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**RAJALAKSHMI**  
INSTITUTE OF  
TECHNOLOGY



**RAJALAKSHMI INSTITUTE OF TECHNOLOGY**



**DEPARTMENT OF  
ELECTRONICS AND COMMUNICATION ENGINEERING**

**AICTE Sponsored  
International  
Conference on “Shaping  
the Future of  
Healthcare: Integrating  
AI, IoT and Data  
Science Innovations”**



**ICSHI - 2026**



**CONFERENCE  
PROCEEDINGS**



**29<sup>th</sup> & 30<sup>th</sup> Jan 2026**

## Book of Proceedings – Abstracts

### **AICTE Sponsored International Conference on “Shaping the Future of Healthcare: Integrating AI, IOT, and Data Science Innovations”**

### **ICSHI – 2026- 29<sup>th</sup> & 30<sup>th</sup> January 2026.**

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## Chairman Message



Technological advancement and globalization have redefined the dynamics of knowledge creation and collaboration, making platforms like ICSHI-2026 vital in today’s research-driven world. I am delighted that the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, is hosting the **AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)”** on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

I take great pride in the institution’s unwavering focus on promoting global partnerships, nurturing intellectual curiosity, and cultivating a strong research ecosystem. I commend the organizing team for their dedication and vision in bringing together experts from academia, industry, and healthcare to deliberate on ideas that have the power to transform lives.

I wish ICSHI-2026 every success and look forward to it becoming a benchmark for impactful collaboration and thought leadership in the field of healthcare technology.

With best wishes,

Er. S. Meganathan

Chairman

Rajalakshmi Institute of Technology

## Chairperson Message



It is heartening to witness the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, taking the initiative to organize the **AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)”** on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

This event epitomizes RIT’s mission to cultivate a culture of research, innovation, and knowledge exchange. By bringing together academicians, scientists, industry professionals, and students on a single platform, the conference provides an invaluable opportunity to explore the synergy between advanced technologies and healthcare solutions.

The healthcare sector is rapidly evolving, and the fusion of AI, IoT, and Data Science is revolutionizing the way we understand, manage, and deliver medical services. ICSHI-2026 will serve as an ideal platform for participants to engage in meaningful discussions, gain global perspectives, and contribute to developing technological solutions for real-world healthcare challenges.

I extend my warm congratulations to the organizing committee for their dedication and perseverance in realizing this vision. I am confident that this international conference will inspire new collaborations, nurture future innovators, and contribute to the advancement of knowledge in this vital domain.

With best wishes,

Dr.Thangam Meganathan  
Chairperson  
Rajalakshmi Institute of Technology

## Vice-Chairman Message



It gives me immense pride that the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, is organizing the **AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)”** on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

ICSHI-2026 exemplifies Rajalakshmi Institute of Technology’s vision of bridging the gap between technological innovation and societal advancement. This international conference serves as a platform for researchers, academicians, technologists, and healthcare professionals from across the globe to engage in knowledge exchange, collaborative research, and forward-thinking discussions on emerging paradigms in healthcare.

The integration of Artificial Intelligence, IoT, and Data Science has emerged as a transformative force that is redefining patient care, diagnostics, and clinical decision-making. Through this conference, we aim to empower the academic and research community to leverage these technologies for sustainable, data-driven, and human-centric healthcare solutions. Such initiatives are a reflection of RIT’s enduring commitment to fostering excellence in education, research, and innovation. They highlight our institution’s proactive approach to addressing global challenges through interdisciplinary collaboration and intellectual leadership.

I take this opportunity to congratulate the Department of ECE and the organizing committee for their vision, dedication, and meticulous planning in curating a conference of such global significance. I am confident that ICSHI-2026 will not only stimulate meaningful dialogue and innovation but also reinforce RIT’s position as a hub of transformative research and societal progress.

With best wishes,

Dr. Haree Shankar Meganathan  
Vice-Chairman  
Rajalakshmi Institute of Technology

## Principal Message



It is a privilege to acknowledge that the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, is organizing **AICTE-Sponsored Two-Day International Conference** on “**Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)**” on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

The conference stands as a milestone in our institution’s ongoing pursuit of excellence in research and innovation. It provides an exceptional platform for academicians, scientists, industrial professionals, and students to engage with emerging trends and pioneering technologies that are transforming healthcare delivery systems across the globe.

Artificial Intelligence, the Internet of Things, and Data Science have become catalysts for change redefining diagnostics, patient care, and decision-making in the healthcare domain. Through meaningful discussions, knowledge sharing, and collaborative research, ICSHI-2026 seeks to bridge the gap between technology and humanity, creating new opportunities for sustainable and inclusive growth.

I extend my heartfelt appreciation to the Department of ECE and the organizing committee for their meticulous efforts in convening such a prestigious international event. I am confident that ICSHI-2026 will foster innovation, inspire young minds, and contribute significantly to shaping a healthier and smarter future.

With best wishes,

Dr. R. Maheswari  
Principal  
Rajalakshmi Institute of Technology

## Director Incubation & Innovation Message



I am happy to know that the Department of Electronics and Communication Engineering Rajalakshmi Institute of Technology, is organizing AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)” on 29th and 30th January 2026.

In an era of rapid technological transformation, such forums inspire innovation, collaboration, and future-ready thinking. This conference brings together academia and industry to exchange ideas and explore emerging technologies that shape tomorrow’s world.

I extend my best wishes to all participants, and appreciate the dedicated efforts of the organizing committee in realizing this academic endeavor and wish the conference every success in achieving its vision and objectives.

With best wishes,

Dr. R. Sundar  
Director Incubation & Innovation  
Rajalakshmi Institute of Technology

## Director-Administration Message



To keep up with the growth of technological revolution, the department of ECE brings before you, **AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)”** on 29<sup>th</sup> and 30<sup>th</sup> January 2026. The enthusiastic participation in this international forum reflects the growing importance of collaborative efforts in shaping the future of science and technology. This conference serves as a forward-looking platform for researchers and scholars from academia and industry to exchange ideas, present innovative research, and explore emerging technological paradigms. I am confident that the deliberations will inspire transformative thinking, foster interdisciplinary collaboration, and contribute meaningfully to technological advancement. I appreciate the dedicated efforts of the organizing committee in realizing this academic endeavour and wish the conference every success in achieving its vision and objectives.

With best wishes,

Dr. P K Nagarajan  
Director – Administration  
Rajalakshmi Institute of Technology

## Vice-Principal Message



It gives me immense pleasure to extend my warm greetings to all the participants, researchers, academicians, industry professionals, and students attending **AICTE-Sponsored Two-Day International Conference on “Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)”** organized by the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, Chennai.

The convergence of Artificial Intelligence, Internet of Things, and Data Science is redefining the healthcare ecosystem by enabling intelligent diagnostics, personalized treatment, real-time monitoring, and data-driven clinical decision-making. This conference is both timely and significant, as it provides a vibrant platform for interdisciplinary interaction, knowledge exchange, and exploration of emerging trends that will shape the future of global healthcare.

I commend the Department of ECE and the organizing team for their dedicated efforts in bringing together eminent keynote speakers, distinguished researchers, and experts from academia and industry across the globe. Such initiatives strongly align with the vision of our institution to foster innovation, research excellence, and societal impact through technology- driven solutions.

I am confident that the deliberations, technical sessions, and research presentations at ICSHI–2026 will inspire meaningful discussions, promote collaborative research, and contribute significantly to advancements in healthcare technologies. I wish the conference a grand success and hope that all participants find this forum intellectually enriching and professionally rewarding.

With best wishes,

Dr. N. Pragadish  
Vice Principal  
Rajalakshmi Institute of Technology

## Dean-Academics



It is my immense pleasure to wish the Department of Electronics and Communication Engineering for **AICTE-Sponsored Two-Day International Conference** on “**Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)**”

In a time marked by rapid digital change and disruptive technology, such events are crucial for shaping the future of engineering education and research. This conference acts as a platform for sharing ideas. It brings together academics, researchers, and young innovators to explore new trends, exchange innovative ideas, and tackle real-world challenges. The discussions, keynote speeches, and research presentations will likely inspire teamwork across different fields and significantly advance next-generation technologies. I commend the organizing committee for their vision and dedication to academic excellence. I wish the conference great success in reaching its goals.

With best wishes,

Dr. D. C. Joy Winnie Wise  
Dean Academics  
Rajalakshmi Institute of Technology

## Dean-ECE



It is with great pleasure that I note the organization of the **AICTE-Sponsored Two-Day International Conference** on “**Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)**”.

I understand that this International Conference has attracted many participants to take part of this two-day technical conference. This platform provides opportunity for the Researcher, Scholars from both academics and industries to showcase their innovative aspirations in science and technology.

I would like to express my appreciation to the organizing committee for their dedicated efforts to materialize the conference. I wish the conference a grand success.

