks in enterprise environments are typically multi-stage in nature, involving initial compromise, lateral movement within internal networks, and eventual data exfiltration. Existing security solutions primarily emphasize intrusion detection and alert generation, offering limited support for reconstructing the complete sequence of attack events during post-incident investigations. This research proposes a novel flow-based forensic framework for reconstructing attack chains in enterprise wired networks. By leveraging network flow data such as packet counts, byte volumes, and flow durations the approach enables scalable and efficient analysis without reliance on packet payloads. The framework employs learning-based techniques, specifically autoencoders, to model normal network behavior and identify anomalous flows based on reconstruction loss. Suspicious flows are subsequently correlated using temporal patterns and shared communication endpoints to uncover relationships indicative of coordinated attack activities.

The proposed system facilitates the reconstruction of multi-stage attack chains, providing a comprehensive view of attacker behavior, including lateral movement across internal systems. Additionally, it generates structured attack timelines that enhance the clarity and effectiveness of forensic investigations. By addressing the limitations of existing methods, this research contributes a scalable, automated, and intelligent solution for post-incident network forensics, improving the ability of organizations to understand, analyze, and respond to sophisticated cyber threats.

KEYWORDS: Enterprise Wired Networks, Network Forensics, Flow-Based Analysis, Network Traffic Analysis, Cybersecurity, Multi-Stage Attacks, Attack Chain Reconstruction, Lateral Movement Detection, Data Exfiltration.

Wavelet-Latent Hybrid Diffusion Model for Robust Image Steganography

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ABSTRACT:

Good image steganography has to meet three contradictive needs: large payload capacity, invisibility and robustness against common distortions (like JPEG compression or resizing). While transform-domain algorithms (e.g., wavelets) work to ensure robustness by spreading data across frequency sub- bands, recent developments in generative steganography based on diffusion models improve success rates and security by hiding the message inside latent noise and sampling procedure. This article presents a Wavelet–Latent Hybrid Diffusion (WLHD) scheme by integrating multi-resolution discrete wavelet transform (DWT) features with a latent diffusion model (LDM), providing stego images which can resist various common attacks and visually undetectable from cover images but enable to recover secret message reliably. In particular, WLHD features (i) a texture- and robustness-aware dynamic wavelet band selection method, (ii) the wavelet-latent fusion module that embeds payload into selected sub-bands and conditions the diffusion denoiser, and (iii) an error-correction-aware decoder for reliable extraction. We all train and evaluate the network on the BOSSBase 1.01 dataset by setting testing goals and doing robustness evaluations against JPEG compression, noise addition, and image resizing. Experimental comparisons with some state-of-the- art wavelet-based and diffusion- based steganographic schemes demonstrate that the new hybrid algorithm can effectively balance between invisibility, capacity and robustness.

KEYWORDS:

Image Steganography, DWT, Latent Diffusion Model, Robust Data Hiding, Stego Image, Image Security, Diffusion Models

Development of Non-Electrical Sun Tracking Mechanism for Solar Panel and its Performance Analysis with Conventional Model

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ABSTRACT:

The performance of solar photovoltaic panels strongly depends on their orientation relative to the sun. Conventional sun trackers use sensors, controllers, and motors, which increase cost, complexity, and maintenance. This study proposes a non-electrical sun tracking mechanism driven by thermally induced pressure variation. Ethanol, used as a working fluid in a sealed chamber, expands when heated by sunlight, generating pressure that actuates a pneumatic cylinder to reorient the panel toward maximum solar irradiance. A prototype was fabricated and experimentally evaluated against fixed and electrical tracking systems. The results show improved energy capture over fixed panels while maintaining a simple, low-cost, and maintenance-free design. The system is especially suitable for remote and off-grid applications where electrical tracking is impractical.

KEYWORDS:

Non-electrical, Photovoltaic, Thermal-actuation, Pneumatic, Ethanol, Passive-tracking, Solar- energy, Low-cost, Off-grid, Irradiance.

Design and Implementation of a Wi-Fi Enabled FPV Surveillance Robot Using ESP32-CAM and L298N Motor Driver

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ABSTRACT:

This paper presents the design and implementation of a low-cost Wi-Fi enabled surveillance robot based on the ESP32-CAM module and L298N motor driver. The proposed system is capable of real-time video streaming and remote navigation through a web-based interface, enabling first-person view (FPV) control using standard web browsers on smartphones or computers. The ESP32-CAM hosts a local web server that simultaneously streams MJPEG video and processes user commands for robot motion.

The robot is built on a dual-motor chassis, where directional control—forward, backward, left, right, and stop—is achieved through GPIO-based signaling to the L298N motor driver. The system leverages specific GPIO pins to ensure reliable communication between the microcontroller and motor driver, providing responsive and seamless operation. The integration is implemented using the Arduino IDE, which facilitates both camera configuration and motor control within a unified framework.

To enhance performance and minimize latency, the ESP32-CAM module is configured with an external antenna, while a portable 5V power supply ensures system mobility. The proposed design demonstrates an effective approach to bridging entry-level robotics with Internet of Things (IoT) applications such as remote monitoring, inspection, and home security. The system offers a scalable and cost-efficient platform for real-time wireless video surveillance and robotic control.

KEYWORDS:

ESP32-CAM, L298N Motor Driver, Wi-Fi Controlled Robot, FPV (First Person View), Surveillance Robot, Internet of Things (IoT), Real-Time Video Streaming, Arduino IDE, Embedded Systems, Wireless Control

Smart Device for Notification and Reminder System for Alzheimer's Patient

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ABSTRACT:

Alzheimer's disease is a common brain disorder that affects memory, thinking, and behaviour. People suffering from this condition often forget their daily tasks, medicine schedules, and important events, which affects their independence and safety. To address this problem, this work presents the design and development of a smart device for a notification and reminder system for Alzheimer's patients. This device reminds through audio and text notifications to take medicines on a daily schedule. The system includes a simple display and voice alert to help patients recognize the type of reminder. The main goal of this project is to provide an easy-to-use, affordable, and portable solution that helps Alzheimer's patients manage their daily lives without relying on others. The proposed design consists of advanced features like data storage for storing the prescriptions, details of patients, and notification schedules. The device offers a practical, user-friendly approach that helps Alzheimer's patients live with greater confidence and comfort.

KEYWORDS:

Alzheimer's, Smart Device, Text Notifications, Reminder System, Voice Alert

AgroEcoVision (AEV): An Integrated Smart Farming Ecosystem with AI-Powered Rover, IoT-Based Monitoring, and Closed-Loop Biogas Optimization.

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ABSTRACT:

AgroEcoVision (AEV) is an integrated smart farming system that unifies solar-powered IoT sensing, autonomous AI-driven disease detection, precision pesticide spraying, and closed-loop biogas management into a single cohesive platform. Solar-powered sensors continuously monitor soil moisture, NPK levels, temperature, humidity, and UV-B radiation across the field, while the AgroVision Rover—equipped with dual cameras and a YOLOv8-based detection model—autonomously navigates the field using GPS (NEO-6M) and sensor fusion (MPU6050 + manometer), identifying infected plants and applying mist spray only to affected regions. A dedicated biogas subsystem employs MQ-4 methane sensors, pressure manometers, and temperature probes to optimize gas production from crop waste, while the enriched slurry is recycled as organic fertilizer. All data is visualized in real-time through the UZHAVAR THOZHAN mobile application, built with MIT App Inventor and connected via ESP32 cloud relay. The system achieves a zero-waste, low-cost, and climate-resilient farming model not found in any single existing solution

KEYWORDS:

AgroEcoVision (AEV), Smart Farming System, Solar-Powered IoT, Precision Agriculture, AI-Based Disease Detection, YOLOv8 Model, Autonomous Rover, GPS Navigation (NEO-6M).

Simulation and Visualization Framework for Real-Time Smart Grid Agents

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ABSTRACT:

The increasing complexity of smart grids, driven by distributed energy resources and dynamic load variations, demands advanced tools for real-time analysis and monitoring. This paper presents a Simulation and Visualization Framework for Real-Time Smart Grid Agents that integrates agent-based modeling with interactive visualization techniques. In the proposed system, grid components such as generation units, transmission lines, and loads are represented as intelligent agents capable of autonomous operation and communication. The simulation engine processes real-time parameters including power flow, voltage levels, and fault conditions, ensuring accurate system representation. A visualization module provides dynamic graphical insights through dashboards and network models, enabling efficient monitoring and decision-making. The framework supports scalability and integration with IoT-enabled devices and renewable energy sources. Results demonstrate improved situational awareness and faster response to grid disturbances, making the framework effective for modern smart grid applications.

KEYWORDS:

Smart Grid, Real-Time Simulation, Agent-Based Modeling, Visualization, IoT, Power System Monitoring

Solar Mosquito Repellent System

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ABSTRACT:

Mosquito-borne diseases such as dengue, malaria, and chikungunya remain major public health concerns, especially in rural and semi-urban regions with limited access to reliable electricity. This paper presents the design and development of an area-efficient and low-cost Solar Mosquito Repellent System intended for sustainable and eco-friendly outdoor protection. The proposed system integrates a compact photovoltaic module, rechargeable battery storage, and an energy-efficient ultrasonic or LED-based repellent unit controlled through a low-power driver circuit. The design emphasizes minimal installation area, optimized power management, and reduced component cost to ensure affordability and scalability. A simple DC-DC regulation stage enables efficient energy conversion and reliable night time operation using stored solar energy. Compared to chemical repellents and grid-powered devices, the system eliminates harmful emissions, lowers recurring expenses, and functions independently of utility supply. Experimental evaluation demonstrates stable performance, low power consumption, and effective mosquito deterrence. The proposed solution offers a practical, economical, and environmentally responsible approach for community-level mosquito control.

KEYWORDS

Mosquito-Borne Diseases, Dengue, Malaria, Chikungunya, Solar Mosquito Repellent System, Renewable Energy, Photovoltaic Module, Rechargeable Battery, Ultrasonic Repellent, LED-Based Repellent, Low-Power Driver Circuit, DC-DC Converter, Energy Efficiency, Sustainable Design, Eco-Friendly Solution

IoT Enabled Module for Bird and Rat Detection and Deterrence in Paddy Fields

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ABSTRACT:

Paddy cultivation often suffers from considerable yield losses due to bird and rodent attacks, especially during the seedling and grain maturity stages. Traditional protection methods such as manual guarding, static scarecrows, and chemical repellents tend to be labour-intensive and gradually lose effectiveness. To address these challenges, this paper presents an IoT-based intelligent pest detection and deterrence system built around the ESP32-S3-N16R8 microcontroller for efficient edge processing. The proposed system combines acoustic sensing, motion detection, and embedded machine learning to enable real-time monitoring of field conditions. Bird activity is detected using an INMP441 microphone, with audio signals analysed through a trained Edge Impulse model that differentiates bird calls from background environmental noise. When a threat is identified, the system responds by activating deterrent mechanisms such as dynamic sound playback and a motorized scarecrow with reflective elements, reducing the likelihood of pest habituation while conserving energy. Rodent movement is detected using Passive Infrared (PIR) sensors, which trigger high-frequency sound emitters to repel them. Overall, the system offers a low-cost, energy-efficient, and autonomous solution suitable for rural agricultural environments. It helps reduce crop damage, improves productivity, and supports sustainable precision farming with minimal human intervention. Index Terms-Paddy field protection, IoT agriculture, bird detection, rodent deterrence, embedded machine learning, precision farming.

KEYWORDS:

Paddy Field Protection, IoT Agriculture, Intelligent Pest Detection, Bird Detection System, Rodent Deterrence, ESP32-S3 Microcontroller, Edge Computing, Acoustic Sensing, Motion Detection.

IoT-Based Smart Cold Storage Monitoring System

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ABSTRACT:

Machine vibrations in industries serve as crucial indicators of equipment health, enabling predictive maintenance and preventing costly downtime. Excessive vibrations can signify misalignment, wear, impending failure, prompting timely interventions. Failure to address such issues can lead to catastrophic accidents, including machinery breakdowns, production halts, and in severe cases, endangering worker safety and causing significant financial losses. Vibration analysis is critical for predictive maintenance and ensuring the smooth operation of machinery, thereby preventing costly downtime and potential failures. The ESP32, known for its versatility and connectivity options, serves as the central processing unit, while the MPU6050 sensor provides precise measurement of vibrations. The system collects real time vibration data, processes it using advanced algorithms, and generates insights into the health and condition of the machinery. Data is transmitted to a MongoDB database via WIFI for continuous integration with cloud-based storage and analysis platforms. By implementing these solute industrial facilities can proactively monitor equipment health, identify potential issues early on, and optimize maintenance schedules to maximize productivity and efficiency. This abstract provides an overview of the project's objectives, methodology, and potential benefits for industrial applications.

KEYWORDS:

ESP32 Microcontroller, MPU6050 Sensor (Vibration Sensor), WIFI Communication, Embedded Systems, Sensor Data Acquisition

IoT-Enabled Smart Assistive Device for Visually Impaired Navigation

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ABSTRACT:

This paper presents an IoT-enabled smart assistive device to improve navigation and safety for visually impaired individuals. The system uses ultrasonic and infrared sensors to detect obstacles and provides real-time feedback through audio or vibration alerts. It integrates GPS and wireless communication for location tracking and emergency monitoring. Designed to be compact, low-cost, and energy-efficient, the device enhances independent mobility and user safety. Experimental results show reliable obstacle detection and timely alerts, making it suitable for everyday use.

KEYWORDS:

IoT, Assistive Device, Visually Impaired, Obstacle Detection, Ultrasonic Sensor, GPS Tracking

IoT-Driven Intelligent Energy Monitoring and Management System

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ABSTRACT:

This paper presents an IoT-driven intelligent energy monitoring and management system for real-time tracking and efficient utilization of electrical energy. The system uses sensors and a microcontroller to measure energy consumption and transmit data to a cloud platform via wireless communication. Users can monitor usage remotely and receive alerts for excessive consumption. The system also enables basic energy management by analyzing usage patterns. It is low-cost, reliable, and suitable for residential and small-scale applications. Results show improved energy awareness and efficient power utilization.

KEYWORDS:

IoT, Energy Monitoring, Smart Meter, Power Management, Real-Time Monitoring, Cloud Computing.

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Real-Time Energy Management for Residential Power Systems

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ABSTRACT:

The growing demand for efficient energy utilization in residential sectors has led to the development of intelligent energy management systems. This paper presents a real-time energy management system for residential power systems aimed at optimizing energy consumption and reducing wastage. The system uses sensors and a microcontroller to monitor electrical parameters such as voltage, current, and power in real time, and to control household appliances based on predefined conditions.

An IoT-based communication framework enables remote monitoring and data visualization through cloud platforms, allowing users to track energy usage and receive alerts for abnormal conditions. The system also supports load scheduling and demand-side management to minimize peak load and improve efficiency. Integration with renewable energy sources further enhances sustainability.

The proposed system is cost-effective, scalable, and suitable for smart home applications. Results indicate improved energy efficiency, reduced electricity costs, and enhanced control over residential energy usage.

KEYWORDS:

Energy Management System, IoT, Real-Time Monitoring, Smart Home, Energy Efficiency

IoT-Based Power System Monitoring Using Wireless Sensor Networks

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ABSTRACT:

The increasing complexity of modern power systems requires efficient and real-time monitoring solutions. This paper presents an IoT-based power system monitoring system integrated with wireless sensor networks (WSN) to enhance reliability and scalability. Distributed sensor nodes measure parameters such as voltage, current, temperature, and frequency, and transmit data via wireless communication (Wi-Fi, ZigBee, or LoRa) to a central system. The data is processed and sent to a cloud platform for real-time monitoring, analysis, and visualization through user-friendly dashboards. The system enables remote access and supports alert mechanisms for detecting faults such as overload, overvoltage, and overheating. The use of WSN reduces wiring complexity and overall cost while improving flexibility. The proposed system is energy-efficient, cost-effective, and suitable for smart grid, industrial, and rural applications. Results demonstrate accurate monitoring and improved system reliability, making it a scalable solution for modern power infrastructure.

KEYWORDS:

IoT, Wireless Sensor Networks (WSN), Power System Monitoring, Smart Grid, ESP32, Cloud Computing

Solar-Based Battery Charger with Secure Charging Mechanism

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ABSTRACT:

This paper presents the design of a solar-based battery charging system with a secure charging mechanism to ensure safe and efficient energy storage. The system utilizes a photovoltaic (PV) panel as the primary energy source and includes a charge controller with protection features such as overcharging, over-discharging, and short-circuit protection. A voltage regulation unit is used to maintain stable charging conditions, while the control circuit continuously monitors battery parameters to improve performance and extend battery life. The proposed system is cost-effective, reliable, and suitable for small-scale and rural applications such as solar lighting and mobile charging. Experimental results demonstrate stable operation under varying solar conditions, ensuring enhanced efficiency and improved battery safety.

KEYWORDS:

Solar Energy, Battery Charger, PV Panel, Protection Circuit, Voltage Regulation, Renewable Energy

Cyber Attack Detection and Prevention in IOT using Deep Learning

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ABSTRACT:

The rapid growth of Internet of Things (IoT) technology has significantly improved connectivity and automation across various sectors such as healthcare, smart homes, agriculture, and industrial systems, but it has also introduced serious security challenges due to the limited computational capacity and weak built-in protection mechanisms of IoT devices. These devices often operate with minimal security configurations, making them easy targets for cyber attacks such as Distributed Denial of Service (DDoS), port scanning, Man-in-the-Middle (MitM), and botnet-based intrusions. To address these challenges, this project proposes an intelligent deep learning-based system designed to detect and prevent cyber attacks in IoT networks in real time. The system works by capturing network traffic data and extracting 20 important behavioral features that represent communication patterns and possible anomalies. These features are then processed using a hybrid model that combines Convolutional Neural Networks (CNN) and Bidirectional Long Short-Term Memory (BiLSTM) along with an attention mechanism. The CNN component helps in identifying important patterns within the data, while the BiLSTM captures the sequence and time-based relationships in network traffic, allowing the system to understand both current and past behaviors. The attention mechanism further improves the model's performance by focusing on the most relevant features, increasing the accuracy of attack detection. Based on this approach, the system classifies network activity into five categories: Normal, DDoS, Port Scan, Man-in-the-Middle, and Botnet attacks.

KEYWORDS:

Internet of Things (IoT), Cybersecurity, Intrusion Detection System (IDS), Deep Learning, Convolutional Neural Network (CNN), Bidirectional Long Short-Term Memory (BiLSTM), Attention Mechanism, Network Traffic Analysis, Feature Extraction, Anomaly Detection, Distributed Denial of Service (DDoS), Port Scanning, Man-in-the-Middle (MitM), Botnet Attacks, Real-Time Detection

Design and Analysis of Automated Athangudi Tiles Manufacturing Machine

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ABSTRACT:

Athangudi tiles are a traditional handcrafted flooring material originating from the Chettinad region of Tamil Nadu, known for their vibrant colors, intricate patterns, and ecofriendly production process. However, the conventional manufacturing method is laborintensive, time-consuming, and highly dependent on skilled artisans, leading to limitations in large-scale production and consistency. This project proposes the design and development of an automated Athangudi tiles manufacturing machine aimed at improving productivity, precision, and uniformity while preserving the aesthetic quality of the tiles. The system integrates automated processes such as pattern molding, color filling, cement slurry preparation, vibration-based compaction, and controlled curing. By incorporating programmable controls and mechanical automation, the machine minimizes human intervention and reduces production time and material wastage. The proposed solution enhances efficiency, ensures consistent tile quality, and supports scalability for commercial production. Additionally, it helps sustain the traditional Athangudi tile industry by blending heritage craftsmanship with modern engineering techniques. This automation approach can contribute to cost-effective manufacturing while maintaining the cultural significance and environmental sustainability of the product.

KEYWORDS:

Athangudi Tiles, Automated Manufacturing System, Traditional Craft Preservation, Industrial Automation, Pattern Molding, Color Filling, Cement Slurry Preparation

Smart EV Charging Infrastructure Optimization

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ABSTRACT:

This paper presents Smart EV-Optimize, an edge-intelligent platform for electric vehicle charging infrastructure that balances demand, grid constraints, charger availability, and user priorities to minimize waiting times by 30%, reduce peak grid stress by 40%, and boost utilization from 40% to 85% across fleets. Built on ESP32 microcontrollers with ZMPT101B voltage, ACS712 current sensors, and relay-switched 100Ω loads simulating EV chargers, the system aggregates real-time data (V, I, P, T, availability) via MQTT to Firebase every 5 seconds. A central cloud engine employs priority queue algorithms and load balancing to dynamically allocate power—shedding loads during peaks, redirecting users via SMS, and activating battery backups—while edge processing ensures low-latency decisions. Operator dashboards provide live maps, analytics, and predictive maintenance. Prototype validation demonstrates scalability from single stations to regional networks using cost-effective components, aligning with renewable energy integration for sustainable EV adoption.

KEYWORDS:

Transformer Monitoring, IoT, Relay Protection, Firebase Realtime Database, Overvoltage Protection, Power Quality, Real-time Dashboard

Next Generation Autonomous Hybrid Electric Vehicle Using AI and IOT with Self Charging Capabilities

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ABSTRACT:

The intersection of Artificial Intelligence (AI), Internet of Things (IoT), and smart energy systems is leading the path towards the next generation of autonomous mobility. This paper suggests the design and development of an AI- and IoT-based self-charging autonomous hybrid electric vehicle (HEV) with an integrated self-charging infrastructure. The car uses AI algorithms for route planning, decision-making, and energy management, and IoT facilitates real-time data exchange between the car, charging stations, and the grid. The self-charging infrastructure uses renewable energy harvesting (solar/wind), regenerative braking, and wireless charging to reduce the need for external charging networks. This serves to enhance vehicle range, reduce downtime, and promote eco-friendly transport. The conceptual framework depicts how autonomous HEVs with AI and IoT technologies can achieve energy independence, reduced carbon footprint, and intelligent mobility in smart cities of the future.

KEYWORDS:

Autonomous Hybrid Electric Vehicle (AHEV), Smart Mobility, Artificial Intelligence (AI), Internet of Things (IoT), Self-Charging Infrastructure, Intelligent Energy Management, Sustainable Transportation

Runtime Fault Prediction and Monitoring Using Edge AI in Microcontrollers

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ABSTRACT:

This paper presents an Edge AI-based runtime fault prediction and recovery framework for embedded systems operating in Internet of Things environments. Microcontroller-based devices used in real-time applications are highly susceptible to runtime anomalies such as memory exhaustion, processor overload, thermal stress and unexpected reset events, which can reduce system reliability and lead to operational failures. To address these challenges, the proposed framework continuously monitors key internal diagnostic parameters, including free heap memory, minimum heap memory, processor utilization, analog-to-digital converter (ADC) readings, reset-cause indicators and on-chip temperature where combines them into a runtime health vector. Since no standard benchmark dataset is available for this application, a custom labeled dataset of 5,000 samples was generated through controlled software-based fault injection under both normal and stress conditions. This dataset was used to train a lightweight neural network model suitable for deployment on resource-constrained embedded devices. The trained model was implemented directly on the microcontroller to enable real-time on-device fault prediction with minimal computational overhead. In addition, a two-stage response mechanism was introduced the first detected fault triggers a controlled one-time restart to recover from transient anomalies, while repeated faults generate a user notification for corrective action. Experimental results show that the proposed model achieves 88.5% accuracy, demonstrating its effectiveness for predictive maintenance and reliable fault management in embedded IoT systems.

KEYWORDS:

Edge AI, TinyML, Runtime Fault Prediction, Microcontroller-Based IoT Devices, Fault Injection, Predictive Maintenance.

Hybrid CNN–Bidirectional LSTM Architecture with SMOTETomek Resampling for Multi-Class ECG Arrhythmia Classification on the MIT-BIH Dataset

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ABSTRACT:

The automatic detection system for cardiac arrhythmias which uses electrocardiogram (ECG) signals faces ongoing difficulties within biomedical signal processing because its processes require advanced time series analysis methods and actual datasets show severe class distribution problems. The current research presents a two-stage deep learning system which performs multi- class ECG arrhythmia identification. The first stage uses one-dimensional Convolutional Neural Networks (1D-CNNs) to extract local morphological features which include QRS complex and P-wave and T-wave attributes from raw ECG signals without needing any manual feature extraction. The second stage implements three Bidirectional Long Short-Term Memory (BiLSTM) layers which operate in both forward and backward modes to identify temporal relationships. The MIT-BIH Arrhythmia Dataset class imbalance problem receives a solution through SMOTETomek hybrid resampling method which combines SMOTE oversampling with Tomek Links removal and uses class-weight penalization for improvement. The training process uses the Adam optimizer together with categorical cross-entropy loss and early stopping method to stop overfitting. The proposed framework tests all five heartbeat categories of the MIT-BIH test set and achieves 97.70% accuracy which shows consistent performance in all class categories.

KEYWORDS:

ECG Arrhythmia Classification, MIT-BIH Dataset, 1D-CNN, Bidirectional LSTM, SMOTETomek, Class Imbalance, Deep Learning, Cardiac Diagnosis

Smart IoT System for Continuous Room Temperature Analysis

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ABSTRACT:

This paper presents a smart IoT-based system for continuous room temperature analysis with real-time monitoring capabilities. The system uses a temperature sensor and microcontroller to collect data and transmit it to a cloud platform via wireless communication. Users can monitor temperature remotely and receive alerts when it exceeds preset limits. The system is low-cost, energy-efficient, and suitable for applications such as homes, labs, and server rooms. Results show accurate, reliable, and real-time performance.

KEYWORDS:

IoT, Temperature Monitoring, Sensor, Real-Time Monitoring, Cloud Computing

Solar Powered Water Pumping for Rural Applications

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ABSTRACT:

Access to reliable water supply in rural areas is limited due to lack of grid electricity andhigh costs of conventional pumping systems. This paper presents a solar-powered water pumping system as a sustainable and cost-effective solution for irrigation and domestic use. The system uses photovoltaic (PV) panels to generate electricity for driving a water pump, supported by a charge controller and optional battery storage for continuous operation. A microcontroller-based control unit, along with sensors for water level and soil moisture, enables automated and efficient operation. IoT integration allows real-time monitoring of system parameters such as voltage, current, and pump status. The proposed system reduces fuel costs, maintenance, and environmental impact compared to traditional methods. Results show improved efficiency, reliable performance, and better water management, making the system suitable for rural applications. It provides a scalable and eco-friendly solution that enhances agricultural productivity and promotes sustainable energy use.

KEYWORDS:

Solar Energy, Water Pumping System, Photovoltaic (PV), Rural Electrification, IoT, Irrigation, Renewable Energy

Hand Gesture Based Wheelchair for Disabled People

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ABSTRACT:

A new assistive technology, called the Hand Gesture Control Wheelchair (HGCW) system, is designed to help individuals with mobility impairments increase their independence and mobility. The system consists of a wearable device with sensors that detect hand movements and Arduino microcontrollers for real-time data processing and wheelchair control. The HGCW system uses gesture recognition algorithms to translate hand gestures into corresponding wheelchair movements, such as forward, backward, left, and right turns, and communicates wirelessly with the wheelchair's control unit. The system is cost-effective, customizable, and intuitive, making it accessible to a wide range of users. The HGCW system has the potential to revolutionize the way disabled individuals navigate their environment, empowering them to lead more independent and fulfilling lives.

KEYWORDS:

Hand Gesture Control Wheelchair, Mobility, Microcontroller, Navigation, Healthcare, Automation

Electrical Power System Analysis for Telecommunication Networks

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ABSTRACT:

Power transformers and distribution transformers serve as integral elements within electrical power systems, enabling efficient transmission and distribution of electricity. While power transformers manage voltage levels in substations, distribution transformers further reduce voltage for safe delivery to homes and businesses. Regular testing involves assessing electrical, mechanical, and insulation systems, encompassing measurements like winding resistance, turns ratio, impedance, and insulation resistance. Experimental tests based on transformer analysis contribute significantly to understanding the premises and applicability of transformer testing methodologies. An experimental case study further illustrates the practical implications and usefulness of these testing methodologies in transformer analysis and maintenance to enhance the communication systems performance.

KEYWORDS:

Power System Analysis, Grid Interface Analysis, Communication systems

AI Process Variable for Controlled DC Drive System

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ABSTRACT:

Implementing AI Process Variable control for DC motors, taking advantage of the inherent benefits like smooth control, high torque, considerable speeds, and faster response. By incorporating rotary encoders as feedback sensors, the system achieves smooth and precise position accuracy, offering a versatile solution for advanced industrial automation and robotic systems. To ensure smooth control of the motor shaft position, a Proportional- Integral- Derivative (PID) controller is employed. By doing so, it effectively minimizes steady-state error and reduces both maximum overshoot and positional inaccuracies.

KEYWORDS:

Process Variable, DC motor, PID controller, H-Controller

IoT Based Smart Bag

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ABSTRACT:

This project proposes an IoT-based smart bag using Arduino to improve luggage safety and convenience during travel. The system enables real-time tracking, motion detection, and automatic following features to help prevent loss, theft, and misplacement of baggage. By using low-cost hardware and smart sensors, the bag can send alerts and support easy monitoring through a mobile device. The proposed design is especially useful for frequent travelers, solo travelers, and physically challenged users. It reduces the effort required to carry luggage and enhances overall travel comfort. The integration of modern technology into a simple bag makes it smarter and more efficient. This system also helps in saving time and avoiding stress during travel. Overall, the smart bag provides a reliable, affordable,and user-friendly solution for modern travel needs, improving both security and convenience while ensuring a better experience for users in different travel situations.

KEYWORDS:

IoT, smart bag, Arduino, GPS tracking, motion detection, automation, sensors, security,alerts, travel, wireless, monitoring, embedded systems, safety, convenience

AI-Based Drowsiness Detection with IoT Alerts for Commercial Transport Safety

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ABSTRACT:

Driver drowsiness is a significant factor contributing to road accidents, resulting in considerable loss of life and property worldwide. This paper presents an IoT-enabled driver drowsiness detection system developed using Python and OpenCV to enhance road safety through real-time monitoring of driver alertness. The proposed system utilizes a camera to capture facial features and employs computer vision techniques to analyze eye movements and blinking patterns. By leveraging facial landmark detection algorithms, the system identifies signs of fatigue such as prolonged eye closure and reduced blink rate.

When drowsiness is detected, an alert mechanism, such as a buzzer or notification, is triggered to warn the driver and prevent potential accidents. Additionally, the integration of IoT technology enables real-time data transmission to a cloud platform or connected devices, facilitating remote monitoring and timely intervention when necessary. The system is designed to be cost-effective, non-intrusive, and suitable for both personal and commercial vehicle applications.

Experimental results demonstrate that the proposed system achieves reliable performance under varying conditions, making it a practical solution for improving transportation safety. The implementation highlights the potential of combining computer vision and IoT technologies to develop intelligent driver assistance systems.