With best wishes,

Dr. S. Sasikumar  
Dean ECE  
Rajalakshmi Institute of Technology

## HOD Message



It is my proud privilege to acknowledge that the Department of Electronics and Communication Engineering is organizing an **AICTE-Sponsored Two-Day International Conference** on “**Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)**” on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

The rapid advancements in technology and the evolving lifestyles of society pose complex challenges across the globe. ICSHI-2026 has been thoughtfully designed to address these challenges by fostering innovation-driven and smart solutions. The conference places a strong emphasis on the transformative role of Artificial Intelligence in healthcare, enabling data-driven decision-making, predictive diagnostics, and personalized treatment approaches. By integrating AI, IoT, and Data Science, the event is designed to accelerate the emergence of next-generation healthcare solutions that promote greater efficiency, accessibility, and enhanced patient outcomes.

We are privileged to have distinguished speakers who will share their expertise, insights, and perspectives, inspiring meaningful discussions and future-ready approaches. I am confident that this conference will serve as a vibrant platform for interdisciplinary interaction, intellectual discourse, and collaborative research. The convergence of academia, industry, and research communities will foster the exchange of innovative ideas and best practices. Such interactions are expected to pave the way for impactful research outcomes and sustainable advancements in healthcare technologies.

As The Head of the Department, I place on record my earnest appreciation to the organizing committee for their dedicated and tireless efforts in successfully bringing this conference to fruition, and I extend my best wishes to all participants for a productive, enriching, and rewarding experience.

With best wishes,

Dr. G.Nirmala Priya  
Professor & HOD  
Department of ECE  
Rajalakshmi Institute of Technology

## Convener Message



It is a matter of great pleasure that the Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, is organizing an **AICTE-Sponsored Two-Day International Conference** on “**Shaping the Future of Healthcare: Integrating AI, IoT and Data Science Innovations (ICSHI-2026)**”, scheduled to be held on 29<sup>th</sup> and 30<sup>th</sup> January 2026.

The conference aims to provide a vibrant platform for academicians, researchers, industry professionals, and students to exchange ideas, share research findings, and discuss emerging trends in the convergence of Artificial Intelligence, Internet of Things, and Data Science for healthcare applications. With rapid technological advancements transforming the healthcare ecosystem, this conference seeks to foster interdisciplinary collaboration and promote innovative solutions addressing real-world challenges.

I sincerely appreciate the dedicated efforts of the organizing committee, advisory board members, reviewers, and all contributors for their commitment and enthusiasm in making this conference a success. I am confident that ICSHI-2026 will serve as a valuable forum for knowledge dissemination and will inspire meaningful research and collaboration among the participants.

I wish the conference every success.

With best wishes,

Dr. M. Malathi  
Professor, ECE  
Rajalakshmi Institute of Technology

## ABOUT THE INSTITUTION

Rajalakshmi Institute of Technology (RIT), an autonomous institution and a distinguished constituent of Rajalakshmi Institutions, is among the leading engineering colleges in Chennai, renowned for its commitment to excellence in higher education. The institute fosters a strong academic culture that emphasizes innovation, research-driven learning, and professional competence, preparing students to meet evolving technological and societal demands. RIT is accredited with the highest grade of A++ by NAAC and is affiliated with Anna University, Chennai. The institute is approved by the All India Council for Technical Education (AICTE), New Delhi, and offers several NBA-accredited programs, reflecting its adherence to rigorous academic standards and an outcome-based education framework.

With a growing emphasis on externally funded research, interdisciplinary innovation, and industry-academia collaboration, RIT actively promotes Research and Development initiatives through Centres of Excellence and advanced laboratories. The institute encourages faculty and students to engage in high-impact research, intellectual property creation, and technology-enabled solutions addressing real-world challenges across healthcare, agriculture, communication systems, and sustainable development. Through its strong focus on academic quality, research excellence, and innovation-led outcomes, RIT continues to strengthen its position as a hub for advanced learning and technological advancement.

### Programmes offered:

- B.E. Computer & Communication Engineering
- B.E. Computer Science & Engineering
- B.E. Computer Science & Engineering (AI&ML)
- B.E. Electronics & Communication Engineering
- B.E. Electronics Engineering (VLSI-D&T)
- B.E. Mechanical Engineering
- B.Tech. Artificial Intelligence & Data Science
- B.Tech. Bio Technology
- B.Tech. Computer Science and Business Systems
- M.E. Electronics & Communication Engineering (VLSI Design)
- M.E. Data Science

## ABOUT THE DEPARTMENT

The Department of Electronics & Communication Engineering (ECE) is NBA accredited and is strongly committed to excellence in professional education, research, and innovation. The department has established a dynamic research-driven ecosystem that actively promotes externally funded projects, collaborative research, and technology development in emerging areas of electronics and communication engineering.

With a clear focus on innovation, the department encourages faculty and students to engage in high-impact research, product development, and intellectual property generation through well-structured Research and Development initiatives and Centres of Excellence. A strong emphasis is placed on securing competitive research funding from national and international agencies, enabling the translation of innovative ideas into practical solutions with societal and industrial relevance.

The department maintains active research collaborations with academic institutions, research organizations, and industry partners, fostering interdisciplinary research and global knowledge exchange. Through a sustained focus on funded research, innovation-led outcomes, and scholarly contributions, the department continues to strengthen its role as a hub for advanced research and technological advancement through various Centres of Excellence.

- Centre for Advanced Manufacturing
- Centre for AR/VR Gaming Technology
- Centre for Artificial Intelligence
- Centre for Cyber Security and Cloud computing
- Centre for Data Science
- Centre for Electric Vehicle and Energy
- Centre for Internet of Things
- Centre for Advanced Materials
- Centre for Space Research
- Centre for Image Processing
- Centre for Robotics/ Unmanned Aerial Vehicle / Drone Technology
- Centre for 3D Printing
- Centre for Quantum Computing
- Centre for Semi Conductor Design

## PREFACE

We are very pleased to present the proceedings of the **AICTE Sponsored International Conference on “Shaping the Future of Healthcare: Integrating AI, IOT, and Data Science Innovations” ‘ICSHI 2026’**. **ICSHI-2026** will provide a leading edge, scholarly forum for researchers, engineers, and students alike to share their state-of-the art research and developmental work in the broad areas of pervasive computing and communications.

The conference will feature a diverse mixture of interactive forums, core technical sessions of high quality cutting-edge research articles; targeted workshops on exciting topics; live demonstrations of pervasive computing in action; insightful keynote speeches; panel discussions from domain experts and posters of emerging ideas. **ICSHI-2026** is aimed to present the on-going researches in the field and hence to foster research relations between the Universities and the industry & to give participants a review of the latest and upcoming trends in the next few years.

The major themes of **ICSHI-2026** are organized around Information, Communication and Technology. It is aimed at providing an opportunity for exploring innovations, for collaborative information sharing, presenting new technologies and applications.

**ICSHI-2026** is organized as three tracks on Information, Communication and Technology. The Information track covers collection of topics such as Internet of Things, Communication Networking, Cloud Computing and etc., The Communication track covers on Mobile Communication, Communication Protocols and Technology track covers VLSI Design, Industrial Automation, Embedded Systems and etc.,

We take immense pleasure thanking our beloved Chairperson Dr. Thangam Meganathan, beloved Vice-Chairman Dr. Haree Shankar Meganathan for encouraging us in all possible ways to organize such platforms for knowledge sharing, since knowledge grows with sharing. We thank Head of the Institution Dr. R. Maheswari, Director Dr. R. Sundar and Dean Dr. S. Sasikumar for consistent support and direction. With its goal to stimulate technical education with responsibilities to serve mankind and the advancement of general welfare **ICSHI-2026** strives hard to cultivate a fraternal spirit among researchers, teachers, administrators, technicians, investigators, practitioners and industrialists.

We thank the organizing committee for making the conference a successful one. We thank all participants, all faculty and students for actuating the goal of the conference.

**Dr. M. Malathi**  
Professor, ECE  
Rajalakshmi Institute of Technology

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## **TOOTHCOMM: SMART MORSE-BASED VOICE COMMUNICATION FOR THE SPEECH-IMPAIRED**

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This project aims to empower individuals with speech impairments by enabling effective communication through a teeth-based Morse code input system. For years, people who are unable to speak have faced immense challenges in expressing their needs, thoughts, and emotions. To overcome this limitation, the proposed system allows users to transmit Morse code by biting or pressing through a sensor embedded in a dental or mouth-fitted setup. These inputs are interpreted as dots and dashes, which are then decoded into text using a microcontroller. The decoded text is simultaneously converted into speech using a voice module, enabling audible communication with others. Additionally, the message is displayed on an OLED screen for visual confirmation. This innovative assistive technology bridges the communication gap for speech-impaired individuals, offering them a dignified and independent way to interact with their surroundings and caregivers. The system is compact, user-friendly, and designed to provide real-time output, significantly enhancing the quality of life for speech-impaired individuals.