KEYWORDS:

Drowsiness Detection, Internet of Things (IoT), OpenCV, Python, Computer Vision, Driver Safety, Eye Detection

IoT-Based Smart Energy Meter with Prepaid Recharge System

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ABSTRACT:

Efficient energy management and accurate billing are critical challenges in modern power distribution systems. Conventional electricity meters rely on manual readings and postpaid billing, which often lead to human errors, delayed payments, and energy misuse. This paper presents the design and implementation of an IoT-based Smart Energy Meter with a Prepaid Recharge System to address these limitations. The proposed system integrates a microcontroller-based energy metering unit with IoT connectivity to enable real-time monitoring of electricity consumption. The collected data is transmitted to a cloud platform, allowing users to access usage details and balance status through a web or mobile interface. A prepaid billing mechanism is incorporated, where users must recharge their account in advance. The system continuously deducts the consumed energy cost from the available balance and provides low-balance alerts to the user. In cases of zero balance, the system automatically disconnects the power supply and restores it upon recharge. The solution enhances transparency, reduces electricity theft, eliminates manual intervention, and encourages efficient energy utilization. Owing to its low cost and scalability, the system is well-suited for residential and small-scale applications.

KEYWORDS:

Smart Energy Meter, Internet of Things (IoT), Prepaid Billing System, Energy Monitoring, Cloud Platform, Power Consumption, Automatic Disconnection.

Multilayer Authentication System Using STM32 Microcontroller for Secure Embedded Access Control

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ABSTRACT:

Embedded access control systems deployed in critical environments such as banking lockers, industrial panels, and research facilities demand robust security beyond what conventional single-factor mechanisms can offer. Password-only or single-biometric approaches remain vulnerable to device cloning, firmware tampering, identity spoofing, and replay attacks. This paper proposes a Multilayer Authentication System (MAS) implemented on the STM32F103C8T6 microcontroller, enforcing a sequential two-tier security model to address both hardware-level and user-level threats. The first tier performs device authentication by verifying the chip factory-programmed unique identifier (UID), validating firmware integrity through a hardware CRC check, and monitoring a tamper detection sensor. The second tier authenticates the user through fingerprint biometric recognition using an R307/AS608 optical sensor, followed by a One-Time Password (OTP) delivered via GSM to the registered mobile number. Access is granted only when both tiers are successfully cleared in sequence, preventing partial bypass attacks. Experimental results confirm reliable detection of cloned devices, tampered firmware, and replay attempts, with an end-to-end authentication latency within acceptable bounds for industrial deployment. The system offers a scalable, cost-effective security solution suitable for banking, industrial automation, and smart infrastructure applications.

KEYWORDS:

STM32 microcontroller; multilayer authentication; device authentication; fingerprint recognition; one-time password; GSM; embedded security; tamper detection; firmware integrity; access control

Energy-Aware Hybrid Multi-Hop and Multipath Routing Approach for Improved Network Lifetime in WSNs

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ABSTRACT:

Wireless Sensor Networks (WSNs) are widely used in applications such as environmental monitoring, smart agriculture, and industrial automation, where continuous and reliable data transmission is essential. However, energy constraints in battery-powered sensor nodes often lead to uneven energy consumption, early node failure, and reduced network lifetime. To address these challenges, this work proposes a hybrid approach by combining HYMN (Hybrid Multi-hop Routing) and EEMCL (Energy-Efficient Multi-Cluster with Multipath Routing) to achieve efficient and balanced communication. The system consists of multiple sensor nodes organized into dynamic clusters, where Nodes B and C act as cluster heads (CHs) based on residual energy. Data is sensed periodically and transmitted efficiently to the sink through optimized routing paths. HYMN enables multi-hop communication between nodes, while EEMCL supports multipath routing, allowing data to be forwarded through different paths such as A → C → F → Sink and B → C → Sink. This multipath strategy ensures that traffic is evenly distributed across the network. As a result, data is delivered efficiently to the sink while avoiding overload on specific nodes, preventing early energy depletion. Additionally, dynamic cluster head rotation and continuous energy tracking improve overall energy utilization. Simulation results demonstrate improved reliability, balanced load distribution, and extended network lifetime, making the proposed system suitable for energy-constrained WSN environments.

KEYWORDS:

Wireless Sensor Network (WSNs), Hybrid Multi-Hop Routing (HYMN), Energy-Efficiency Multi-Cluster with Multipath Routing (EEMCL), Energy Efficiency, Clustering, Multipath Routing, Network Lifetime.

Real-Time PCB Inspection using Image Processing

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ABSTRACT:

Printed Circuit Board (PCB) inspection is an essential process in electronics manufacturing to ensure product quality and reduce defective outputs. Manual inspection methods are time-consuming, inconsistent, and prone to human error. This project presents a real-time PCB inspection system using image processing techniques for automatic defect detection. A camera captures live images of the PCB, which are then processed using software algorithms. The captured image is pre-processed through grayscale conversion, noise removal, and edge enhancement to improve clarity. The processed image is compared with a reference PCB image to identify defects such as missing components, misalignment, short circuits, broken tracks, and soldering errors. Image segmentation, contour analysis, and pattern matching methods are used for accurate inspection. The system provides fast and reliable results in real time, helping industries improve productivity and maintain quality standards. This project reduces labor cost, increases inspection speed, and minimizes manufacturing losses. It can be implemented in small-scale and large-scale electronic production units for efficient PCB quality control.

KEYWORDS:

PCB Inspection, Image Processing, Defect Detection, Real-time Monitoring, Pattern Matching, Quality Control, Automated Inspection

Multimodal AI Communication and Assistance System for Differently-Abled Individuals

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ABSTRACT:

The proposed system is a multimodal assistive communication platform designed to bridge communication gaps among individuals with visual, hearing, and speech impairments. Unlike traditional systems, it integrates speech, text, gesture, and video communication to ensure inclusivity and accessibility. AI-based modules enable seamless interaction by converting speech into text for hearing-impaired users and text into audio for visually impaired users. Additionally, gesture recognition translates sign language and hand movements into meaningful outputs, improving real-time communication. Beyond communication, the platform incorporates safety and health monitoring features. An emergency alert mechanism allows users to send instant notifications via dashboard, email, and SMS, supported by an intelligent prioritization system. The system also monitors vital parameters such as heart rate and triggers alerts during abnormal conditions. Developed using modern web technologies and AI frameworks, the solution is scalable, efficient, and user- friendly, enhancing communication, safety, and overall quality of life.

KEYWORDS:

Multimodal Communication, Assistive Technology, Speech Recognition, Text-to-Speech, Gesture Recognition, Sign Language Processing, Artificial Intelligence, Accessibility, Emergency Alert System, Health Monitoring.

Smart Solar-Powered Agriculture Monitoring and Animal Intrusion Alert System using IoT

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ABSTRACT:

Agriculture faces significant challenges such as inefficient resource management and crop damage caused by animal intrusion, particularly in regions located near forests and wildlife zones. This project proposes a smart, low-cost, and solar-powered system that integrates agricultural monitoring with animal intrusion detection using Internet of Things (loT) technology. The system employs soil moisture sensors to enable automated irrigation and Light Dependent Resistor (LDR) sensors to monitor sunlight intensity, thereby ensuring optimal crop growth conditions. A Passive Infrared (PIR) sensor is used to detect the movement of animals entering the farmland. Upon detection, the system activatesa buzzer and LED alert mechanism, while simultaneously displaying real-time status updates on an LCD module. The entire setup is powered using solar energy, making it highly suitable for rural and remote areas with limited access to electricity. This integrated solution enhances crop protection, improves energy efficiency, and minimizes manual intervention, offering a sustainable and reliable approach for modern smart agriculture.

KEYWORDS:

Smart Agriculture, loT, Solar Energy, Soil Moisture Sensor, PIR Sensor, Animal Intrusion Detection, Automated Irrigation, LDR Sensor, Sustainable Farming

Skill Bridge – Connecting Talent to Opportunity

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ABSTRACT:

SkillBridge – Connecting Talent to Opportunity is an AI-powered skill and job recommender system designed to address the issue of skill mismatch among students and fresh graduates. Many candidates struggle to identify suitable career paths due to limited awareness of industry requirements and lack of structured guidance. Existing platforms mainly provide job listings but do not offer personalized insights into skill gaps or employability readiness. SkillBridge uses Natural Language Processing (NLP) to extract skills from resumes and applies similarity-based algorithms to match candidates with relevant job roles through a Smart Matching Score. The system also performs skill gap analysis and generates personalized career roadmaps to guide users toward their target roles. Additionally, it evaluates employability using an Interview Readiness Score and tracks progress through a dashboard. By combining AI with structured career guidance, SkillBridge helps users make informed decisions and improve their employability.

KEYWORDS:

Artificial Intelligence, Job Recommendation System, Natural Language Processing, Skill Gap Analysis, Career Guidance, Resume Parsing, Machine Learning, Employability Enhancement, Cosine Similarity, Career Development

Eco Friendly Plastic Recycling using Solar Thermal Energy

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ABSTRACT:

The increasing accumulation of plastic waste due to inadequate recycling practices has become a major environmental concern, particularly in developing regions such as India. This study presents the development of a low-cost solar thermal system for converting plastic waste into usable products such as molded blocks and sheets. A modified Direct-To-Home (DTH) dish integrated with reflective mirror elements is utilized as a solar concentrator to harness and focus solar radiation for heat generation. The system performance was evaluated based on temperature profile, melting behavior of different thermoplastics, and processing time. Experimental results showed that the setup achieves a maximum temperature of approximately 80 °C, which is sufficient for softening low-density plasticssuch as LDPE and polystyrene but insufficientfor complete melting of high-density plastics like HDPE and polypropylene. The study also identifies challenges associated with mixed plastic processing, including non-uniform melting and reduced product quality. Potential improvements such as enhanced reflector alignment, thermal insulation, and the use of a transparent cover are proposed to increase efficiency. The findings demonstrate that solar concentrator-based plastic recycling is a sustainable, eco-friendly, and cost-efective approach for decentralized waste management, contributing to resource recovery and reduced environmental impact.

KEYWORDS:

Plastic Waste Management, Solar Thermal System, Solar Concentrator, Recycling, Thermoplastics, Sustainable Energy, Waste Conversion

Open CV Control Robot Using ArUco Markers for the Application of Warehouses

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ABSTRACT:

This paper presents a low-cost, vision-based robot control system using OpenCV and ArUco markers for real-time localization and navigation. A monocular camera is used to detect ArUco markers placed in the environment and estimate their position and orientation with high accuracy. Based on the detected marker ID and pose information, the system generates control commands that enable the robot to perform actions such as forward movement, turning, stopping, and precise alignment with targets. The proposed approach eliminates the need for expensive sensors such as LiDAR, making it a cost-effective solution for indoor environments where GPS is unavailable. The system is designed to be computationally efficient and capable of real-time performance on low-power hardware platforms. It also demonstrates robustness under varying lighting conditions and partial occlusions. Experimental results validate the effectiveness and reliability of the system for accurate navigation and consistent performance in practical scenarios.

KEYWORDS:

OpenCV, ArUco Markers, Computer Vision, Pose Estimation, Monocular Camera, Localization, Navigation, Real- Time Processing, Control System, Low-Cost System

Solar Thermal Water Purifier using Arduino for Post Disaster and Emergency Situations

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ABSTRACT:

Access to safe drinking water is a major challenge, especially during natural disasters like floods where clean water sources become contaminated. This project presents a simple and cost-effective solution called a Solar Water Purifier using Arduino, designed mainly for emergency situations. The system uses solar energy to purify saline or contaminated water through a natural evaporation and condensation process. In this method, impure water is placed inside a glass chamber coated with black material to absorb maximum heat from sunlight. As the temperature increases, the water evaporates, leaving behind impurities such as salts, dirt, and harmful particles. The water vapor then rises and comes in contact with a cooler surface, where it condenses into pure water droplets. These droplets are collected as clean water at the outlet. To ensure the quality of the purified water, sensors are used along with a microcontroller. A temperature sensor measures the surrounding temperature, which directly affects the evaporation rate. A TDS (Total Dissolved Solids) sensor checks the amount of dissolved impurities in the water, and a turbidity sensor measures the clarity of the water. These sensors are connected to an Arduino, which processes the data and displays the results on an LCD. This helps in verifying whether the water is safe for use. The system is simple, eco-friendly, and does not require electricity, making it suitable for remote or disaster-affected areas. However, since the process removes essential minerals, the water is mainly intended for short-term emergency use rather than regular consumption. Overall, this project demonstrates an efficient use of solar energy combined with basic electronics to provide a practical solution for water purification in critical situations.

KEYWORDS:

Solar Water Purifier, Arduino, Water Purification, Solar Energy, TDS Sensor, Turbidity Sensor, Emergency Water Supply

Vision Based PPE (Personal Protective Equipment) Monitoring System using EDGE AI

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Abstract:

Ensuring proper personal protective equipment (PPE) usage in industrial environments is critical for worker safety. Current PPE monitoring systems either rely on continuous camera surveillance or static access badges, resulting in high costs, reduced scalability, and inability to verify PPE compliance after entry. This work proposes a low-cost, embedded system that integrates Edge Impulse-based AI detection, proof-of-wear sensors, and BLE zone tracking to address these limitations. The system performs one-time PPE verification atentry using an ESP32-CAM running an Edge Impulse TinyML model, assigning a dynamic BLE smart tag corresponding to the worker's PPE level. Embedded sensors in helmets, gloves, and vests continuously validate that PPE is still being worn. BLE beacons installed in different zones allow the ESP32 controllers to enforce zone-specific PPE rules without requiring cameras in every area. This approach significantly reduces infrastructure cost while maintaining real-time PPE compliance monitoring. The prototype demonstrates accurate detection, live validation, and automated access control, offering a scalable and practical solution for industrial safety. The system's combination of embedded AI, wearable sensors, and BLE-based zone enforcement presents a novel integration in the field of smart industrial safety systems. Keywords: PPE compliance, Edge Impulse, BLE, TinyML, industrial safety, proof-of-wear sensors, zone access control.

KEYWORDS:

PPE compliance, industrial safety, Edge Impulse, Bluetooth Low Energy (BLE), TinyML, proof-of-wear sensors, zone-based access control, embedded AI, smart safety systems.

An Efficient Asynchronous FIFO for High -Speed Applications

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ABSTRACT:

An asynchronous Fist-In-First-Out (FIFO) is a fundamental data storage and buffering mechanism designed to operate across different clock domains, where the read and write operations are driven by separate, and asynchronous clock sources. This characteristics makes asynchronous FIFOs an essential component for enabling reliable data transmission between circuits with mismatched or independent clocks. The FIFO design employs gray code for read/write address. It highlights the design approach for empty/full state detection and implements the design using Verilog. This paper presents an enhanced asynchronous FIFO design incorporating gray code-based pointer synchronization and a modified pipeline control technique to improve overall performance. The use of gray code counters prevents metastability issues during clock domain crossing by ensuring only a single bit transition between successive states. In addition, the proposed modified pipeline structure reduces critical path delay by introducing intermediate storage stages, thereby improving timing performance and increasing operating frequency. The combined approach significantly enhances data stability, reduces power consumption and achieves high performance compared to conventional asynchronous FIFO designs. The design is suitable for high-speed and low-power VLSI applications, demonstrating improved efficiency in terms of delay, timing margin, and frequency performance.

Keywords:

Asynchronous FIFO, clock domain crossing, Gray code, metastability reduction, pipeline optimization, critical path delay, Verilog, high-speed design, low-power VLSI, timing performance, data synchronization.

ETA-Based Emergency Vehicle Priority System

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ABSTRACT:

Urban traffic congestion has become a major challenge in modern cities, significantly delaying emergency vehicle movement due to the absence of intelligent traffic management and real-time emergency prioritization. Existing manual traffic signal systems fail to respond dynamically to emergency situations, leading to inefficient road utilization and critical time loss. To address this issue, the proposed system introduces an automated emergency vehicle prioritization framework using ESP32, RFID, and GPS technologies. RFID readers installed along road intersections detect the presence of emergency vehicles equipped with RFID tags, while the GPS module continuously tracks real-time parameters such as latitude, longitude and distance. This data is transmitted to a centralized web dashboard for monitoring and processing. A Random Forest algorithm is employed to analyse the collected data and accurately predict the emergency vehicle route, movement pattern, and Estimated Time of Arrival. Based on these predictions, the system dynamically controls traffic signals by turning them green along the emergency vehicle path, ensuring uninterrupted movement. This intelligent approach minimizes delays, improves emergency response time, reduces congestion impact, and ultimately enhances the efficiency of urban transportation systems while saving lives.

KEYWORDS:

Intelligent traffic management, emergency vehicle prioritization, ESP32, Radio Frequency Identification, Global Positioning System, Random Forest algorithm, route prediction, Estimated Time of Arrival (ETA), smart traffic signals, urban transportation systems.

Hybrid Edge-Cloud Conversational AI with Face Recognition and Multilingual Speech for Autonomous Humanoid Robots

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ABSTRACT:

The increasing deployment of humanoid robots in service sectors such as healthcare, education, and public assistance requires the development of conversational systems that are not only intelligent and personalized but also resilient to real-world infrastructure challenges. This paper presents a Comprehensive interaction framework designed for humanoid robotic platforms, addressing three major issues: dependence on network connectivity, limited personalization for individual users, and restricted linguistic accessibility across diverse languages. A dynamic inference routing engine continuously evaluates query complexity and network latency, intelligently distributing tasks between lightweight locally deployed language models and more powerful cloud-based models to ensure smooth and uninterrupted conversations. User personalization is enhanced through an integrated face recognition system that identifies individuals across multiple sessions and retrieves their interaction histories from a local SQLite database, enabling context-aware and relationship-based responses. Multilingual speech recognition, powered by Whisper ASR, supports regional Indian languages such as Hindi and Kannada, improving accessibility for a linguistically diverse user base. All generated outputs are processed through a dedicated safety filtering layer before delivery, ensuring secure and reliable interactions. User experience is further improved through expressive OLED-based visual feedback that displays emotional states synchronized with text-to-speech voice output, creating more natural communication. Experimental results demonstrate that the proposed system reduces response latency during routine interactions while maintaining high response quality for complex queries, thereby enhancing autonomous human-robot interaction in real-world environments.

KEYWORDS:

LLM Models, AI Edge Computing, Multilingual conversation, Face recognition.

Review on Need of Smart Parking and Use of Sensors

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ABSTRACT:

The rapid growth of vehicles in urban environments has intensified parking challenges, leading to congestion, increased fuel consumption, and environmental concerns. Traditional parking systems lack real-time monitoring and efficient space management, making them inadequate for modern needs. This paper presents a review on the necessity of smart parking systems and the role of sensor-based technologies in enhancing parking efficiency and security. The integration of Internet of Things (IoT) enables real-time detection and management of parking spaces. Ultrasonic sensors are utilized to identify slot occupancy and assist in vehicle guidance, while fingerprint sensors provide secure and authorized vehicle access. The proposed approach improves space utilization, reduces search time, and enhances safety. Smart parking systems thus contribute significantly to sustainable urban development and form a key component of intelligent transportation systems.

KEYWORDS:

smart parking system, Internet of Things, real-time monitoring, Ultrasonic sensor, Fingerprint recognition, parking space management, vehicle guidance, sustainable urban development, intelligent transportation systems.

AI Based Automated Defective Exhibit Identification System Placed in a Gallery

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ABSTRACT:

Maintaining exhibits in galleries is an important task, but it becomes difficult when there are many items to monitor regularly. Usually, manual inspection is carried out, which takes more time and may lead to human errors. To solve this problem, this project presents an AI based automated system to identify defective exhibits in a gallery. In this system, cameras are used to continuously capture images of exhibits. These images are processed using basic image processing and machine learning techniques to find defects such as cracks, color changes, or damages on the surface. The system is trained with sample images so that it can differentiate between normal and defective exhibits.When any defect is detected, the system provides an alert so that necessary action can be taken quickly. It also stores the details of defects for future reference. This helps in reducing manual work and improves the overall monitoring process.This project can be useful not only in galleries but also in museums and other places where maintaining object quality is important. The proposed system helps in improving efficiency and ensures proper maintenance of exhibits.

KEYWORDS:

Artificial Intelligence, Image Processing, Defect Detection, Gallery Monitoring

Embedded Nutritional Scheduling Infrastructure (ENSI)

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ABSTRACT:

Pet nutrition requires consistency, accuracy, and adaptability to maintain animal health, yet conventional feeders often lack precision, remote monitoring, and intelligent scheduling. The proposed Embedded Nutritional Scheduling Infrastructure (ENSI) addresses these limitations by integrating embedded controllers, IoT connectivity, and sensorbased feedback into a unified feeding system. The architecture employs an Arduino Nano microcontroller, RTC DS1307 for time scheduling, HX711 load cell for precise weight measurement, and a NEMA 17 stepper motor for controlled dispensing. An LCD interface provides realtime alerts, while EEPROM storage preserves user preferences for personalized routines. Cloud integration enables remote monitoring, feeding logs, and multipet management. The ENSI algorithm combines scheduled feeding with adaptive feedback, ensuring portion accuracy within ±2 grams and scheduling deviations under one second. This work contributes a lowcost, scalable, and technically robust solution for intelligent pet care, advancing automated nutrition systems through embedded design and IoT innovation.

KEYWORDS:

Embedded controllers, IoT connectivity, Adaptive scheduling, Portion control, Nutrition monitoring

Design and Implementation of an RFID-Based Smart Attendance System with Integrated Payroll Management

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ABSTRACT:

In many organizations, attendance tracking and payroll management are handled manually or through separate systems, resulting in inefficiencies, increased processing time, and potential human errors. This paper presents the design and implementation of an RFID-based smart attendance system integrated with payroll management to automate and streamline these processes. The proposed system utilizes RFID technology to record employee attendance in real time through card scanning. The captured data is stored in a centralized database and directly linked to payroll processing, enabling automatic salary computation based on attendance records. This integration eliminates manual data entry, reduces administrative workload, and improves overall system accuracy. Unlike conventional attendance systems that focus solely on monitoring presence, the proposed solution provides a unified platform for both attendance tracking and payroll management. The system is cost-effective, reliable, and scalable, making it suitable for deployment in organizations seeking efficient workforce management solutions.

KEYWORDS:

RFID, Smart Attendance System, Payroll Management, Automation, Real-Time Monitoring, Database Management, Embedded Systems, Workforce Management

Smart Livestock Monitoring and Automation System for Goat Farming Using IoT and AI

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ABSTRACT:

This paper presents an intelligent goat farm automation and monitoring system based on Internet of Things (IoT) and Artificial Intelligence (AI) technologies to enhance operational efficiency, resource utilization, and livestock welfare in small-scale goat farming. Traditional farming practices rely heavily on manual operations for feeding, watering, and gate control, resulting in inconsistent feeding schedules, increased labor requirements and limited monitoring of animal health and activity. The proposed system integrates a microprocessor- based automation framework to manage routine farm operations, including scheduled gate control using a timer-driven Automatic gate system, automated feeding through a conveyor and automated watering and cleaning mechanisms to improve farm hygiene and resource efficiency. For livestock monitoring, AI-enabled edge cameras are deployed at strategic locations across the farm. A computer vision model trained using the Roboflow platform is utilized for real-time goat detection, population counting, and activity classification into active and inactive states. The trained model is deployed on a Raspberry Pi edge computing device to perform real-time inference and local video processing. To reduce bandwidth consumption and storage requirements, only structured analytical data is transmitted to a cloud-based dashboard for visualization, alert generation and historical analysis. The proposed system enables real-time monitoring and supports data-driven decision-making for improved livestock productivity and smart farm management.

KEYWORDS:

Internet of Things (IoT), Artificial Intelligence (AI), Computer Vision, Edge Computing, Raspberry Pi, Roboflow, Livestock Monitoring, Smart Farming

Bone Fracture Detection Techniques

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ABSTRACT:

The Cloud-Based Smart X-ray Analysis and Monitoring System is designed to provide a simple and cost-effective solution for the early detection of bone- related problems. The system combines image capturing, cloud technology, embedded systems, and communication modules to analyse X-ray images and provide results to the user.In this system, X-ray images are captured using an ESP32-CAM module or a mobile camera and then uploaded to a cloud platform for analysis. The cloud processes the image and checks for possible fractures or abnormalities. The result is then sent back to the system and displayed on a local display unit. At the same time, a GSM module is used to send a message to the user's mobile phone with the analysis result. The main aim of this project is to make the system easy to use, affordable, and accessible for common people, especially in areas where medical facilities are limited. This system helps users get a basic idea about their condition and encourages them to consult a doctor if needed. Overall, the project shows how cloud computing and embedded systems can be used together to build a simple and useful healthcare application.

KEYWORDS:

Cloud Computing, X-ray Analysis, Image Processing,GSM, Embedded Systems, Smart Healthcare

Design and Implementation of an IoT-Based Fire and Gas Leakage Detection System Using ESP32

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ABSTRACT:

Fire hazards and gas leakages pose significant risks to human life and property, necessitating reliable and real- time monitoring systems. This paper presents the design and implementation of an IoT-based fire and gas leakage detection system using the ESP32 microcontroller. The proposed system integrates a flame sensor to detect fire and an MQ-2 gas sensor to identify the presence of combustible gases such as LPG and smoke.The ESP32 processes sensor data and activates immediate local alerts through a buzzer and LED when hazardous conditions are detected. Furthermore, leveraging the built-in Wi-Fi capability of the ESP32, the system sends real-time notifications to users via IoT platforms, enabling remote monitoring and timely response. The proposed system is cost-effective, reliable, and easy to implement, making it suitable for deployment in residential, industrial, and laboratory environments. By combining embedded systems with IoT technology, the system provides an efficient solution for early detection and prevention of fire and gas-related accidents, thereby enhancing overall safety.

KEYWORDS:

IoT, ESP32, Fire Detection, Gas Leakage Detection, MQ-2 Sensor, Flame Sensor, Smart Safety System, Real-Time Monitoring

Smart Queue Management System for Government Offices

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ABSTRACT:

The Smart Queue Management System for Government Offices is a full stack web-based application developed to modernize and optimize the traditional queuing process in public service departments. In many government offices, citizens experience long waiting hours, overcrowding, and inefficient manual token systems while accessing essential services such as document verification, license renewal, bill payment, certificate issuance, and grievance submission. These issues reduce service efficiency and negatively impact citizen satisfaction. The proposed system introduces a digital platform that enables citizens to register, log in, and generate queue tokens online through a user-friendly web interface. The system automatically assigns a unique token number, estimates waiting time, and provides real-time queue status updates. Notifications can be sent via SMS or email when the user's turn is approaching, thereby minimizing unnecessary physical presence and reducing crowd congestion within office premises. From a full stack perspective, the system integrates frontend technologies for interactive user interfaces, backend server-side logic for token management and queue processing, and a relational database for storing user information, token records, and service details. An administrative dashboard is provided for government staff to manage service counters, call the next token digitally, monitor queue flow, and generate analytical reports. The system also supports priority-based token allocation for senior citizens and differently-abled individuals to ensure fairness and inclusivity. By automating the queue handling process and maintaining digital records, the Smart Queue Management System enhances transparency, improves operational efficiency, reduces waiting time, and promotes better public service delivery. The system is scalable, secure and adaptable to various government departments, making it an effective step toward digital governance and smart public administration.

KEYWORDS:

Smart Queue Management System, Full Stack Web Application, Token Management, Real-time Updates, Digital Governance, Queue Optimization, Public Service System

Adaptive Power Reduction in CMOS-based VLSI Circuits using Integrated Gating Techniques

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ABSTRACT:

Power has emerged as the most limiting factor in VLSI design today due to the development of high performance, battery-operated portable devices. A substantial portion of power consumption in CMOS is dissipated not only through switching due to computation but also due to the leakage current, as well as redundant power to circuit blocks that are idle. Such inefficiencies are further amplified by scaling into the deep submicron regime, adversely impacting system reliability, thermal behavior, and battery life. This paper proposes an adaptive and unified power management scheme for CMOS based VLSI circuits based on dynamic adjustment of power according to the dynamic demands of the circuit. The proposed technique integrates several power saving schemes namely clock gating, power gating, and dynamic voltage scaling in a comprehensive manner. Contrary to previous approaches where each technique is implemented individually, this scheme focuses on the co-integration of these techniques for significantly effective and scalable reduction of both dynamic and leakage power consumption. Design is evaluated under various workload conditions through simulations that analyze various performance metrics such as power, delay, and efficiency. Additionally, the proposed system brings a higher level of intelligence in the power management by making it possible for blocks of circuitry to vary power depending on the activity thereby avoiding useless energy wastage. Hence the design is highly applicable to various modern applications like the Internet of Things (IoT), wearable devices, and embedded systems where reduction of power is a foremost requirement. The proposed scheme thereby presents a scalable, efficient, and practical solution for designing low-power VLSI circuits that can effectively address current and future needs of energy-efficient electronics without sacrificing significantly on the performance and at the same time minimizing the complexity in design.

KEYWORDS:

Low Power VLSI, CMOS Circuits, Power Management, Clock Gating, Power Gating, Dynamic Voltage Scaling, Energy Efficiency

Reconfigurable Intelligent Surface (RIS) assisted Non – Orthogonal Multiple Access (NOMA)

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ABSTRACT:

Reconfigurable Intelligent Surfaces (RIS) have emerged as a promising technology for reducing Bit- Error rate (BER) in next-generation wireless communication systems. When combined with Non-Orthogonal Multiple Access (NOMA), RIS assisted systems offer significant potential to improve user connectivity, coverage, and throughput, particularly in dense and interference limited environments. This research project is motivated by the need to better understand and optimize the performance of NOMA assisted RIS systems under practical deployment conditions, where factors such as power allocation and Successive Interference Cancellation (SIC) play a critical role. The study focuses on evaluating system performance by investigating different power allocation strategies among users in a NOMA framework integrated with RIS. In parallel, the effect of varying the elements of RIS is systematically examined to understand how Bit error rate influences signal enhancement. The expected contributions of this work include a comparative analysis of power allocation techniques in RIS assisted NOMA systems, along with insights of varying the layers of RIS for improved communication performance.

KEYWORDS:

NOMA, RIS, BER, Power Allocation, SIC, Spectral Efficiency

Shrimp Larvae Counting Using YoloV8

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ABSTRACT:

India is one of the largest producers and exporters of shrimp, with hatcheries playing a crucial role in meeting global demand. A major challenge in shrimp farming is the accurate counting of post-larvae (PL), which is traditionally carried out manually by workers. This manual process is time-consuming, labor-intensive, and prone to human error, particularly in dense hatchery conditions where overlapping and fast-moving larvae make visual estimation unreliable. To overcome these challenges, we propose an automated shrimp larvae counting system based on YOLOv8, a state-of-the-art deep learning framework known for its balance of speed and accuracy. The workflow integrates segmentation, component analysis, and real-time image capture using a Raspberry Pi and Pi Camera, enabling efficient deployment in hatchery environments. Compared to heavier models such as EfficientNet and MobileNetV2, YOLOv8 provides superior detection capabilities while remaining computationally efficient, making it suitable for embedded systems. The system achieved a test-set mAP@0.5 of 0.729 and Count Accuracy (CA) of 94.6%, surpassing human technician accuracy by 11-13 percentage points.

KEYWORDS:

YOLOv8, shrimp larvae counting, object detection, aquaculture, deep learning, SAHI, Weighted Boxes Fusion, Raspberry Pi, precision agriculture.