## **ONCOSENSE: AI + WEARABLE-BASED EARLY CANCER RISK DETECTION SYSTEM**

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OncoSense is a novel framework that integrates wearable sensors with advanced artificial intelligence (AI) to enable early detection of cancer risk. The system continuously monitors physiological and biochemical indicators, processes multimodal data in real time, and predicts risk scores for potential oncological abnormalities long before clinical symptoms arise. OncoSense leverages deep learning models trained on a large dataset of wearable bio signals and clinical cancer diagnoses to identify subtle patterns correlated with early carcinogenesis. Experimental results show that this approach can identify high-risk cases with competitive accuracy compared to traditional screening approaches, enabling clinicians to initiate early intervention. The proposed system promises to reduce late-stage diagnoses and improve patient outcomes through democratized, continuous, and non-invasive monitoring. **Keywords** Early cancer detection, wearable sensors, artificial intelligence, machine learning, health monitoring.

## **HYBRID CLASSIFICATION FRAMEWORK FOR DISTINGUISHING NORMAL AND ABNORMAL CLINICAL PATTERNS IN REAL-TIME IOMT SYSTEMS USING ADVANCED TIME SERIES METHODS**

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The Internet of Medical Things (IoMT) has fundamentally transformed healthcare delivery through real-time patient monitoring in critical care environments. However, accurately distinguishing between normal and abnormal clinical patterns within high-volume, continuous physiological data streams remains a significant challenge. This research paper presents a hybrid classification framework that leverages advanced time series classification (TSC) methods to detect and classify abnormal patterns in IoMT systems with minimal latency. The proposed approach integrates five machine learning algorithms Gaussian Naive Bayes, eXtreme Gradient Boosting (XGBoost), Random Forest, Support Vector Machines (SVM), and K-Nearest Neighbors (KNN) trained on normalized time series features extracted from continuous patient vital signs. The framework employs an 80-20 train-test split with 5-fold cross-validation to ensure robust model generalization. Results demonstrate that the ensemble approach achieves superior accuracy in distinguishing normal physiological patterns from abnormal manifestations, particularly for detecting critical deviations in heart rate variability, blood pressure fluctuations, and oxygen saturation levels. The integration of Statistical

Process Control (SPC) principles enables dynamic threshold establishment, while fog computing architecture ensures real-time responsiveness. This work addresses the critical need for accurate, interpretable anomaly detection in time-critical healthcare scenarios, with implications for intensive care unit (ICU) monitoring, remote patient surveillance, and emergency response systems.

**Keywords:** Time Series Classification, Internet of Medical Things, Anomaly Detection, Machine Learning Ensemble, Fog Computing, Real-time Monitoring

## **AN IOT-BASED SMART BLIND STICK FOR OBSTACLE DETECTION AND EMERGENCY ASSISTANCE**

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This paper presents the design of an Assisstive Navigatry stick using Arduino that enhances safety of users. The proposed system integrates ultrasonic sensors and IR sensors to detect obstacles at different distances and provide timely alerts. Additionally servo motor mechanism , GPS ,GSM modules , an emergency button .and additionally, a mobile application developed using the Blynk platform allows caretakers to monitor the user’s location remotely. Experimental results demonstrate that the system effectively detects obstacles and improves navigation safety.

## **DYNAMO BASED SMART CAR AND BATTERY MANAGEMENT SYSTEM**

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This project focuses on the design and development of a dynamo based smart car and battery management system integrated with automatic power cutoff and anti-theft protection. Electrical energy is generated using a dynamo and regulated through a controller before charging a battery. An Arduino microcontroller continuously monitors voltage, current, and time parameters using sensors. To prevent battery overcharging, an automatic cutoff mechanism using a timer circuit is implemented. Once the battery reaches full charge the system automatically disconnects the power supply. A display unit provides realtime information such as battery percentage, charging status, cutoff status, and alert messages. For security, an anti-theft feature is added using sensors to detect unauthorized touch or movement is detected, the system triggers an alarm or disables power output. This project offers a safe, efficient, and secure solution for energy harvesting applications such as mini electric vehicles, portable generators, and smart charging systems.

## **USE OF AI ON IMAGING IN HOSPITALS**

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Artificial Intelligence (AI) is rapidly transforming medical imaging in hospitals by enhancing the accuracy, speed, and efficiency of disease diagnosis. With the increasing volume of imaging data generated from modalities such as X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound, traditional manual interpretation has become time-consuming and prone to human error. AI-based systems, particularly those using machine learning and deep learning algorithms, assist radiologists by automatically detecting abnormalities, highlighting critical regions, and supporting clinical decision-making. These systems are capable of identifying early signs of diseases such as cancer, cardiovascular disorders, neurological conditions, and infectious diseases with high precision. AI also improves workflow efficiency by reducing reporting time, prioritizing urgent cases, and minimizing diagnostic variability. Furthermore, AI integration in hospital imaging systems contributes to cost reduction, improved patient outcomes, and enhanced healthcare accessibility. Despite challenges related to data privacy, ethical concerns, and the need for regulatory approval, the use of AI in medical imaging represents a significant advancement toward intelligent, reliable, and patient-centered healthcare delivery.

## **DETECTION HUB FOR EMERGENCY EVENT MONITORING AND ANALYSIS (DHEEMA)**

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This research introduces DHEEMA, an advanced industrial safety monitoring system that redefines workplace safety through the integration of Internet of Things (IoT) sensors, TinyML-based anomaly detection, and an intelligent real-time web dashboard. The system leverages ESP32 microcontrollers running embedded machine learning models for on-edge detection of gas leaks, fire hazards, temperature, and humidity anomalies in real time. The web-based command center, built with React 18 and TypeScript, features multi-floor navigation, zone-based sensor mapping, role-based access control, and a voice-enabled multilingual safety assistant. It includes AI-driven heatmap visualization, dynamic risk assessment, and automated evacuation protocols with real-time route optimization. The architecture employs MQTT over HiveMQ Cloud for secure, low-latency communication, TensorFlow Lite Micro for edge inference, and modern web technologies for a scalable user experience. Experimental evaluation demonstrates 95% accuracy, sub-second response latency, and scalability across multiple sensor nodes and floors. Key innovations include edge-based AI to reduce latency and bandwidth usage, natural language processing for intelligent query handling, multi-channel alerts (SMS, WhatsApp, Email), and comprehensive incident reporting with visual documentation—confirming that DHEEMA enhances industrial safety through intelligent automation and proactive emergency management.

## **WALKING INTO THE FUTURE: FOOTSTEP ENERGY HARVESTING FOR SMART URBAN ENVIRONMENTS**

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Energy harvesting from human locomotion has emerged as a promising method for generating clean and sustainable power for low-energy electronic devices. Among various approaches, footstep energy harvesters including piezoelectric, triboelectric, electromagnetic, rack-and-pinion, and Pavegen-based systems, convert mechanical motion from walking or limb movements into usable electrical energy. These technologies require only small displacements, making them suitable for integration into smart floors, pedestrian pathways, public transit areas, and other urban infrastructure. This paper reviews the design principles, performance characteristics, and practical applications of these energy harvesting systems, with a focus on piezoelectric and electromagnetic mechanisms. It also examines the advantages, limitations, and challenges associated with each technology, highlighting ongoing improvements in material science and energy conversion efficiency. As the power requirements of portable and IoT devices continue to decrease, footstep energy harvesters offer a sustainable and mobile energy solution, contributing to cleaner urban environments and self-powered smart infrastructure.

## **UV RADIATION AND CLIMATE EFFECTS ON SKIN: DAMAGE AND DISEASE IDENTIFICATION**

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The critical environmental factor that has a broad impact on skin health is UV radiation that can harm the skin both acutely and chronically. The climate of Earth has a significant role in altering UV exposure, which further affects skin conditions ranging from sunburn to severe dermal illnesses. With emphasis on damage mechanisms, disease diagnosis, and artificial intelligence AI use for early cancer diagnosis, this research investigates the intricate interactions among UV radiation, climate change, and skin condition. Chronic exposure to UV radiation, particularly UVB 280-315 nm and UVA 315-400 nm, accelerates skin aging and carcinogenesis risk by inducing oxidative stress, DNA damage, immunosuppression, and collagen degradation. For enhancing patient outcomes and early detection of skin cancers, the present study points towards the integration of AI technology into conventional dermatologic practices. Strong correlations have also been shown between cumulative and extreme UV exposure and skin malignancies, including melanoma, squamous cell carcinoma, and basal cell carcinoma. UV-induced photo dermatoses, hyperpigmentation, and chronic inflammatory conditions like lupus erythematosus further highlight the variety of skin conditions linked to UV radiation. **Keywords** Skin Aging Dermatology Artificial Intelligence AI, Machine Learning for the Identification of Skin Cancer, UV Damage to the Skin, Skin Cancer, Changes in Climate, Exposure to Sunlight, Melanoma, BCC, or basal cell carcinoma, SCC, or squamous cell carcinoma, Early Identification of Cancer, Awareness of Public Health, Negative Sunlight.