Design and Implementation of a Smart Battery Management System with IoT-Based Mobile Alerts for Electric Vehicles

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ABSTRACT:

The rapid growth of electric vehicles (EVs) has increased the need for efficient and reliable battery management systems to ensure safety, performance, and longevity. This project presents a Smart Battery Management System (BMS) with mobile alert functionality for electric vehicles. The proposed system focuses on continuous monitoring of critical battery parameters such as temperature and voltage using sensors interfaced with a microcontroller. The system detects overheating conditions and activates a cooling fan and buzzer while sending IoT-based alerts to a mobile device. Compared to conventional systems, the proposed system improves safety, reduces battery damage, and enhances reliability. Implemented using Arduino, sensors, LCD, relay, and IoT modules, the system increases battery lifespan and ensures efficient EV operation.

KEYWORDS:

Battery Management System, Electric Vehicles, IoT, Thermal Management, Real-Time Monitoring, Mobile Alerts.

Wireless Power Transform Road to Running Vehicle

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ABSTRACT:

The increasing adoption of electric vehicles (EVs) has intensified challenges such as limited driving range, long charging times, and dependency on conventional charging infrastructure. This has led to extensive research on wireless power transfer (WPT) technologies as a viable solution. The collected studies focus on inductive and resonant magnetic coupling methods for efficient wireless charging, including static, quasi-dynamic, and dynamic charging systems that enable vehicles to charge while stationary or in motion, thereby reducing range anxiety and improving convenience.

Key contributions include the optimization of coil design, mutual inductance, compensation circuits, and system modeling to achieve high power transfer efficiencies, typically above 90%, along with innovations in roadway-powered systems and multi-lane charging infrastructure. Several works also emphasize the integration of renewable energy sources such as solar power and the use of smart grid technologies to enhance sustainability and energy management. Overall, these studies demonstrate that wireless EV charging is a safe, efficient, automated, and eco-friendly solution with the potential to reduce battery dependency and eliminate charging downtime, although challenges such as high implementation cost, infrastructure complexity, and electromagnetic interference remain areas for future research.

Keywords:

Electric Vehicles (EVs), Wireless Power Transfer (WPT), Inductive Coupling, Resonant Magnetic Coupling, Static Charging, Quasi-Dynamic Charging, Dynamic Charging, Coil Design Optimization, Mutual Inductance, Compensation Circuits, System Modeling, Power Transfer Efficiency, Roadway-Powered Systems, Multi-Lane Charging Infrastructure.

IoT-Based Industrial Monitoring and Safety System

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ABSTRACT:

Industrial environments are inherently prone to accidents due to human error, equipment malfunction, or unsafe operational practices. Ensuring comprehensive worker safety requires real-time continuous monitoring and rapid response mechanisms that can detect anomalies before they escalate into critical incidents. This project proposes an intelligent industrial safety system that utilizes an ESP32 microcontroller integrated with a high-resolution camera module and advanced AI-based image processing algorithms to detect potential accidents in real time with minimal latency.The system continuously monitors the workspace using a distributed network of sensors, captures live video feed from strategic viewpoints, and processes the captured frames using machine learning algorithms trained to identify various hazardous situations. These hazards include human falls, equipment collisions, unsafe body movements, unauthorized zone entry, and other safety violations that require immediate intervention. Upon detection of any accident or abnormal condition, the system immediately triggers multi-channel alerts including audio warnings, visual indicators, and notifications sent to safety personnel, enabling prompt emergency response and intervention.By combining state-of-the-art IoT hardware with AI-driven real-time analysis, the proposed system significantly enhances workplace safety standards, dramatically reduces emergency response time, and minimizes the risk of severe injuries and fatalities. This integrated approach provides an efficient, automated, and highly scalable solution for modern industrial safety management that can be deployed across diverse industrial sectors including manufacturing, processing, warehousing, and chemical industries.

KEYWORDS:

Industrial Safety, Accident Detection, Real-Time Monitoring, ESP32 Microcontroller, AI-Based Image Processing, Machine Learning, Computer Vision, Workplace Safety, Hazard Detection, Human Fall Detection, Equipment Collision Detection.

Comparative Study and Hybrid Framework for mmWave Radar Based Non-Contact Heart Rate Monitoring

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ABSTRACT:

Millimeter-wave (mmWave) radar technology has become one of the most promising solutions for contactless vital sign monitoring because it can measure micro chest movements caused by breathing and heartbeat without direct physical contact. Earlier studies mainly focused on improving heartbeat extraction accuracy and extending monitoring range. The previous two papers compared in this study presented high-accuracy heart rate monitoring using Adaptive Notch Filter (ANF) and Empirical Wavelet Transform (EWT), and long-distance multi-user monitoring using Minimum Variance Distortionless Response (MVDR) beamforming and Wavelet Packet Decomposition (WPD). The additional three papers further expand this field by investigating the effect of radar carrier frequency, low-power radar hardware, and comparative performance of 24 GHz, 60 GHz, and 120 GHz Frequency Modulated Continuous Wave (FMCW) radars. These studies analyse baseline noise, range resolution, displacement sensitivity, and heart-rate estimation accuracy. When all five papers are compared, it becomes clear that mmWave healthcare sensing is progressing in three directions: advanced signal processing, practical deployment in long-range multi-user environments, and optimized low-power hardware design. This comparative study provides a complete understanding of current radar-based healthcare systems and future opportunities for hybrid intelligent monitoring platforms.

KEYWORDS:

Millimeter-Wave Radar (mmWave), Contactless Vital Sign Monitoring, Heart Rate Detection, Respiration Monitoring, Micro Chest Movement Sensing, Adaptive Notch Filter (ANF), Empirical Wavelet Transform (EWT), Minimum Variance Distortionless Response (MVDR), Wavelet Packet Decomposition (WPD).

Deep Learning-Aided Predictive Model for Precision Design and Rapid Prototyping of Meta Material Based 5G Antennas for Cancer Detection

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ABSTRACT:

Recent advancements in microwave imaging have demonstrated the effectiveness of metamaterial- and meta surface-based monopole antennas for early-stage breast cancer detection. This review examines three related studies, focusing on compact antenna design, gain enhancement, and biomedical safety.

The first study presents an ultra-wideband metamaterial-based monopole antenna integrated with a frequency selective surface (FSS), achieving a wide operating range of 2.9–36 GHz, high gain up to 8.5 dBi, and compliance with safety standards through a low specific absorption rate (SAR). The second study proposes a miniaturized FSS-backed monopole antenna operating in the 3.4–9 GHz band, offering improved gain and suitability for multistatic microwave imaging systems. The third study introduces a metasurface-based monopole antenna sensor operating at 2 GHz, emphasizing antenna miniaturization, high radiation efficiency, and enhanced tumor detection sensitivity using a heterogeneous breast phantom model.

Overall, the integration of metamaterials and metasurfaces significantly improves antenna performance in terms of bandwidth, gain, and detection capability while ensuring patient safety. A trade-off between bandwidth and detection sensitivity is observed: ultra-wideband designs provide imaging flexibility, whereas narrowband designs improve accuracy. Future research should focus on hybrid, high-performance, and wearable antenna systems for practical clinical applications.

KEYWORDS:

Microwave Imaging, Breast Cancer Detection, Metamaterial Antennas, Metasurface Antennas, Monopole Antenna, Ultra-Wideband (UWB), Frequency Selective Surface (FSS), Antenna Miniaturization

Design & Implementation of a Phase Frequency Detector for mm Wave Frequency Range Phase Locked Loop Application

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ABSTRACT:

This report presents the design and implementation of a Phase Frequency Detector (PFD) for millimeter-wave (mm-wave) frequency range Phase-Locked Loop (PLL) applications. The proposed PFD is designed to operate at high frequencies with improved phase detection accuracy and reduced dead zone, which are critical for mm-wave communication systems. The architecture utilizes efficient digital logic to ensure fast response, low power consumption, and high-speed performance. Simulation results demonstrate reliable operation over a wide frequency range, making the design suitable for next-generation wireless and high-frequency integrated circuit applications.

KEYWORDS:

Phase Frequency Detector (PFD), Millimeter-Wave (mmWave), Phase-Locked Loop (PLL), High-Frequency Design, Phase Detection Accuracy, Dead Zone Reduction.

Miniaturized UWB Implantable Antennas for Leadless Cardiac Pacemakers: A Review

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ABSTRACT:

Implantable antennas used in leadless cardiac pacemakers encounter significant challenges, including detuning effects arising from complex in-body conditions, variations in surrounding biological tissues, and interference from nearby electronic components. Furthermore, the demand for extreme miniaturization places strict constraints on achievable bandwidth and overall antenna performance. In this study, a compact and flexible implantable antenna is presented for intracardiac pacemaker applications. The design incorporates advanced miniaturization strategies such as fractal-inspired geometry, meandered paths, and slot-based modifications, including a cross-shaped radiator with circular openings and minor structural cuts. The antenna is enclosed within a biocompatible polymer layer to reduce direct interaction with human tissues and improve operational stability.

The proposed antenna operates at both the 2.4 GHz ISM band and 6 GHz, enabling reliable biomedical telemetry. Performance evaluation is conducted using both homogeneous and heterogeneous human body models, including voxel-based simulations to emulate realistic implantation scenarios. The antenna achieves acceptable gain, enhanced bandwidth, and stable performance under detuning conditions. In addition, specific absorption rate (SAR) analysis confirms compliance with established safety standards, while wireless communication link margin evaluation verifies effective data transmission. The findings indicate that the proposed design provides a reliable, safe, and efficient solution for miniaturized communication in next-generation leadless pacemaker systems.

KEYWORDS:

Implantable Antenna, Leadless Pacemaker, Specific Absorption Rate (SAR), Miniaturization, Fractal Antenna, Biomedical Telemetry, ISM Band, Wireless Communication.

AI-Enabled Smart Waste Management System using IoT

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ABSTRACT:

Waste management is a major challenge in both urban and rural areas due to increasing population and improper disposal practices. Traditional waste collection methods are often inefficient, leading to overflowing bins, environmental pollution, and associated health risks.

This paper proposes an AI-enabled Smart Waste Management System using the Internet of Things (IoT) to monitor waste levels in real time and optimize collection processes. The system employs sensors to detect waste levels and environmental conditions, transmitting data to a cloud platform for continuous monitoring. Additionally, basic machine learning techniques are applied to predict bin fill levels and improve collection scheduling.

The proposed system ensures efficient waste handling, reduces operational costs, and contributes to the development of smart cities.

KEYWORDS:

IoT, Smart Waste Management, Artificial Intelligence, ESP32, Ultrasonic Sensor, Cloud Monitoring, Smart City, Waste Level Detection.

Design of Dual Band Antenna for Sub – 6Ghz and mmWave Applications

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ABSTRACT:

The rapid advancement of fifth-generation (5G) wireless communication systems has increased the demand for compact antenna systems capable of supporting both sub-6 GHz and millimeter-wave frequency bands. This project focuses on the analysis of an integrated antenna system designed for modern smartphone applications. The proposed design combines a 2×2 planar inverted-F antenna (PIFA) MIMO configuration for sub-6 GHz frequencies with millimeter-wave antenna arrays operating at 28 GHz, enabling multi-band communication with improved coverage and high data rate capability. The antenna structure is implemented on a Rogers RT/Duroid 5880 substrate with a thickness of 0.508 mm, selected for its low dielectric loss and suitability for high-frequency operation. The sub-6 GHz PIFA antenna is designed to operate at 3.5 GHz for 5G communication and 5.4 GHz for LTE band-46. The millimeter-wave section consists of two arrays of eight antenna elements positioned along the smartphone rim to achieve directional radiation and enhanced gain at 28 GHz. Electromagnetic simulations are conducted to evaluate key antenna parameters such as reflection coefficient (S-parameters), impedance bandwidth, gain, and radiation pattern. The results demonstrate that the integrated antenna system operates successfully across the intended frequency bands, with good impedance matching and stable radiation characteristics. The compact design and array configuration make the proposed antenna system suitable for next-generation 5G wireless communication devices and smartphone platforms.

KEYWORDS:

5G Communication, Sub-6 GHz, Millimeter-Wave (mmWave), Integrated Antenna System, Planar Inverted-F Antenna (PIFA), MIMO Antenna, Smartphone Antenna Design, 28 GHz Antenna Array, Rogers RT/Duroid 5880, High-Frequency Antennas, Multi-Band Communication.

Driver Alertness and Safety Monitoring System Using IoT

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ABSTRACT:

This paper proposes an intelligent driver safety monitoring system that aims to minimize such accidents by continuously observing and analysing the driver's condition in real time. The system integrates multiple sensing and processing technologies, including a camera module for eye-blink detection, an MQ-3 gas sensor for alcohol detection, and a vibration sensor for accident identification. By combining these components into a unified framework, the system provides a comprehensive and reliable solution for enhancing road safety. The proposed system utilizes image processing techniques to monitor the driver's eye movements and blinking patterns. If the driver's eyes remain closed beyond a predefined threshold, the system detects a state of drowsiness and immediately triggers an alert through a buzzer. Simultaneously, the MQ-3 gas sensor analyses the driver's breath to detect the presence of alcohol. If the detected alcohol level exceeds the permissible limit, the system identifies the driver as unfit to operate the vehicle. In addition, a vibration sensor is incorporated to detect sudden shocks or unusual movements that may indicate a collision or accident. Upon detecting such events, the system activates emergency alerts. To further enhance safety, the system includes a motor control mechanism that can automatically slow down or stop the vehicle under critical conditions, thereby preventing potential accidents. Moreover, the integration of an IoT module, enables real-time data transmission to a cloud platform or mobile application. This feature allows remote monitoring and ensures that alerts can be communicated instantly to concerned individuals or emergency services, facilitating rapid response during emergencies.

KEYWORDS:

Driver Safety Monitoring, Drowsiness Detection, Eye-Blink Detection, Alcohol Detection, MQ-3 Gas Sensor, Vibration Sensor, Accident Detection, Real-Time Monitoring, Image Processing, IoT-Based System, Embedded Systems.

Real-Time Autonomous Navigation for Robots Using Stereo Vision, LiDAR Fusion, and Dual-Processor Edge AI Architecture

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ABSTRACT:

Autonomous humanoid robots deployed in real-world environments such as healthcare, education, and public service require fast, reliable, and adaptive navigation systems that operate without cloud dependency. Existing robotic systems are limited by single-sensor perception, a lack of real-time multi-sensor fusion, and communication delays between AI and motor control units. This paper presents the design and implementation of a real-time navigation system for a half-humanoid robot that addresses these challenges by integrating stereo vision, LiDAR sensing, and edge AI processing.

A stereo camera provides accurate depth estimation for obstacle distance measurement, while a LiDAR sensor enables immediate safety-stop control in critical situations. YOLOv9 is deployed for real-time object detection, and a sensor fusion module combines stereo depth and LiDAR data for robust spatial awareness. A dual-processor architecture — NVIDIA Jetson Orin for AI inference and Raspberry Pi 4 for motor/servo control — communicates via UART, effectively separating computation and actuation to reduce system latency.

The navigation engine supports multi-domain operational modes, enabling the robot to adapt across different real-world environments. Experimental results demonstrate that the proposed system achieves efficient obstacle detection, low-latency decision-making, and stable autonomous movement, making it suitable for deployment in intelligent automation applications aligned with SDGs in healthcare, education, and smart city infrastructure.

KEYWORDS:

YOLOv9, LiDAR Sensing, Autonomous Mobility, Multi-Sensor Fusion, Object detection**.**

A Review Paper on Smart Wireless underground Cable Fault Detection and Distance Locator

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ABSTRACT:

This project presents a Smart Wireless Underground Cable Fault Detection and Distance Locator aimed at improving the efficiency and reliability of power distribution systems. The system detects faults such as short circuits, open circuits, and earth faults using voltage and resistance variations, and estimates their location accurately. It is implemented using an ESP8266 NodeMCU integrated with voltage sensors and IoT modules to enable real-time data processing, remote monitoring, and alert generation through cloud platforms. This reduces manual inspection and minimizes downtime.