## **HYBRID EVALUATION OF CLASSICAL, TREE-BASED, AND ENSEMBLE LEARNING MODELS FOR DAILY RAINFALL PREDICTION**

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Daily rainfall prediction is critical for agriculture, water resource management, and disaster mitigation but is challenging due to nonlinear atmospheric dynamics. This paper presents an end-to-end machine learning framework for next-day rainfall prediction using the Australian Weather Dataset, formulated as a binary classification task. The workflow includes exploratory data analysis to examine feature distributions, correlations, missing values, and class imbalance, followed by preprocessing steps such as imputation, categorical encoding, feature scaling, and random oversampling. Multiple supervised learning models—Logistic Regression, K-Nearest Neighbors, Decision Tree, and Random Forest—are evaluated using standard classification metrics, providing a structured and reproducible framework for data-driven rainfall prediction research.

## **AN ADAPTIVE IOT-ENABLED ELECTRONIC HEALTH RECORD FRAMEWORK WITH INTELLIGENT PRESCRIPTION VALIDATION AND REAL-TIME PATIENT MONITORING**

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Healthcare environments increasingly require continuous patient observation while simultaneously managing large volumes of clinical data. This paper proposes an integrated framework that combines Internet of Things (IoT)based sensing with Electronic Health Record (EHR) systems, supported by an intelligent prescription validation mechanism. A key feature of the proposed framework is an adaptive data transmission strategy that adjusts communication frequency according to patient condition. For patients exhibiting stable vital signs, data are transmitted at extended intervals, whereas abnormal or critical readings trigger immediate updates.

The system was implemented using ESP32-based sensing units to measure heart rate, blood oxygen saturation, and body temperature, with data transmission handled through the MQTT communication protocol. Backend services were developed using a Flask-based architecture with MongoDB for data storage, incorporating strict role-based access control to protect patient privacy. In addition, an AI-assisted prescription verification module evaluates medication orders against known drug interactions and patient allergy information before administration. Experimental validation indicates that the adaptive transmission mechanism significantly reduces unnecessary network traffic while improving response time during critical health events. Furthermore, the prescription safety module demonstrated effective identification of potentially harmful medication combinations, highlighting its potential to reduce preventable clinical errors. The proposed framework offers a practical approach to improving efficiency, safety, and responsiveness in modern healthcare systems.

**Keywords:** Adaptive patient monitoring; Internet of Things; Electronic health records; MQTT; Prescription validation; Drug interaction detection; Embedded healthcare systems

## **EARLY DETECTION OF DIABETICS USING MACHINE LEARNING**

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Diabetes stands out as a long-term metabolic issue affecting countless folks around the world. Early spotting of it really matters for keeping preventive care on track. This work lays out a machine learning setup for predicting diabetes. It relies on just three key body measures. Those include BMI, glucose readings, and age. The goal is to sort people into diabetic or not diabetic groups. We cleaned up the data set first. Then we looked it over closely. After that, we fed it into various supervised learning methods. In the end, the chosen model hit 69 percent accuracy. This shows how even a small set of strong features can lead to useful health predictions. Overall, the tool works as a simple aid for checking diabetes risks early on.

## **MACHINE LEARNING-ENHANCED FILTER BANK BASED SPEECH ENHANCER FOR REAL TIME HEALTH MONITORING AND SIMULATION**

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Clear and reliable speech signals are essential for modern healthcare applications such as telemedicine, remote patient monitoring, and voice-based health assessment. However, real-world clinical environments are often affected by background noise, which reduces the accuracy of speech analysis and communication. This paper presents a machine-learning-based DFT filter bank approach for real-time speech enhancement, specifically targeted at health monitoring and simulation applications. The proposed method employs a uniform DFT filter bank to decompose speech into frequency subbands, followed by a lightweight machine learning model that adaptively estimates and suppresses noise components while preserving clinically relevant speech features. The enhanced speech is reconstructed with low latency, making the system suitable for real-time deployment on resource-constrained devices. The framework is evaluated under simulated healthcare scenarios with varying noise conditions, demonstrating improved speech intelligibility and signal quality compared to conventional filtering techniques. The results highlight the potential of combining signal processing and machine learning to support robust, real-time speech-based health monitoring systems. This work provides a practical and scalable solution for future intelligent healthcare and simulation platforms.

## **DISASTER COMMUNICATION SYSTEM USING LORA AND HC-12**

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In times of disasters and emergencies, traditional communication infrastructures like mobile networks and internet services often fail, severely affecting coordination between rescue teams. Current communication methods, such as walkie-talkies, have limited range and suffer from interference, while satellite-based systems are expensive and not easily accessible. To overcome these challenges, this project proposes a LoRa-based disaster communication node that enables reliable, offline message transmission without the need for internet connectivity. The proposed system integrates LoRa SX1278 for long-range communication and HC-12 for mid-range communication, ensuring adaptability to different terrains and various signal conditions. An ESP32 microcontroller manages message transmission and selectively chooses the suitable transmission module based on signal strength, thereby enhancing communication reliability. A Keypad and LCD interface(16x2) allows users to input and view messages in real-time. The system is lightweight, battery-powered, and designed for continuous operations in disaster environments. The proposed design aims to provide stable communication over long distances with low power consumption. Also, this solution offers a cost-effective, portable, and scalable communication system suitable for disaster management, rescue operations, and emergency response applications.

## **ALGORITHMIC BIAS IN CLINICAL DECISION SUPPORT: A FRAMEWORK FOR AUDITING FAIRNESS IN HEALTH AI**

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Artificial Intelligence (AI) based Clinical Decision Support Systems (CDSS) are increasingly used in healthcare to assist clinicians in diagnosis, treatment planning, and risk prediction. Despite their benefits, these systems may suffer from algorithmic bias caused by imbalanced datasets, limited population representation, and evolving clinical data, leading to unfair outcomes for certain patient groups. This paper examines the sources and impacts of bias in healthcare AI and highlights the associated ethical challenges. To address these issues, a comprehensive fairness auditing framework is proposed, which includes data diversity assessment, identification of sensitive attributes, group-wise fairness evaluation, bias mitigation strategies, and continuous monitoring. In addition, the framework introduces a Bias Early-Warning System that monitors model predictions over time and detects fairness drift, triggering alerts when performance disparities emerge for specific groups, such as elderly or vulnerable patients. This proactive approach supports timely model re-evaluation and intervention. The proposed framework aims to promote transparent, equitable, and responsible AI-driven clinical decision support, enhancing trust, safety, and long-term reliability in healthcare applications.

## **QUANTUM MACHINE LEARNING FOR SECURE IOT NETWORKS**

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The rapid proliferation of Internet of Things (IoT) devices in smart home and healthcare applications has introduced unprecedented vulnerabilities to cyber threats. Classical machine learning (ML) techniques, while effective in many cases, are increasingly inadequate to defend against the sophisticated attack vectors emerging in distributed and resource-constrained IoT environments. This paper proposes a novel security framework that integrates Quantum Machine Learning (QML) to enhance threat detection, authentication, and secure communication in IoT networks. Leveraging Qiskit, we simulate quantum-enhanced models such as Quantum Support Vector Machines (QSVM) and Quantum k-Nearest Neighbors (QKNN) for anomaly detection. The proposed QML-based framework demonstrates superior performance in terms of detection accuracy and computational efficiency when compared to classical ML counterparts. Furthermore, the hybrid quantum-classical architecture is designed to resist quantum-era attacks, thereby future-proofing IoT security. Use cases in smart home and healthcare domains are presented to validate the practical applicability of the system. Our results highlight the transformative potential of QML in establishing a next-generation cybersecurity paradigm for IoT networks.

## **REAL-TIME ECG SIGNAL ACQUISITION AND ANOMALY DETECTION USING BIOAMP EXG AND A MULTI-LAYER EMERGENCY ALERT SYSTEM**

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Cardiovascular diseases remain the leading cause of death worldwide, and there is a strong demand for continuous and reliable health monitoring systems that are capable of early anomaly detection. The present study describes a real-time, cost-effective health monitoring system that incorporates electrocardiogram signal acquisition with multi-parameter physiological sensing and an automated emergency response mechanism. Non-invasive electrocardiogram monitoring is performed using a BioAmp EXG module along with sensors for blood oxygen saturation, heart rate, and body temperature. Physiological data acquired through a microcontroller platform are transmitted to a host system for real-time analysis.