By applying Ohm's Law and resistance-based analysis, the system converts physical faults into measurable electrical variations to identify fault location. The use of wireless communication enhances response time and operational efficiency. Overall, the solution is cost-effective, scalable, and suitable for smart grid applications, contributing to improved maintenance and reliable power distribution.

KEYWORDS:

Underground Cable Fault Detection, Distance Locator, Smart Grid, ESP8266 NodeMCU, IoT-Based Monitoring, Voltage Sensing, Resistance Measurement, Ohm's Law, Fault Localization, Real-Time Monitoring, Cloud Integration, Remote Alerts, Power Distribution Systems, Short Circuit Detection, Open Circuit Detection

AI and IoT Based Manual Waste Segregation Monitoring and Enforcement System

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ABSTRACT:

Improper waste disposal remains one of the most pressing environmental challenges in rapidly urbanising societies. Traditional waste management systems largely depend on manual segregation, which is often inconsistent, error-prone, and lacks effective monitoring and accountability mechanisms. To address these limitations, this paper proposes an AI-driven Smart Waste Monitoring System that focuses on supervising and improving user-performed manual waste segregation rather than fully automating the process.

The proposed system integrates a vision-based AI module powered by the YOLOv8 deep learning model to perform real-time verification of waste categories. RFID technology is used for reliable user identification, while an IoT-enabled cloud platform enables continuous data logging, remote monitoring, and analytics. Waste deposited by users is classified into degradable, non-degradable, and mixed categories, ensuring that only properly segregated waste is accepted into the system. A key feature of the proposed framework is its behaviour-enforcement mechanism. The system conditionally accepts waste based on correct segregation. If incorrect disposal is detected, users are given a limited time to correct their action. If the error persists during the next interaction, the waste is automatically rejected, recorded as a violation, and a penalty is imposed on the responsible user. This mechanism promotes responsible behaviour and strengthens accountability in waste disposal practices.

All transactional data, including user identity, timestamp, waste classification, and acceptance or rejection status, is securely stored in the cloud and visualised through a municipal dashboard for administrative monitoring. In addition, integrated sensors track bin capacity and generate real-time alerts when thresholds are reached. Experimental results show that the YOLOv8 model achieves approximately 90% accuracy in waste classification.

KEYWORDS:

Smart Waste Monitoring, Manual Waste Segregation, YOLOv8, RFID-Based User Identification, Internet of Things (IoT), Behaviour Enforcement, Smart City, Waste Classification, Cloud Dashboard.

A Review Paper on Voice Controlled Air Purifier with Sleep Assist System

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ABSTRACT:

The Voice Controlled Air Purifier and Sleep Assist System is a smart device designed to improve indoor air quality and create a comfortable environment for better sleep. It uses sensors to detect pollutants such as dust, smoke, allergens, and harmful gases in real time. When pollution levels increase, the purifier automatically activates to clean the air and maintain a healthy atmosphere. The system also provides air quality updates for user awareness. In addition to purification, it includes sleep assist features such as soft lighting, soothing sounds, and environmental control to promote relaxation and restful sleep. Voice command functionality allows users to control the purifier, lighting, and sleep modes hands-free, making it convenient and user-friendly. This feature is especially useful for elderly people and those with mobility limitations. By integrating IoT technology, automation, and embedded systems, the device ensures efficient performance, energy saving, and easy remote access through smartphones. Overall, the system offers a cost-effective solution for healthier living, greater comfort, and improved sleep quality.

KEYWORDS:

Voice-Controlled System, Air Purifier, Sleep Assist System, Indoor Air Quality, IoT-Based Device, Smart Home Automation, Pollution Detection, Dust Sensor, Smoke Detection, Gas Sensor, Allergen Control, Real-Time Monitoring, Environmental Control.

A Real-Time Offline Gesture-to-Speech Conversion System for Multilingual Assistive Communication

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ABSTRACT:

Assistive communication systems are essential for improving interaction for individuals with hearing and speech impairments. However, many existing sign language recognition solutions are limited by single-language output, reliance on internet connectivity, and lack of real-time performance. These challenges are more significant in multilingual environments like India, where communication must support multiple regional languages.

This paper presents a real-time gesture-based communication system that interprets Indian Sign Language and converts it into multilingual speech output. The system captures hand gestures using a camera and extracts key hand landmarks through an efficient vision-based approach. These features are processed using a lightweight machine learning model to ensure fast and accurate gesture recognition.

The recognized gestures are translated into text and further converted into speech in regional languages, providing both visual and audio feedback. The system is designed to operate offline using an embedded controller, reducing latency and improving accessibility. Experimental results show that the system achieves an accuracy of 94.8% and supports real-time processing at approximately 25 frames per second.

Overall, the proposed approach offers a practical balance between accuracy, speed, and usability, making it suitable for assistive communication in real-world environments.

KEYWORDS:

Gesture Recognition, Edge Computing, Hand Landmark Detection, Multilingual Speech, Embedded Systems, Assistive Technology.

Wearable Device for Monitoring Vital Signs and Detecting Health Emergencies.

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ABSTRACT:

The use of wearable technology has become a cornerstone of the medical and healthcare industry for continuously monitoring patients' health status. Medical data is processed to predict abrupt changes and notify doctors accordingly, while also supporting healthcare professionals, patients, and their families.

This paper presents the design of an IoT-based smart wearable health monitoring system capable of collecting, measuring, and transmitting health data to cloud platforms for processing and storage. The proposed hardware system integrates multiple sensors with an ESP8266 microcontroller to monitor body temperature, heart rate, pulse rate, and detect falls. The MAX30105 sensor is used for measuring heart rate and body temperature, while the MPU6050 sensor is employed for fall detection.

The data acquired from the sensors is displayed on an OLED connected to the microcontroller and is also transmitted to Google's cloud server via Wi-Fi for storage and analysis. The data visualization process enables healthcare professionals to identify potential health issues and respond promptly during emergency situations.

This smart wearable system is particularly beneficial for elderly care, intensive care units (ICU), and other critical healthcare environments. The integrated hardware and software model, along with learning-based prediction, has been tested and demonstrates improved efficiency compared to existing systems.

KEYWORDS:

IoT, Smart Wearable Device, Health Monitoring System, Heart Rate Measurement, Body Temperature Monitoring, Fall Detection, MAX30105 Sensor, LM35 Sensor, MPU6050, ESP8266, Cloud-based Monitoring, Real-time Data Logging, Remote Healthcare, Elderly Care.

IoT-Enabled Smart Drainage and Worker Health Monitoring System

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ABSTRACT:

Manual scavengers are exposed to hazardous working conditions, including toxic gases, wastewater blockages and overflows, and extreme climatic conditions. To address these challenges, this paper presents an IoT-based Smart Drainage and Health Monitoring System designed to enhance operational safety and efficiency. The system utilizes ultrasonic sensors to monitor water levels, gas sensors to detect toxic gases such as methane, hydrogen sulfide, and carbon monoxide, and temperature sensors to track extreme environmental conditions. When critical water levels are detected, a solenoid valve is automatically activated to prevent overflow and clogging.

Sensor data is transmitted to a cloud-based IoT platform for processing, visualization, and storage. A dedicated mobile application provides real-time monitoring, alerts, and historical data analysis, enabling authorities to take timely action and reduce human exposure to hazardous environments.By integrating automated control, smart sensing, and predictive analytics, the system supports predictive maintenance and contributes to sustainable urban drainage management. Overall, the proposed solution demonstrates how IoT-enabled smart systems can significantly improve safety, efficiency, and working conditions in sanitation operations.

KEYWORDS:

IoT, Smart Drainage, Health Monitoring, Manual Scavengers, Real-Time Sensors, Automated Control, Toxic Gas Detection. Defense surveillance, intelligent monitoring systems, border security, and autonomous navigation platforms.

Decentralized E-Voting with Aadhaar Salt Authentication and Homomorphic Vote Tally.

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ABSTRACT:

This work presents a decentralized electronic voting system prototype designed to address key limitations in conventional digital voting platforms, including centralized control, vulnerability to tampering, inadequate ballot secrecy, and weak voter authentication mechanisms. The proposed system integrates multiple security approaches to ensure privacy, integrity, and verifiability. First, an Aadhaar-based salted hash authentication scheme is implemented to verify voter eligibility without storing or transmitting raw Aadhaar identifiers, thereby preserving user privacy. Second, ballot confidentiality is achieved using the Paillier partially homomorphic encryption scheme, where votes are encrypted entirely on the client side before transmission, preventing server-side access to plaintext data. Third, encrypted votes are stored on a blockchain through a smart contract, ensuring immutability, transparency, and prevention of double voting. Vote tallying leverages the additive homomorphic property of the Paillier cryptosystem, enabling aggregation of encrypted votes without decryption. The final results are decrypted only once after the voting phase concludes, and a cryptographic hash of the tally is stored on-chain to support independent verification of election integrity. The system is evaluated through functional, security, and performance testing, demonstrating correct operation, resilience against potential attack vectors, and efficient tallying performance. Compared to existing blockchain-based voting solutions, the proposed architecture offers improved guarantees for ballot privacy, data integrity, and transparent verification.

KEYWORDS:

Decentralized Voting System, Electronic Voting (E-Voting), Blockchain Technology, Smart Contracts, Aadhaar-Based Authentication, Salted Hashing, Voter Authentication, Paillier Cryptosystem, Homomorphic Encryption, Ballot Privacy, Data Integrity, Vote Tallying, Encrypted Voting, Election Security,

Next-Generation Contactless EV Charging Using Solar Energy and Wireless Power Transfer

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ABSTRACT:

The increasing adoption of electric vehicles (EVs) necessitates efficient and sustainable charging solutions. This paper presents a next-generation contactless EV charging system that integrates solar energy with wireless power transfer (WPT). Photovoltaic (PV) panels are used to generate clean energy, which is regulated and stored to ensure continuous operation. Wireless charging is achieved through inductive coupling, enabling safe and convenient power transfer without the need for physical connectors.

A maximum power point tracking (MPPT) algorithm is employed to optimize solar energy harvesting, while a smart energy management system dynamically controls power flow based on EV demand and battery state of charge. Simulation results demonstrate improved energy efficiency, reduced power losses, and enhanced operational flexibility compared to conventional charging methods.

The proposed system supports sustainable transportation by reducing carbon emissions and provides a scalable solution for future EV charging infrastructure.

KEYWORDS:

Electric Vehicles (EVs), Wireless Power Transfer (WPT), Solar Energy, Contactless Charging, Photovoltaic Systems, Maximum Power Point Tracking (MPPT), Inductive Coupling, Smart Energy Management, Sustainable Transportation, Energy Efficiency

Advanced Integrated Safety Architectures for Two-Wheeler Riders: A Smart Helmet Automation Approach

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ABSTRACT:

Road traffic accidents involving two-wheelers account for a significant portion of global fatalities, often exacerbated by non-compliance with helmet laws and delayed emergency response. This project proposes an Advanced Smart Helmet Automation System that transforms traditional head protection into an active IoT-based safety solution.

The system utilizes an ESP32 dual-core microcontroller and an MPU6050 inertial measurement unit (IMU) to enable real-time accident detection and fall analysis. A 6-axis motion tracking framework monitors linear acceleration and angular velocity to distinguish between normal riding conditions and high-impact collisions. Additionally, a Force Sensing Resistor (FSR) is integrated to ensure helmet usage compliance, while an alcohol sensor prevents vehicle ignition if intoxication is detected.

By incorporating sensor fusion techniques and low-latency wireless communication, the system ensures that emergency alerts are transmitted within the "Golden Hour," significantly increasing the chances of timely medical intervention.

KEYWORDS:

Accident Mitigation, ESP32, IoT, MPU6050, Sensor Fusion, Smart Helmet, Two-Wheeler Safety.

Dual Superstrate High-Efficiency X-Band Slot Antenna

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ABSTRACT:

The rapid growth of high-frequency wireless communication systems has created a strong demand for compact and high-performance antennas, particularly for X-band applications such as radar, satellite links, and remote sensing. Conventional antenna designs often face issues like limited bandwidth, low gain, and higher transmission losses, which reduce overall efficiency. This work proposes a compact slot antenna integrated with a dual superstrate structure to address these limitations. In the proposed design, an air substrate is employed to minimize dielectric losses and enhance radiation efficiency. Furthermore, the inclusion of copper and silicon superstrate layers improves current distribution and ensures stable electromagnetic propagation. The antenna is designed to operate at 10.57 GHz, achieving a very low return loss of –42 dB along with enhanced bandwidth and gain performance. The antenna performance is analysed using HFSS simulation, focusing on parameters such as return loss, VSWR, gain, and radiation characteristics. The results indicate that the proposed antenna offers reliable and efficient performance within the X-band frequency range. Its compact size and improved characteristics make it well suited for modern communication systems and advanced RF applications

KEYWORDS:

Dual Superstrate Antenna, X-Band Slot Antenna, Air Substrate Design, High-Gain Compact Antenna, HFSS-Based Optimization, Wideband RF Performance.

AI-Integrated Electromagnetic Flux Analysis for Autonomous Self-Healing Industrial Motors

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ABSTRACT:

Reliability in industrial motor systems is critical to prevent significant financial losses caused by unexpected downtime. Conventional maintenance strategies, such as fixed schedules or reactive repairs, often fail to address internal faults before catastrophic failure occurs. This paper proposes an intelligent, self-healing framework for industrial motors utilizing multi-parametric condition monitoring. The system integrates three key sensing units: an SS49E Hall-effect sensor for electromagnetic flux analysis, an LM35 for thermal monitoring, and an ACS712 for current consumption tracking. By employing Edge Machine Learning logic on an ESP32 microcontroller, the system identifies subtle magnetic signatures associated with internal winding faults and mechanical stresses. Upon detection of a critical anomaly, an autonomous failover mechanism is triggered through a relay bank, instantaneously transferring the operational load to a secondary standby motor. This Self-Healing approach ensures continuous operation without human intervention. Furthermore, the system incorporates an IoT-based monitoring dashboard for real-time data visualization and remote fault notification. The proposed method was validated using industrial motor prototypes, demonstrating high accuracy in fault classification and rapid failover execution, making it highly applicable for critical industrial processes such as chemical mixing and automotive assembly lines.

KEYWORDS:

Electromagnetic Flux Analysis, Self-Healing, Fault-Tolerant Systems, Edge ML, ESP32, Industrial IoT, Redundancy Switching.

Experimental Investigation on Thermophysical Properties of Nanofluids Compared with Conventional Fluids

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ABSTRACT:

Heat transfer fluids are essential in applications such as heat exchangers, automobile cooling, refrigeration, and electronic systems. Conventional fluids like water and ethylene glycol are widely used, but their low thermal conductivity limits heat transfer efficiency. To address this, nanofluids are developed by dispersing nanoparticles such as zinc oxide (ZnO) and copper oxide (CuO) into a base fluid. In this study, a base fluid of 70% water and 30% ethylene glycol is used to achieve a balance between thermal performance and stability. An experimental investigation is conducted to measure thermophysical properties, including thermal conductivity, viscosity, density, and specific heat, for both nanofluids and conventional fluids. Techniques like ultrasonication are used to ensure proper dispersion and stability. The results are analyzed to compare performance and evaluate heat transfer enhancement. The study shows that nanofluids improve thermal conductivity and overall efficiency, making them suitable for advanced cooling and thermal management applications

KEYWORDS:

Nanofluids, Thermophysical Properties, Thermal Conductivity, Viscosity, Density, Specific Heat Capacity, Heat Transfer Enhancement, Conventional Fluids, Zinc Oxide (ZnO) Nanoparticles, Copper Oxide (CuO) Nanoparticles, Water–Ethylene Glycol Mixture (70:30), Ultrasonication.