The acquired electrocardiogram signals are preprocessed with noise reduction, bandpass filtering, and correction for baseline drift to ensure accurate interpretation of cardiac activity. Key temporal and morphological features extracted from the processed signals are later used for anomaly detection. Supervised machine learning techniques will be used to classify cardiac patterns as normal or abnormal, based on learned feature representations. Further physiological parameters enhance the reliability of the detection by giving complementary health indicators. The multi-layer emergency alert mechanism is automatically activated in case of detection of abnormal conditions or critical thresholds. This mechanism provides health status notifications, along with location information, through multiple communication channels to medical professionals, emergency services, and designated caregivers. A graphical user interface is developed in order to visualize real-time physiological signals, system status, and alert notifications.

Experimental evaluation based on real-time signals and reference datasets yields effective detection of anomalies along with timely generation of alerts. This system is practical, scalable, and can be applied to continuous cardiac monitoring and fast responses in emergencies. Potential applications also relate to remote healthcare and personal health monitoring.

## **COMPREHENSIVE STUDY ON SLEEP APNEA DETECTION**

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Sleep is an essential and vital element of a persons life which helps to recharge the mind and body of a person. There are many people who were suffering during sleep and many hot died due to uneven changes in their body during sleep. Sleep apnea is the major cause for this. Traditional diagnosis polysomnography PSG but it is intrusive and expensive. This has motivated research into alternative methods for sleep apnea detection using various technology. These approaches aims to estimate clinical indices such as AHI and RDI. This review synthesizes the literature on sleep apnea detection system, highlighting their methodology, metrics, strengths and limitations and to enhance the clinical utility.

## **AGENTIC DIGITAL TWIN ARCHITECTURE FOR PREDICTIVE YIELD STABILIZATION AND AUTONOMOUS CONTROL IN MICROBIAL FERMENTATION**

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Microbial fermentation processes display strong nonlinear behaviour and sensitivity to environmental fluctuations, leading to inconsistent product yields and frequent batch failures. Conventional control strategies depend on reactive feedback mechanisms that respond only after deviations have occurred, limiting their effectiveness in making an effective bioprocess environments. This paper presents a novel agentic digital twin framework designed for yield prediction and autonomous control in microbial fermentation systems. The proposed approach integrates mechanistic growth modeling with data-driven temporal learning to form a hybrid digital representation of the fermentation process. A Long Short-Term Memory (LSTM) network augments classical Monod kinetics to enable early detection of abnormal process behaviour. An agentic reinforcement learning layer utilizes predictive insights to generate autonomous corrective actions, including nutrient feeding and environmental regulation. Simulation based validation demonstrates that the proposed system can identify critical deviations up to 60 minutes in advance and recover a majority of perturbed fermentation runs, resulting in a measurable improvement in yield consistency. The results indicate that agentic digital twins offer a promising pathway toward resilient, intelligent, and scalable bio manufacturing systems.

**Keywords:** Digital twin, agentic AI, microbial fermentation, predictive control, bioprocess optimization

## **IOT-ENABLED SMART HEALTH MONITORING SYSTEMS**

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This IoT-Enabled Smart Health Monitoring System presents a comprehensive framework for real-time patient monitoring using IoT technologies with cloud computing and machine learning. The system integrates biosensors for continuous monitoring of vital signs including heart rate, blood pressure, temperature, and oxygen saturation. Data from wearable devices transmits to a cloud platform where advanced analytics process information in real-time. An intelligent alert mechanism notifies healthcare providers of critical conditions. By leveraging edge computing for initial processing and cloud infrastructure for comprehensive analysis, the system achieves low latency with high accuracy. The system demonstrates significant improvements in patient outcomes, reduces hospital readmissions by 37%, and enables efficient resource allocation in healthcare facilities.

## **ADVANCES IN AI FOR PERSONALIZED AND PREDICTIVE LIVER CANCER DIAGNOSIS USING DEEP LEARNING**

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This report presents a very advanced AI put forth by us for the diagnosis of liver cancer which is mainly based on deep learning. We look at liver CT scans which the system goes in to great detail to analyze and present info on the tumor location, size, and shape. For accurate detection and classification of liver tumors we use a deep learning model which mostly includes convolutional neural networks. Also by looking at each patient individual scans the framework also puts out early disease progression reports in addition to a diagnosis. With regards to patient survival which is a critical issue in case of liver cancer what we have here is a very early diagnostic tool. Conventional diagnosis is mainly through manual review of medical images which is very labor intensive and at the discretion of the expert. In recent we have seen great promise from the application of AI to put forth predictive and personalized health care solutions.

Experimental results show that the new technique is significantly more accurate and reliable than the conventional approaches to image analysis. These results show the potential of AI to help professionals in the medical field facilitate a faster, more reliable, and personalized diagnosis of liver cancer. nnU-Net, that is, no-new-U-Net, is a popular and highly effective deep learning architecture for the detection of liver cancer in CT or MRI scans. It uses the original architecture of U-Net and modifies it to fit the required dataset. It works well on liver cancer datasets, the cancerous nodules that are often difficult to find manually, and the diverse dataset of tumors in terms of shape and size. In summary, nnU-Net is the most suitable architecture for the automation of the processes at hand.

**Keywords:** Artificial Intelligence, Deep Learning, Liver Cancer, nnU-net, Personalized Healthcare, Predictive Diagnosis, Medical Imaging.

## **MODELLING AND PREDICTION OF 5G CORE CONTROL-PLANE BEHAVIOR USING A PCAP FILE ANALYSIS WITH TRANSFER LEARNING**

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Accurate modeling of control-plane CP state transitions is essential for understanding the behavior of 5G core networks. This paper presents an AI-based modeling approach for the 5G core network control plane using NAS and NGAP signaling messages captured in PCAP format. The captured signaling messages are organized into sequential datasets that serve as input for deep learningbased sequence modeling. LSTM-based Seq2Seq and Transformer models are employed to learn temporal and contextual dependencies in control-plane signaling. A transfer learning strategy is applied to improve model flexibility when adapting to new signaling conditions.

## **EEG - BASED EMOTION RECOGNITION USING HYBRID CNN - LSTM MODEL FOR MENTAL STATE ANALYSIS**

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The progress of braincomputer interface BCI technology has enabled real-time understanding of human emotions through electroencephalogram EEG signals, and this research proposes a hybrid deep learning framework that combines Convolutional Neural Networks CNN and Long Short-Term Memory LSTM networks for emotion recognition using the DEAP dataset. In this approach, EEG signals are pre-processed to remove noise, normalized, and transformed into spatial temporal representations suitable for deep feature extraction, where the CNN component captures spatial dependencies among EEG channels while the LSTM component models temporal variations over time. Experimental results show that the CNNLSTM model achieves higher classification accuracy in identifying emotional states across valence and arousal dimensions compared to traditional methods. Furthermore, the extended model incorporates an attention mechanism to enhance feature weighting and improve interpretability of the learned representations. Overall, this hybrid framework supports the development of robust affective computing systems with applications in mental health monitoring, adaptive learning, humancomputer interaction, and emotion-aware virtual assistants, demonstrating the strong potential of combining CNN, LSTM, and attention-based deep architectures for effective emotion recognition from non-invasive EEG signals.

## **AUTOMATED BRAIN TUMOR SEGMENTATION AND CLASSIFICATION USING HYBRID EFFICIENTNET-CNN ARCHITECTURE**

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Objective Developing an AI-based System for the Detection of Brain Tumor at an early stage using MRI images. Method Convolutional Neural Network CNNs and EfficientNet are used to classify MRI images as normal or tumor affected. Tumor regions are identified using segmentation, and tumor sizes calculated based on affected pixels in MRI image. Grad-CAM is applied for tumor visualization, and that system is deployed using Streamlit based web interface. Findings The proposed model outperforms existing methods with improved accuracy and F1-score and hence can classify the different tumor types, such as glioma, meningioma, and pituitary tumor. Approach We utilize an EfficientNet to perform high precision tumor segmentation. For an detection, we apply N Sampling algorithms to quantify the tumors physical size in cm<sup>2</sup>. Finally, we classify the tumor type using Spatial Probabilistic Logic based on the anatomical location of segmented region. Keywords Brain Tumor Detection MRI Images Convolutional Neural Networks EfficientNet Grad-CAM.

## **PERFORMANCE ANALYSIS OF EXTREME GRADIENT BOOST AND CONVOLUTIONAL NEURAL NETWORK FOR LOG-BASED ANOMALY DETECTION**

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With the rapid expansion of interconnected systems, log-based anomaly detection has become a critical pillar of cybersecurity for identifying system failures and malicious intrusions. This research provides a comparative performance analysis between eXtreme Gradient Boosting XGBoost and Convolutional Neural Networks CNN for detecting anomalies within system logs. While deep learning models like CNN are often praised for their feature extraction capabilities, their effectiveness in structured log analysis remains a subject of investigation. In this study, both models were evaluated across 10 experimental iterations N10 to ensure statistical significance. Experimental results demonstrate that XGBoost achieved a superior mean accuracy of 95.64, significantly outperforming the CNN, which recorded a mean accuracy of 87.64. Furthermore, XGBoost exhibited higher reliability and consistency, evidenced by a significantly lower standard deviation 0.678 compared to the CNN 3.337. The findings suggest that for log-based datasets, gradient boosting architectures provide more robust classification boundaries and are less sensitive to noise than deep learning approaches. This research concludes that XGBoost is a more efficient and accurate solution for real-time log-based anomaly detection in environments where computational consistency and high precision are paramount.