Local Adaptive Statistical Enhancement (LASE): A Block Based Variance Driven Image Enhancement Framework

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ABSTRACT:

Image enhancement remains a fundamental challenge in digital image processing, particularly when dealing with noise degraded inputs where conventional methods tend to either over-amplify background regions or suppress fine structural details. Global techniques such as Histogram Equalization treat the entire image with a single intensity transformation, which frequently distorts natural colour balance and introduces undesirable artifacts in high-frequency regions. This paper presents a block based Local Adaptive Statistical Enhancement algorithm, referred to as LASE, which operates on non-overlapping 32×32 spatial blocks by computing the local mean and variance to assign a spatially adaptive contrast gain. Blocks exhibiting low variance, indicative of flat or underexposed regions, receive a higher gain factor to recover suppressed detail, while blocks with high variance corresponding to edges and textured regions are assigned a conservative gain to prevent noise amplification. To preserve natural colour fidelity, the enhancement is applied exclusively to the luminance channel within the CIE LAB colour space, leaving the chrominance components unmodified throughout the process. The entire framework is implemented from scratch in MATLAB without any external toolbox dependencies, including custom implementations of CLAHE, Unsharp Masking, SSIM, EME, and Average Gradient. Experiments were conducted on five standard colour test images under Gaussian noise conditions, and the proposed method is evaluated against Histogram Equalization, Contrast Limited Adaptive Histogram Equalization, and Unsharp Masking using five quantitative metrics: PSNR, SSIM, MSE, EME, and Average Gradient. Results consistently show that LASE achieves superior performance across all test images, recording a mean PSNR improvement of approximately 2 to 4 dB over competing methods while maintaining SSIM values above 0.96, demonstrating that perceptual quality and structural fidelity can be simultaneously improved through variance-driven local gain adaptation.

KEYWORDS: Image Enhancement, Local Adaptive Processing, Block-Based Variance, CIE LAB Colour Space, PSNR, SSIM, CLAHE, Unsharp Masking, MATLAB.

Intelligent IoT Enabled Crop Defense System for Preventing Animal and Bird Intrusion

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ABSTRACT:

For optimizing performance in real time, images are compressed by reducing their dimensions, extracting features, and fusing images to reduce computational load while maintaining data quality. Once the image is pre-processed and analysed, the system triggers a set of automatic actions. The notification would be emailed immediately to the farmer, consisting of the timestamp and the kind of animal or bird identified. It also includes an immediate auditory alert through a buzzer, which may repel the intruder or make the nearby farm workers aware of it. The buzzer can also be manually controlled through web and mobile interfaces by farmers. An LCD display shows "Animal/ Bird Detected" along with the type and detection time. In the case of a night intrusion, the LED floodlights would automatically be turned on to enhance visibility and repel nocturnal wildlife. The YOLO V8 model is continuously refined for detecting a wide range of animals and birds to fit into changing environmental conditions. Pre-processing for each captured image is done by reducing noise, resizing, and normalizing the images using OpenCV to ensure better accuracy in the detection process. For real-time performance optimization, the compression of images is done by reducing their dimensions, extracting features, and fusing images to decrease the computational load without affecting the quality of data. Once the image has been pre-processed and analysed, the system automatically triggers a set of actions. The notification, containing the timestamp and the type of animal or bird detected, would be emailed immediately to the farmer. Besides this, there will be an immediate audio notification via a buzzer that could repel the intruder or make the farm workers nearby aware of the presence of the intruder. Also, the buzzer can be manually controlled via web and mobile interfaces by farmers. The LCD display shows "Animal/ Bird Detected" with the type and time of detection. In the case of any night intrusion, the LED floodlights would automatically turn on for better visibility and repelling nocturnal wildlife. In order to fit into the changing environmental conditions, the model YOLO V8 will further be refined in detecting a wide range of animals and birds.

KEYWORDS:

Animal Intrusion Detection, Smart Agriculture, YOLOv8, Image Processing, Real-Time Monitoring

Autobot for Precision Farming

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ABSTRACT:

Agricultural productivity is one of the most pressing global challenges, directly impacting food security, economic stability, and sustainable land management. Conventional farming methods are highly labour-intensive, resource-inefficient, and lack real-time responsiveness to dynamic crop and soil conditions. These limitations result in overuse of fertilizers, irregular irrigation, delayed pest detection, and reduced crop yields, causing significant environmental degradation and economic losses. To address these challenges, we propose an AI-driven Autobot for Precision Farming that enables autonomous, intelligent, and real-time field operations by integrating Internet of Things (IoT), Computer Vision, and Machine Learning technologies. The primary objective is to enable continuous crop health monitoring, automated irrigation, precision fertilization, and early pest and disease detection directly in the field, minimizing human intervention, resource wastage, and crop losses. The proposed system is built around a microcontroller-based robotic platform equipped with advanced IoT sensors that monitor critical agronomic parameters such as soil moisture, temperature, humidity, pH levels, and Nitrogen-Phosphorus-Potassium (NPK) content. A high-resolution camera module performs real-time image acquisition and preprocessing including image segmentation, noise filtering, and feature extraction to enhance data quality. A key innovation is the deployment of hybrid deep learning models, namely Convolutional Neural Networks (CNN) and Random Forest classifiers, directly on the edge device for on site crop disease identification and soil health classification.

KEYWORDS:

Precision Farming, Smart Agriculture, AI-Based Autobot, IoT Sensors, Crop Monitoring Machine Learning, CNN, Random Forest, Soil Health Analysis, Pest Detection, Automated Irrigation

Design and Analysis of a Wearable Textile Patch Antenna with Coplanar Waveguide Feed for 2.4 GHz Applications

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ABSTRACT:

This paper presents the design and analysis of a wearable textile patch antenna utilizing a coplanar waveguide (CPW) feeding technique for wireless communication applications. The antenna is fabricated on a flexible textile substrate, enabling seamless integration into clothing and making it suitable for wearable technology. It operates at 2.4 GHz, a widely used frequency in the Industrial, Scientific, and Medical (ISM) band for applications such as WiFi, Bluetooth, and healthcare monitoring systems.

The CPW feed structure enhances flexibility, simplifies fabrication, and ensures effective impedance matching. The antenna consists of a radiating patch on a textile substrate, along with a CPW feed comprising a central signal line and two ground planes on the same layer. The design and simulation are carried out using ANSYS HFSS.

Simulation results demonstrate that the antenna achieves good performance, with return loss (S11) below -10 dB and a voltage standing wave ratio (VSWR) close to 1 at the operating frequency, indicating efficient signal transmission with minimal reflection. The proposed antenna is suitable for applications in wearable medical devices, wireless body area networks, and IoT-based smart clothing. Future work may focus on improving durability, minimizing the effects of bending and moisture, and enhancing performance under real-time conditions.

KEYWORDS:

Wearable Antenna, Textile Patch Antenna, Coplanar Waveguide (CPW), 2.4 GHz ISM Band, Wireless Communication

Design and Implementation of AR-Enabled Smart Campus Guide with Voice Narration

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ABSTRACT:

Navigating large campus environments can often be a challenging and time-consuming task, particularly for new students and visitors who are unfamiliar with the layout and facilities. Traditional methods such as printed maps, signboards, and websites provide only limited assistance and lack real-time interactivity. To address these challenges, this paper presents the design and implementation of an Augmented Reality (AR)-based smart campus guide system integrated with a 3D avatar and voice narration. The proposed system operates using a marker-based approach, where scanning a college logo through a mobile application triggers the appearance of a virtual 3D avatar that acts as a digital guide, delivering information about campus infrastructure, departments, and facilities through synchronized audio narration. The system is developed using Unity integrated with ARCore/Vuforia frameworks, ensuring accurate image detection and smooth rendering of virtual content. Experimental evaluation demonstrates that the system performs efficiently in real-time scenarios, offering stable tracking, responsive interaction, and improved user engagement, while the integration of visual and audio guidance provides an intuitive and immersive experience, making the system suitable for smart campus applications.

KEYWORDS:

Augmented Reality, Smart Campus, 3D Avatar, Unity, Voice Narration, Image Target Detection, Mobile Application

Multi-Layer Security System for Theft Detection Using GPS, RFID and Face Recognition

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ABSTRACT:

This project proposes a Multi-Layer Security System for Theft Detection to improve the safety of vehicles and valuable assets. Conventional security systems are often limited in functionality and may fail to prevent unauthorized access effectively. To address this issue, the system integrates RFID authentication, face recognition, GPS tracking, and a vibration sensor, all controlled by an Arduino Mega.The RFID and face recognition modules ensure that only authorized users can access the system. In case of unauthorized access, an alarm is triggered and the engine is locked. The vibration sensor detects tampering attempts, while the GPS module provides real-time location tracking. This integrated approach offers a reliable, cost-effective, and intelligent solution for modern theft prevention and security monitoring.

KEYWORDS:

Multi-Layer Security System, Theft Detection, Live Tracking

Edge Computing for the Internet of Things: A Comprehensive Overview

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ABSTRACT:

The rapid growth of Internet of Things (IoT) devices as well as the increase in data driven applications have exposed the limitations of traditional cloud computing particularly in terms of latency, bandwidth usage and real time response. Edge Computing has evolved as a useful paradigm for processing the data closer to the source, hence improving the response time and Quality of Service (QoS). This study presents an overview of Edge Computing, Internet of Things, Cloud Computing, Edge Computing architecture and also its diverse applications. The study further highlights the benefits of edge computing, challenges and also future research directions.

KEYWORDS:

Edge Computing, Cloud Computing, Internet of Things, Real Time Processing, Low Latency.

Hybrid Ocean Energy System with Intergrated Storage and Load Management

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ABSTRACT:

The increasing demand for sustainable and carbon-neutral energy sources globally has made ocean energy an attractive alternative, which offers higher energy density and predictability than wind and solar resources. In this study, the design and conceptual analysis of a Hybrid Tidal–Wave Energy Generation System is proposed to overcome these inherent limitations. The Tidal Stream Turbine converts the kinetic energy of the predictable currents of water below the surface of the ocean. The Wave Energy Converter converts the kinetic energy of the oscillations of the water on the surface. The central idea behind this hybrid approach is to generate a 'complementary power profile', where the high predictability of tidal cycles compensates for the stochastic nature of wave patterns, ensuring a more continuous and reliable supply of power.

In order to evaluate the feasibility of this integration, a conceptual model has been developed and analyzed with simulation tools to test the performance under different sea states and tidal flow velocities. The study focuses in particular on the role of power conditioning units and energy storage buffers in smoothing transient fluctuations and maintaining frequency stability. Simulation results indicate that the hybrid system outperforms the standalone configurations significantly, demonstrating a more stabilized voltage output and an overall improvement in system efficiency. The hybrid system provides a scalable and robust framework for the future of offshore renewable energy by sharing subsea infrastructure and reducing the levelized cost of energy (LCOE), paving the way for more resilient coastal power grids.

KEYWORDS:

Hybrid Tidal–Wave Energy, Ocean Energy Systems, Renewable Energy, Tidal Stream Turbine, Wave Energy Converter Power Conditioning, Energy Storage, Frequency Stability, Offshore Energy, Levelized Cost of Energy (LCOE)

IoT-Enabled Smart Shipping Container with Real-Time Environmental Monitoring and GPS Location Tracking

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ABSTRACT:

This paper presents an IoT-enabled smart shipping container designed for real-time environmental monitoring and GPS-based location tracking to enhance cargo safety and operational efficiency in modern logistics. The system is built around an STM32F103C8 ARM Cortex-M3 microcontroller integrated with an ESP8266 Wi-Fi module for wireless data communicationandaNEO-6M GPS module for live location tracking. Environmental sensors including DHT11 temperature/humidity, vibration, and lightsensors continuously monitor internal container conditions. Sensor data is securely transmitted to a Node.js/MongoDB cloud backend hosted on a private Virtual Private Server (VPS). A React-based web dashboard enables logistics managers to monitor container status, environmental readings, and shipment routes in real time. An intelligent alert system delivers immediate Email and Telegram notifications when abnormal conditions such as temperature spikes, shocks, or unauthorized access are detected. Experimental results confirm sensor accuracy of ±0.5°C, GPS accuracy of 3–5 m, alert response within 5 seconds, and 99.2% system uptime, validating the proposed system for modern supply chain deployment.

KEYWORDS:

IoT, smart container, GPS tracking, STM32F103C8, ESP8266, MongoDB, React dashboard, cold chain logistics, supply chain management.

Next-Gen Secured EVM System with Multi-Factor Authentication

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ABSTRACT:

This project presents the design and development of a Next-Generation Secure Electronic Voting Machine (EVM) using Multi-Factor Authentication (MFA). The system combines Aadhaar-based verification, facial recognition, and fingerprint scanning to provide a reliable, transparent, and tamper-resistant voting process. Unlike conventional EVMs, which rely on single-step verification, this model validates each voter's identity through multiple biometric and digital checks before granting access to the voting panel. A microcontroller-based control unit manages voter authentication and voting procedures. Initially, the voter's Aadhaar ID is entered or scanned and verified against a preloaded database. Upon successful verification, biometric identification is performed using a camera and fingerprint sensor. The voting interface is activated only after all verification stages are passed, ensuring that each vote is cast by an authenticated voter. Votes are encrypted and stored in non-volatile memory to prevent tampering or data loss. Additional features such as tamper detection, real-time logging, and secure communication protocols maintain system integrity. The design provides fast authentication, a user-friendly interface, and reliable performance even in large-scale elections. Development involved embedded programming, biometric processing, Aadhaar integration, and encryption techniques. Testing confirmed high accuracy, fast response time, and operational stability. This system demonstrates how combining biometric verification and secure communication can create a modern, transparent, and trustworthy electronic voting framework

KEYWORDS:

EVM Security, Multi-Factor Authentication, Electronic Voting, Data Encryption, Voter Authentication, Tamper-Proof System, Secure Transactions, Real-Time Monitoring, Blockchain Integration, Cybersecurity, Voting System Reliability

AI – Assisted Online Quiz Platform

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ABSTRACT:

Digital technologies have rapidly transformed education, making online learning and assessment widely adopted. Among these, online quiz systems play a key role in evaluating and improving student performance. However, many existing systems lack adaptability, personalization, intelligent feedback, and effective classroom control, often relying on static question sets with limited analytical insight.

The AI-Assisted Online Quiz Platform addresses these limitations by integrating modern web technologies with artificial intelligence to create a smart, efficient, and user-friendly system. It enables teachers to create and manage quizzes within virtual classrooms using secure classroom codes, ensuring controlled and organized assessment environments. The platform supports both public quizzes for open practice and classroom-specific quizzes restricted to enrolled students.

A major feature is its automated evaluation system, which provides instant results, reducing grading time and minimizing errors. Additionally, the AI component analyzes student performance and identifies learning gaps, helping teachers improve instruction. The system is scalable, with potential for advanced features such as adaptive quizzes and personalized recommendations.

Overall, this platform enhances assessment efficiency, supports better learning outcomes, and offers a modern solution for digital education.

KEYWORDS:

AI-Assisted Learning, Online Quiz Platform, Digital Education, E-Learning Systems, Automated Assessment, Virtual Classrooms, Classroom Management, Student Performance Evaluation, Intelligent Feedback, Adaptive Learning, Personalized Learning, Quiz Automation.

A Behavioural Framework Using Deep Earning

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ABSTRACT:

BioKey is a deep learning-based framework designed for continuous user authentication using keystroke biometrics in real-time computing environments. Traditional authentication methods, such as passwords, only verify users at login and remain vulnerable to threats like session hijacking and unauthorized access during active sessions. To overcome these limitations, BioKey introduces a continuous authentication approach that monitors user identity throughout a session by analyzing typing behavior.