## **LEAKSENSE PRO - STREETLIGHT EARTH LEAKAGE DETECTION AND ALERT SYSTEM**

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This project presents a real-time IoT-based streetlight earth leakage detection and alert system designed to improve electrical safety and maintenance efficiency. The system continuously monitors phase and neutral currents using Current Transformers CTs to identify earth leakage caused by faulty insulation or improper earthing. Additionally, a soil moisture sensor is used to assess the condition of the earthing system, as soil moisture directly affects earthing resistance and system reliability. An ESP32 microcontroller processes the sensor data and compares it with predefined safety thresholds. When abnormal conditions such as leakage current or poor earthing are detected, the system automatically disconnects the affected streetlight using a relay to prevent electrical hazards. At the same time, real-time fault alerts and streetlight status information are transmitted to a mobile application through Wi-Fi and Power Line Modem PLM communication. Local alerts are also generated using LEDs and a buzzer for immediate indication. The proposed system offers a cost-effective, scalable and automated solution for continuous streetlight monitoring. It reduces the need for manual inspections, ensures faster fault detection and enhances public safety. This system is suitable for deployment in smart city infrastructure and can be further extended with predictive analytics for preventive maintenance.

## **REAL-TIME WEAPON DETECTION AND BEHAVIORAL THREAT RECOGNITION USING AN INTEGRATED DEEP LEARNING APPROACH**

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With the increase in public violence, it is vital to have real-time monitoring tools that can detect weapons and analyze the behavior of individuals who may be a threat. This document proposes a novel integrated deep learning architecture that combines YOLOv11, Generative Adversarial Networks GANs, and a convolutional long short-term memory CNN-LSTM structure for effectively identifying weaponry in addition to examining threats from human behavior. The YOLO model is utilized for the rapid identification and localization of weapons, while GAN-generated synthetic data is used to enhance the coverage of the training dataset and create a balanced dataset. CNNs extract spatial characteristics from images, and by applying them to LSTMs, an understanding of behavior over time temporal analysis is captured by modelling movement patterns to detect threats when they arrive. All results are based on data collected from a combined dataset containing weapon/non-weapon conditions with varying levels of illumination, obstructive objects, and population density. Results indicate superior performance of 98.3, 97.9, and 98.6, and an F1 score of 98.2, which is significantly better than the performances obtained with standard approaches that employed only a single model. The combined framework allows for real-time monitoring at low latency, allowing for easy integration into both smart city surveillance and public safety systems. Results also indicate that the integration of identification through detection, augmentation through data generation, and temporal analysis enhances both the reliability of a framework and its capability to identify threats in complex environments. Keywords Generative Adversarial Networks GAN, you only look once YOLO, Convolutional Neural Networks CNN, Long Short-Term Memory LSTM, Anomaly detection.

## **A SURVEY ON INTELLIGENT RFID/IOT FRAMEWORKS FOR REAL-TIME PATIENT MONITORING AND MEDICAL INVENTORY AUTOMATION IN SMART HOSPITALS**

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Radio Frequency Identification RFID is used to identify the characteristics of an object wirelessly using radio waves. This project combines the power of RFID technology with real-time health monitoring in a hospital setting. Utilizing RFID tags for patient identification and asset tracking, the system seamlessly integrates with temperature sensor, blood pressure sensor and SpO2 sensor. The collected data is then transmitted to an Internet of Things IoT platform for continuous monitoring. The system not only ensures accurate patient identification and efficient asset management, but also provides real-time oxygen saturation, blood pressure rate and temperature data. This information is displayed on the LCD screen, offering healthcare professionals immediate insights into patient health. This innovative solution enhances patient care, promotes proactive medical interventions, and exemplifies the IOT in advancing healthcare.

## **AI-POWERED NLP DRIVEN FRAMEWORK FOR RESUME MATCHING, RANKING, AND AUTOMATED RECRUITMENT ALERTS**

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The exponential growth of unstructured textual data across enterprises, recruitment platforms, and digital repositories has made accurate document comparison and relevance assessment a challenging task. Manual evaluation of documents such as resumes, job descriptions, and reports is time consuming, subjective, and often inconsistent. This paper presents an intelligent Document Similarity Comparison and Ranking system that leverages natural language processing and machine learning techniques to automate document analysis and relevance based ranking. The proposed approach systematically processes documents through text normalization, feature extraction, and semantic representation, enabling meaningful comparison beyond simple keyword matching. Multiple similarity measurement techniques are applied to quantify the contextual alignment between documents, and the resulting similarity scores are used to rank documents in order of relevance. In addition to ranking, the system incorporates an automated email notification mechanism that securely delivers shortlisted resumes to recruiters, thereby streamlining the end-to-end recruitment workflow and reducing human intervention. The system architecture is designed to support scalability and real time processing, making it suitable for practical deployment in large scale environments. Performance evaluation is carried out using standard similarity metrics and benchmark datasets to analyze accuracy, ranking effectiveness, and computational efficiency. The results indicate that the proposed system delivers improved matching precision and more consistent rankings when compared to traditional rule based and keyword driven approaches. Furthermore, the study discusses the strengths and limitations of different similarity techniques under varying document lengths and content complexity. Finally, the paper highlights domain adaptation, contextual understanding, and explainable similarity scoring.

## **DESIGN AND SIMULATION OF MICROSTRIP PATCH ANTENNA FOR WIRELESS COMMUNICATION**

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Microstrip patch antennas are commonly used in wireless communication because they are compact, lightweight, easy to fabricate, and cost-effective. In this project, microstrip patch antennas with different shapes are designed and analyzed to operate at 2.4 GHz in the ISM band for Bluetooth communication. All antenna designs use the same substrate material and are created under identical conditions to allow a fair comparison. The antennas are simulated using ANSYS HFSS, and important parameters such as return loss, bandwidth, gain, VSWR, and radiation pattern are studied. The simulation results show that the shape of the patch has a major influence on antenna performance. One geometry is found to provide better impedance matching and stable radiation at the required frequency. These antennas can be used in Bluetooth-enabled devices and wearable applications such as ECG sensor patches. The designs also perform reliably near the human body, making them suitable for low-power, short-range wireless communication systems.

## **FEDERATED DIGITAL TWINS FDT FOR GERIATRIC REMOTE PATIENT MONITORING**

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The proliferation of the Internet of Medical Things IoMT has revolutionized geriatric care by enabling continuous Remote Patient Monitoring RPM. However, there are numerous challenges to using the cloud-centric approach of creating new IoMT devices, including significant concerns with data privacy, possibility of latency in emergency situations, and limited bandwidth availability. To combat these issues, we propose a new architecture called Federated Digital Twins FDT, which integrates Edge AI, Federated Learning FL, and Generative AI to develop and solve these challenges. Our proposed architecture includes a three-tier framework that consists of an individualised Digital Twin residing on a local Edge Gateway, using Convolutional Neural Networks CNN to detect arrhythmias in real-time via training through the FedProx algorithm. Additionally, to increase the amount of data available for training, we synthesised a high-fidelity ECG data set using the Pulse Physiology Engine, thereby ensuring still adhere to regulations concerning data privacy. Via experimental simulations a proposed architecture has been demonstrated as an effective method for diagnosing Atrial Fibrillation at a level of accuracy of 95.3 with a reduction in the amount of bandwidth used for upstream transmission of data of 98, while also providing guarantees of Differential Privacy. Keywords Digital Twin, Edge Artificial Intelligence, Federated Learning, Geriatric Care, Remote Patient Monitoring, Differential Privacy.

## **A HYBRID, MULTI-LAYERED SYSTEM FOR REAL-TIME PHISHING URL DETECTION**

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Global cybersecurity is constantly threatened by phishing attempts, which calls for sophisticated, real-time detection systems. The design, implementation, and assessment of a unique hybrid security solution for real-time phishing URL detection delivered through a user-centric browser extension are presented in this work. The system architecture uses a multi-layered defense-in-depth approach, fusing an advanced AI backend with a rule-based heuristic engine. The AI backend is a hybrid, using an enhanced XGBoost model for lexical feature interpretation and a potent Deep Learning Convolutional Neural Network CNN for sequence analysis. The resulting model was assessed on a sizable, balanced dataset following an iterative process of data-centric re-training to reduce algorithmic bias. With excellent precision 95 and recall 96, the system attained a strong overall accuracy of 95.82. For the crucial phishing class, the system attained a strong overall accuracy of 95.82, with good precision 95 and recall 96. This paper shows that a realistic and very successful option for real-time phishing defense is a hybrid AI technique nested within a tiered security architecture.

## **LOW-POWER ALU DESIGN USING FSSS LOGIC IN 16NM FINFET**

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The full design and implementation of an ultra-low power Arithmetic Logic Unit ALU using Full-Swing Single Source FSSS logic in 16 nm FinFET technology is presented in the case of its optimization for wearable AI inference processors. The FSSS logic style employs full voltage swing outputs while allowing switching paths from a single source, thereby minimizing, if not eliminating, short-circuit current and erasing the necessity for level restoration circuits that are typically seen in pass transistor-based designs. The presented ALU exploits enhanced electrostatic control, low subthreshold leakage, and high drive strength of FinFET devices in near threshold conditions and consumes power in the microwatt range. The Tanner EDA tools S-Edit, T-Edit, W-Edit have been extensively used for circuit-level design and simulation of the ALU, wherein the power efficiency, propagation delay, and area utilization have been markedly improved in comparison with conventional CMOS, transmission-gate, and pass-transistor logic implementations. These designs can be incorporated into the energy-constrained wearable applications meant potentially for continuous health monitoring, activity recognition, and lightweight neural network inference. The simulation results substantiate the capability of the architecture to maintain reliable functioning at supply voltages as low as 0.7 V while still maintaining full-swing outputs and reduced dynamic energy consumption. The FSSS-based ALU proposed provides a potential candidate for next-generation battery-operated wearable AI processors, which are designed for uninterrupted functioning with minimal energy overhead.

## **MEDIBUDDY- THE ULTIMATE MEDICAL SIDEKICK**

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In today's fast-paced world, maintaining effective healthcare routines is challenging due to hectic lifestyles and fragmented health systems. Elderly individuals and those with chronic conditions often struggle with medication adherence, while accessing services like medicine ordering, lab test analyzing, consultations, and emergency care requires navigating multiple disjointed platforms, leading to inefficiencies and delays. To address these issues, we propose MediBuddy, an AI-integrated mobile application serving as a comprehensive health management platform. It centralizes essential services, enabling users to track medication intake with customizable alarms, pop-ups, and voice reminders to ensure timely adherence. Key features include an AI-powered Voice Assistant and Chatbot for personalized health guidance and support. The app integrates online medicine ordering with doorstep delivery, lab test booking, nurse and doctor appointments, and ambulance requests, streamlining healthcare access. Each user receives a unique ID linked to their secure medical records, facilitating easy sharing with healthcare professionals. By leveraging artificial intelligence, automation, and user-centric design, MediBuddy enhances medication compliance, simplifies service accessibility, and fosters proactive health management. This innovative solution represents a pivotal advancement in digital healthcare, empowering users with a smarter, safer, and more connected approach to overall well-being.

## **CLINICALLY CALIBRATED COUNTERFACTUAL EXPLAINABLE AI FOR RARE DISEASE SCREENING UNDER EXTREME CLASS IMBALANCE**

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Screening for rare diseases remains a difficult task for machine learning systems, mainly due to the very small number of positive cases and the severe clinical consequences associated with missed diagnoses. Although recent deep learning models have achieved strong predictive performance, their lack of transparency and unreliable probability estimates often limit their usefulness in clinical practice. As a result, clinicians are hesitant to rely on these systems without clear explanations that align with medical reasoning. In this work, we present a Clinically Calibrated Counterfactual Explainable AI C3-XAI framework designed specifically for rare disease screening in highly imbalanced settings. Therefore, the framework incorporates counterfactual explanations directly into the learning process, allowing the model to highlight minimal and clinically plausible changes in patient data that could influence a screening decision. So, by integrating clinical constraints and calibration objectives during training, the proposed approach produces explanations that are both interpretable and medically meaningful. To address extreme class imbalance, the framework places greater emphasis on rare positive cases while maintaining stable overall performance. Therefore, experimental results on rare disease screening tasks show improved recall for minority classes and better calibrated probability estimates, without increasing clinically unacceptable false-positive rates. The proposed solution is scalable, power-efficient, and robust, making it well-suited for elderly care, chronic disease management, and large-scale deployment in healthcare environments.

## **A SOFTWARE-BASED MULTI-MODAL FRAMEWORK FOR REAL-TIME COGNITIVE LOAD MONITORING IN E-LEARNING SYSTEMS**

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Monitoring a learners cognitive load in real time is key to improving learning efficiency in digital education. Traditional e-learning systems do not have the ability to assess users mental workload during study sessions. This paper introduces a Cognitive Load Monitoring System, a software-based and non-intrusive method for assessing cognitive states in real time. The system collects data through webcams to analyze facial behavior, keystroke dynamics, and scrolling patterns. Extracting facial landmarks allows for the calculation of eye aspect ratio, blink rate, and head movement features, while interaction-based metrics offer more behavioral signals. To increase reliability, signal processing techniques like Kalman filtering and Fast Fourier Transform FFT are used for noise reduction and frequency analysis. The system combines data from multiple sources with machine learning classifiers, such as Random Forest and Support Vector Machines, to categorize cognitive states into focused, relaxed, and overloaded. Experimental tests show effective real-time performance and a strong link to established measures of cognitive workload. This approach provides a scalable and cost-effective solution for smart educational systems without needing special hardware.

## **NON-INVASIVE BLOOD HEALTH TREND MONITORING FRAMEWORK USING ELECTRO-IMPEDANCE SPECTROSCOPY AND MACHINE LEARNING**

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Repeated blood testing is required for monitoring chronic health conditions such as dehydration, anemia, and metabolic imbalance. However, conventional blood testing techniques are invasive, painful, and unsuitable for frequent or community-level monitoring, particularly in home and rural healthcare settings. This paper presents a conceptual non-invasive blood health trend monitoring framework based on Electro-Impedance Spectroscopy EIS and machine learning. The proposed approach applies low-amplitude, multi-frequency electrical signals to biological tissue and analyzes the resulting impedance response to capture physiological trends associated with hydration status, hemoglobin-related variations, and electrolyte balance, with glucose-related behavior explored as a secondary research direction. Rather than providing diagnostic measurements, the framework focuses on screening-level alerts and longitudinal trend monitoring. A high-level system architecture comprising signal acquisition, impedance analysis, feature extraction, and AI-based interpretation is described. The proposed framework demonstrates the feasibility of EIS as a supportive, privacy-preserving health monitoring approach and establishes a foundation for future prototype development and clinical validation.

## **A REVIEW OF MACHINE LEARNING MODELS FOR EARLY PREDICTION OF ALZHEIMERS DISEASE**

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Alzheimers disease AD is a neurological condition that worsens over time and mostly impairs memory and cognitive abilities. It presents major problems for healthcare systems around the world. Effective treatment planning and stopping the progression of Alzheimers disease depend on early detection and diagnosis. Using clinical data, neuroimaging, genetic information, and cognitive tests, machine learning ML and deep learning DL algorithms have demonstrated encouraging results in predicting Alzheimers disease in recent years. This survey study offers a thorough analysis of current datasets, feature extraction strategies, classification methods, and prediction approaches for Alzheimers disease. It also addresses the difficulties, constraints, and potential avenues for future research in the field of Alzheimers disease prediction. Hence, the counterfactual explanations generated by the model provide clear and good insights that support clinicians in understanding and validating model predictions. Therefore, this study shows that using clinical calibration, counterfactual reasoning, and imbalance-aware learning may improve the reliability and transparency of AI-based rare disease screening systems, bringing them closer to a secure and helpful application in actual healthcare settings.

## **FROM MIRROR WORLDS TO PRECISION MEDICINE DIGITAL TWINS IN MODERN HEALTHCARE**

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The rapid growth of healthcare data, combined with the increasing demand for predictive and personalized care, has exposed the limitations of traditional reactive healthcare systems. Digital twin technology addresses these challenges by enabling continuously updated virtual representations of physical entities such as patients, medical devices, and clinical processes. In healthcare, these virtual models support real-time monitoring, simulation, and data-driven clinical decision-making. When integrated with Internet of Things IoT technologies and artificial intelligence AI-based analytics, digital twins enable predictive modeling, risk assessment, and personalized treatment planning within smart healthcare environments. This paper presents a comprehensive survey of digital twin technology in healthcare, reviewing its conceptual foundations, architectural components, key application domains, existing challenges, and emerging research directions based on recent literature.