The system utilizes keystroke dynamics as a behavioral biometric, focusing on timing features such as Hold Time and Flight Time to capture unique typing patterns. It combines temporal feature extraction with Long Short-Term Memory (LSTM) networks to model sequential dependencies in user behavior. BioKey consists of two main modules: a Temporal Feature Extraction module that builds detailed user profiles from typing data, and a Classification module that detects anomalies by identifying deviations from normal behavior.

By continuously analyzing typing patterns, the framework enables early detection of unauthorized users and enhances session security. BioKey achieves high performance in terms of accuracy and reliability, offering a scalable, non-intrusive, and hardware-independent solution for modern cybersecurity challenges.

KEYWORDS:

BioKey, continuous authentication, keystroke biometrics, deep learning, LSTM, user authentication, typing patterns, security, anomaly detection, real-time monitoring, intrusion detection, behavioral analysis, secure systems

Database – Driven Billing Management System

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ABSTRACT:

Many small poultry retail businesses still depend on manual billing and record-keeping methods, which often lead to calculation errors, inefficient transaction handling, and difficulty in tracking inventory. These challenges become more significant as the volume of daily transactions increases. To address these issues, this study proposes a database-driven billing management system designed to streamline and improve retail operations.

The system provides an integrated digital platform that automates key processes such as invoice generation, weight-based price calculation, transaction recording, and inventory management. It also includes a Khata (credit ledger) module to track customer credit, manage outstanding balances, and organize payment records. By replacing manual processes with automated workflows, the system reduces human errors, enhances operational efficiency, and ensures accurate record maintenance.

Additionally, the structured database design enables retailers to monitor sales trends, generate reports, and manage stock levels effectively. Overall, the proposed system offers a practical and scalable solution for small poultry retailers, helping them transition to a more organized, reliable, and data-driven business environment**.**

KEYWORDS:

Database Management System, Poultry Retail Automation, Billing System, Inventory Management, SQL, Point-of-Sale Systems.

Gesture Recognition for Indian Sign Language Using Centroid

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ABSTRACT:

This project offerings the plan and operation of a low-cost wearable glove beginning for spotting Indian Sign Dialect (ISL) signals applying an inserted microcontroller. The proposed framework points to help people with hearing and discourse disabilities by changing over hand motions into significant yields. Not at all like customary vision-based frameworks, the proposed approach employments flex sensors and an inertial estimation unit (IMU) to capture finger development and hand introduction. The sensor material is prepared applying a centroid- based neighboring neighbor classification scheming, investing real- time motion comeback with negligible computational requirements. The comes about institute that the advocated organization is operative, useful, and practical for assistive publication presentations.

KEYWORDS:

Indian Sign Language (ISL), wearable smart glove, assistive communication, flex sensors, IMU sensor, microcontroller, hand gesture recognition, real-time motion detection, low-cost device, k-nearest neighbor classification, accessibility for hearing impaired.

Design and Implementation of Artificial Intelligent Air Transportation Safety System

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ABSTRACT:

An escape crew capsule is an advanced safety system designed to protect occupants during critical aircraft emergencies such as engine failure, fire, or structural damage. As modern aircraft evolve, traditional emergency methods are becoming less effective. The capsule is a strong, enclosed unit that detaches from the aircraft, securely housing passengers or crew. It is built to withstand extreme conditions like high pressure, heat, and vibrations. After separation, it uses aerodynamic controls and systems like parachutes or air brakes to ensure a stable and controlled descent.

Inside, safety features such as shock-absorbing seats, life-support systems, and thermal insulation protect occupants until landing on land or water. Unlike conventional ejection systems, the capsule provides complete protection throughout the evacuation process, improving survival chances.

This project focuses on the design, materials, and working mechanisms of the escape capsule, along with the challenges and advancements in this technology. Overall, it represents a significant innovation in aviation safety for both military and civilian use.

KEYWORDS:

Escape Crew Capsule, Aircraft Safety System, Emergency Evacuation, Aviation Safety, Crash Survival Technology, Capsule Separation Mechanism, Aerodynamic Stabilization, Parachute Deceleration, Life Support Systems, Thermal Protection.

IoT Based Stability Analysis of Robotic Arm

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ABSTRACT:

In robotic systems, however, sustaining steady operation and detecting performance fluctuations throughout operation continue to be major issues. An Internet of Things (IoT)- based robotic arm stability monitoring and analysis system is presented in this work. To monitor important operational characteristics like vibration, tilt angle, payload, and motor current, the suggested system combines a number of sensors, including an accelerometer, gyroscope, load cell, and current sensor. Sensor data is assembled by an ESP32 microcontroller, which then uses Wi-Fi to send it to a cloud-based policy. An IoT dashboard is used to display the data in real time, allowing for ongoing robotic arm performance checking. Experiments are carried out. The developed IoT-based monitoring approach increases the safety and dependability of robotic arm applications in smart manufacturing environments, facilitates early problem identification, and improves system visibility.

KEYWORDS:

IoT, Robotic Arm, Stability Analysis, Sensor Monitoring, Smart Manufacturing, Predictive Maintenance.

Wiring All Devices Monitoring and Fault Detection Using Web Server

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ABSTRACT:

In modern electrical and electronic systems, continuous monitoring and timely fault detection are essential to ensure safety, reliability, and efficient operation. This project presents a web-based solution for monitoring multiple wired devices and detecting faults in real time using a centralized web server. The system integrates sensors and microcontroller-based modules to collect key parameters such as voltage, current, temperature, and device status from various connected devices. The collected data is transmitted to a web server through network communication protocols, enabling remote access and real-time visualization via a user-friendly interface. The system continuously analyzes incoming data to identify abnormal conditions such as short circuits, overloads, wiring faults, and device failures. Upon detection of any fault, instant alerts and notifications are generated to enable quick corrective action. Additionally, the system maintains a log of historical data for analysis, supporting predictive maintenance and reducing system downtime. The proposed solution enhances operational efficiency, improves safety, and minimizes manual inspection efforts by providing an automated, scalable, and cost-effective monitoring platform. This approach is suitable for applications in industrial automation, smart buildings, and power distribution systems.

KEYWORDS:

Web-Based Monitoring System, Real-Time Fault Detection, Electrical System Monitoring, IoT-Based Monitoring, Centralized Web Server, Sensor Integration, Microcontroller Systems, Voltage Monitoring, Current Monitoring, Temperature Monitoring, Remote Monitoring, Data Transmission Protocols.

Frequency-Based Adaptive Canny Edge Detection for High-Resolution Images

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ABSTRACT:

This paper proposes a frequency-based adaptive Canny (FBAC) edge detector that eliminates manual threshold tuning. Using 2D FFT analysis and Otsu's thresholding on gradient magnitude images, FBAC automatically computes optimal hysteresis thresholds. Implemented in MATLAB R2025b, the system visualizes frequency-domain effects of Gaussian filtering and gradient computation. On 4608×3072 test images, FBAC detected 183,000 edge pixels (4.1% density) vs. 106,000 (2.3%) for fixed-threshold Canny—a 78% improvement at 21 FPS. FBAC enables robust, automated edge detection for computer vision applications.

KEYWORDS:

Adaptive Canny, Otsu thresholding, frequency analysis, edge detection, MATLAB

AI Based Load Monitoring and Smart Alert System

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ABSTRACT:

Unique data makes a difference us recognize peculiarities, figure over-burden conditions and classify stack behavior in frameworks. The framework at that point sends computerized cautions through SMS, e-mail or portable applications to guarantee stack observing and convenient cautions. These cautions are significant for guaranteeing security, unwavering quality and vitality optimization in systems. This paper presents an AI-based stack observing and keen alarm framework that ceaselessly tracks stack varieties identifies irregularities. By coordination sensors and real-time information examination the framework gives computerized notices to anticipate hardware harm and minimize downtime. Experimental assessments illustrate the system's adequacy in checking stack designs and creating opportune alarms beneath shifting operational conditions. The primary center of this paper is on AI-based stack checking, stack administration, shrewd caution framework, machine learning, prescient upkeep, vitality optimization and inconsistency detection.

KEYWORDS:

Machine Learning, SMS, Tracks Stack, Computerized Notice.

An Integrated Hardware and Software Platform for Electrochemical Detection of Nitrates in Water

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ABSTRACT:

Water quality monitoring is essential for safeguarding public health and environmental sustainability. This work presents the development of an integrated hardware and software platform for electrochemical detection of nitrates in water. The system utilizes low-noise amplifier-based circuitry to capture precise electrochemical signals. A mobile application is developed to measure and display Open Circuit Potential (OCP) values in real time. Low-cost conductive screen-printed electrode strips are used for selective nitrate detection in water samples. The proposed system is compact, portable, and cost-effective, enabling rapid and on-site testing without the need for complex laboratory infrastructure. This platform provides a reliable solution for continuous water quality monitoring and can be applied in environmental monitoring, agriculture, and drinking water safety.

KEYWORDS:

Electrochemical Sensor, Nitrate Detection, Open Circuit Potential. Water Quality Monitoring, Portable System.

Design of Compact Dual Band Rectangular Probe Microstrip Patch Antenna

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ABSTRACT:

Microstrip patch antennas are widely used in modern wireless communication systems due to their low profile, lightweight structure, and ease of fabrication.

In this project, a rectangular dual-band microstrip patch antenna is designed and simulated using ANSYS HFSS. The antenna is developed on a dielectric substrate with a ground plane and a rectangular patch element.

The performance of the antenna is analyzed using key parameters such as return loss (S11), radiation pattern, gain, and input impedance. The simulation results demonstrate that the antenna operates efficiently at the desired resonant frequencies, achieving a return loss below −10 dB along with good radiation characteristics.

KEYWORDS:

Microstrip Patch Antenna, Dual-Band Antenna, Rectangular Patch Antenna, Wireless Communication, ANSYS HFSS, Antenna Design, Dielectric Substrate, Ground Plane, Return Loss (S11), Radiation Pattern, Antenna Gain, Input Impedance, Resonant Frequency, Antenna Simulation, Low-Profile Antenna

IoT-Enabled Predictive Battery Management System for Electric Vehicles: Real- Time Monitoring and Safety Optimization

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ABSTRACT:

The fast transition to electric vehicles (EVs) has highlighted the need for smart battery management to provide performance, safety, and longer lifespan. This article proposes an IoT-based predictive battery management system contain real-time monitoring, anomaly detection, and data-driven analytics. The system employs embedded sensors and microcontrollers for continuous measurement of key parameters such as voltage, current, temperature, State of Charge (SOC), and State of Health (SOH). The data is transmitted securely through lean wireless protocols (MQTT/LTE) to a cloud platform, where the data is subjected to predictive analytics with machine learning algorithms to predict battery aging, identify early indications of thermal runaway, and optimize charging–discharging cycles. There is a personalized dashboard to offer fleet operators as well as personal users real-time visualization, notifications, and actionable insights for predictive maintenance. Prototype execution and simulation findings illustrate that the system presents low-latency, scalable, and secure monitoring, ultimately improving safety, prolonging battery life, and enhancing EV performance. This work contributes to the creation of smart EV infrastructure, enabling sustainable and reliable transportation systems.

KEYWORDS:

Electric Vehicles (EVs), IoT, Battery Management System (BMS), Predictive Analytics, State of Charge (SOC), State of Health (SOH), Cloud Monitoring, Thermal Runaway Prevention, Smart Mobility

Multi-Band Reconfigurable Antenna for Wireless Application

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ABSTRACT:

This paper presents the design and analysis of a compact multi-band reconfigurable antenna capable of both frequency and polarization switching for modern wireless communication systems. The proposed antenna is realized on an FR-4 substrate with dimensions of 30 × 20 × 1.6 mm3 and incorporates a modified hexagonal radiating element along with a partial ground plane to achieve enhanced radiation characteristics. Reconfigurability is achieved using two PIN diodes (SMP1345-079), enabling four distinct operating modes through different switching combinations. The antenna operates at multiple frequency bands including 2.4 GHz, 3.5 GHz, and 4.3 GHz, supporting applications such as WLAN and sub-6 GHz 5G systems. In Mode 1 (both diodes OFF), the antenna resonates at 4.3 GHz with linear polarization. Modes 2 and 3 (single diode ON) provide dual-band operation at 2.4 GHz and 4.3 GHz with left-hand circular polarization (LHCP) and right-hand circular polarization (RHCP), respectively, due to variation in surface current distribution. Mode 4 (both diodes ON) enables operation at 3.5 GHz with linear polarization. To improve antenna performance, stub structures are introduced in successive design iterations, resulting in enhanced impedance matching and gain characteristics. The final design exhibits excellent return loss characteristics, with S_{11} values reaching approximately -34 dB at 4.3 GHz, -31 dB at 2.4 GHz, and -37 dB at 3.5 GHz across different modes. The antenna also demonstrates acceptable VSWR and stable radiation patterns with peak gain around 2 dBi. Simulation results obtained using CST Microwave Studio validate the effectiveness of the proposed design. The antenna offers a compact, low-cost, and efficient solution for multi-standard wireless and adaptive communication systems.

KEYWORDS:

Reconfigurable antenna, PIN diode, multi-band antenna, polarization switching, microstrip antenna, WLAN, 5G.

Design of an Embedded Black Box Module for Intelligent Accident Detection Analysis

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ABSTRACT:

The rapid increase in road accidents has highlighted the need for intelligent systems that can accurately detect, analyze and record accident events for post-incident investigation and insurance claim processing. This paper presents the design and development of an embedded black box module for intelligent accident detection and analysis. The proposed system integrates multiple sensors such as accelerometers, gyroscopes, and GPS modules to continuously monitor vehicle parameters including speed, orientation, and impact forces. In the event of a collision, the system detects abnormal variations using threshold-based and algorithmic analysis techniques. Upon detection, critical data such as timestamp, location, vehicle dynamics, and impact severity are recorded and securely stored within the embedded module. Additionally, the system can transmit real-time accident data to cloud servers or emergency contacts using wireless communication technologies. This recorded data plays a crucial role in improving the transparency and efficiency of insurance claim processing by providing reliable, tamper-proof evidence of the incident. The proposed embedded black box system aims to reduce fraudulent claims, enable faster claim settlements, and enhance road safety through accurate accident analysis. Its compact design, low power consumption, and cost-effectiveness make it suitable for integration into modern intelligent transportation systems.

KEYWORDS:

Intelligent Accident Detection, Embedded Black Box System, Vehicle Data Recorder, Accelerometer and Gyroscope Sensors, GPS-Based Tracking, Impact Analysis, Real-Time Data Transmission, Internet of Things (IoT) , Wireless Communication

AI Based Disaster Response Drone

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ABSTRACT:

Natural disasters such as earthquakes, floods, landslides, and cyclones cause severe damage and make it very difficult for rescue teams to quickly locate survivors. In many cases, victims remain trapped under debris or stranded in hard-to-reach areas, where delays in detection can reduce survival chances. Therefore, there is a need for an efficient system that can quickly identify and locate humans in disaster zones. This project proposes an AI-based disaster response drone system designed to detect human presence using real-time image processing. The system uses an ESP32-CAM module mounted on a drone to capture live video from affected areas. The captured video is transmitted wirelessly to a processing unit, such as a laptop, where image processing is performed using the YOLO (You Only Look Once) algorithm. This algorithm is capable of detecting humans accurately and quickly, even in complex environments with debris and obstacles.

KEYWORDS:

Disaster Response, Search and Rescue Operations, Human Detection, AI-Based Drone, ESP32-CAM, Real-Time Image Processing, YOLO (You Only Look Once), Computer Vision, Aerial Surveillance, Wireless Communication.