## **MULTI-SENSOR DATA ACQUISITION AND ANALYSIS FOR PORTABLE HEALTH MONITORING APPLICATIONS**

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The constant keep of watch and identification of risks prior to their occurrence are turning out to be very challenging responsibilities to the healthcare systems. Traditional monitoring is not predictive, is often reactive, and it is only available within the hospital environments. The BIO CARE is an Internet of Things platform that employs sensors that are connected to an ESP32 microcontroller to measure vital signs, including body temperature, heart rate, SpO2, and ECG. The real-time data transmission is sent to a Firebase cloud database which is then visualized with two web portals of the patient and the doctor. The patient portal is focused on simplified vitals, device status and direct communication with doctors whereas the doctor portal provides dashboards, alerts, patient profiles. The experiments reveal the enhancement of doctor-patient interaction and reliable low-latency data transfer. BIO CARE ensures timely response in the case of an emergency and effective communication between doctors and patients.

## **REAL-TIME VITAL MONITORING AND EMERGENCY ALERT SYSTEM**

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The Real-Time Vital Monitoring and Emergency Alert System is designed to continuously monitor essential health parameters of patients and provide immediate alerts during emergency situations. This system measures vital signs such as heart rate, body temperature, and blood oxygen level using biomedical sensors. The collected data is processed in real time by a microcontroller and transmitted wirelessly to a remote monitoring platform for continuous observation. When any vital parameter exceeds predefined safe limits, the system automatically triggers an emergency alert to caregivers, doctors, or family members through SMS, mobile application notifications, or email. The integration of GPS technology enables real-time location tracking of the patient, ensuring quick assistance during critical conditions. This system reduces the need for constant manual monitoring and enhances timely medical intervention. The proposed system is cost-effective, portable, and reliable, making it suitable for hospitals, home healthcare, quarantine monitoring, and elderly care. By providing real-time health data and instant emergency alerts, the system aims to improve patient safety and support efficient healthcare management.

## **AI-BASED PRE-SYMPTOM ANOMALY DETECTION FOR RABIES RISK IN STREET DOGS USING MULTIMODAL BEHAVIOR ANALYSIS**

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Rabies is a major, but preventable, global public health concern that is mostly caused by household and stray dogs. The existing detection techniques are mostly reactive in nature and therefore the disease is only detected once the clinical symptoms present thus crippling the ability to intervene in time and contain it. The paper describes an artificial intelligence-driven model of the pre-symptom detection of anomalies in street dogs through the use of multimodal behavior analysis. The proposed system combines two different data streams high-resolution video of closed-circuit television CCTV to observe macro-behavioral changes, and time-series physiological data i.e. jaw tremor, heartbeat and breathing pattern measured by a non-invasive leash-mounted sensor device. A You Only Look Once YOLO trained network is used to analyze the visual stream to give gait and salivation anomaly information, and a Convolutional Recurrent Neural Network CRNN is used to analyze sensor data. Both networks are combined and fed to a One-Class Support Vector Machine OC-SVM in order to continuously calculate an anomaly risk score. The architecture will detect physiological and behavioral abnormalities with a high likelihood of causing a symptom that could be treated in quarantine, indicating a very important window of time. The assessment shows that this type of multimodal fusion has much higher accuracy and, more importantly, time-to-detection of the risk of rabies than that of a single-modality system.

## **A WEARABLE HEALTHCARE MONITORING SYSTEM FOR REAL-TIME ANOMALY AND FALL DETECTION**

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This paper presents the design of a wearable healthcare monitoring system that integrates multi-sensor fusion, edge computing, and machine learning-based anomaly detection to enable real-time physiological monitoring and fall prevention. The system comprises biomedical and motion sensors, including the MAX30102 SpO2 and heart rate and MLX90614 temperature for continuous health tracking. A hybrid machine learning model is employed for real-time anomaly detection, leveraging the Isolation Forest algorithm for unsupervised outlier detection in physiological signals. This model dynamically identifies critical deviations in SpO2 and temperature readings, enabling early medical intervention. For fall detection, a Decision Tree-based classification model processes inertial sensor data, distinguishing between normal movements and fall events with high sensitivity and minimal false positives. The system architecture follows a hybrid edge-cloud computing paradigm, where on-device preprocessing using ESP32 optimizes latency and power efficiency, while cloud-based long-term health trend analysis refines predictive accuracy. Data is transmitted via Bluetooth Low Energy BLE for local communication and Firebase cloud services for remote caregiver notifications, ensuring instant emergency alerts via a mobile application developed using Flutter.

## **EDGE-IIOT FOR SMART TANNERY EFFLUENT MONITORING WITH CHROMIUM SURROGATES AND SECURE COMPLIANCE LEDGER**

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The leather tanning industry is a significant source of hazardous chromium discharge, yet small-to-medium-scale tanneries often lack the financial resources for continuous, real-time effluent monitoring. This paper proposes a Decentralized Effluent Monitoring and Control System based on an Edge-IIoT architecture that utilizes surrogate sensing to provide an affordable alternative to expensive industrial analyzers. By deploying an Autoencoder-based Machine Learning model on a Raspberry Pi edge gateway, the system identifies the complex chemical signature of chromium discharge through low-cost sensors such as pH, TDS, and Turbidity. Upon detecting an anomaly, the system executes real-time automated control via a solenoid valve to divert contaminated water. To ensure regulatory compliance and prevent data manipulation, all sensor events are cryptographically sealed in a tamper-proof SHA-256 secure ledger. We demonstrate the systems utility through a use case involving integration with a municipal water treatment facility, serving as a secondary safety layer to protect public water supplies from industrial contamination. Experimental results demonstrate that this decentralized architecture provides a significant cost reduction compared to traditional analyzers while maintaining an immutable audit trail for environmental inspections.

## **NEURO-AUTONOMIC AWARE EXPLAINABLE DEEP LEARNING FOR EARLY COGNITIVE FATIGUE DETECTION USING WEARABLE EEG/ECG SIGNALS**

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Cognitive Fatigue Syndrome CFS is an emerging neurophysiological condition characterized by progressive deterioration of attention, working memory, and mental endurance, often preceding clinical burnout and neurological impairments. Existing assessment methods rely mainly on subjective self-reports and post-fatigue assessments, limiting their effectiveness for early intervention. This paper proposes an explainable deep learning framework for early detection of cognitive fatigue using multimodal EEG and ECG signals recorded from wearable sensors. The proposed system adopts a hybrid CNN BiLSTM architecture that automatically learns spatiotemporal fatigue patterns from EEG rhythms and HRV features extracted from ECG signals. An adaptive preprocessing pipeline enhances the quality and robustness of learning before model training. Raw EEG and ECG signals are preprocessed with band-pass filtering and wavelet-based artifact suppression to reduce motion artifacts, baseline wander, and high-frequency noise. To address the intrinsic class imbalance in fatigue datasets, a physiology-aware oversampling strategy, dubbed Physio-SMOTE, is proposed to synthesize temporally coherent and biologically plausible synthetic samples for minority fatigue classes. To enhance clinical interpretability and trust, an XAI module is integrated to identify fatigue-critical signal segments and physiological biomarkers that influence model decisions.

## **INTELLIGENT REMOTE DISEASE PREDICTION USING AI-ENABLED IOT AND DATA ANALYTICS**

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Remote Patient Monitoring RPM is gradually becoming the core of telehealth and chronic disease management, as Artificial Intelligence AI, the Internet of Things IoT, and data science are making it possible to monitor health continuously and detect diseases outside the traditional hospital settings. Nevertheless, the currently available RPM systems are confronted with a number of obstacles such as incompatibility of sensor devices, short battery life, data quality that varies, security and privacy issues, and a limited range of health parameters that can be measured. This work introduces an AI- and IoT-powered RPM framework for chronic disease prediction that features multimodal data integration, edge analytics, communication methods that are battery-efficient, and privacy-enhancing machine learning approaches. The envisaged system mitigates the major issues pinpointed by recent articles in MDPI, Nature, and PMC and achieves efficacy in heart failure monitoring as well as in the general scenarios of chronic disease management.

## **INTRUSION DETECTION AND DEFENSE MECHANISMS FOR CYBER- SECURE CONNECTED AND AUTONOMOUS VEHICLES CAVS**

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The rapid evolution of Connected and Autonomous Vehicles CAVs has changed the very nature of modern transportation systems by allowing advanced sensing, communication, and intelligent decision making. Nevertheless, the close coupling of in-vehicle networks, Vehicle-to-Everything V2X communications, cloud services, and artificial intelligence has greatly increased the cyberattack surface, thus posing significant security and safety challenges. This survey offers an exhaustive review of recent peer-reviewed research 2018-2025 in the field of CAVs cybersecurity, with a concentration mainly on intrusion detection systems IDS and advanced defense mechanisms. We categorize intrusion detection system methods in a structured manner by considering their data sources, detection methodologies, and deployment architectures and also review the primary attack vectors targeting CAN, V2X, and autonomous driving subsystems. Moreover, the survey evaluates IDS performance using widely accepted metrics and evaluation datasets, thereby bringing out the advantages and drawbacks of traditional, machine learning, and deep learning methods. Various innovative concepts such as federated learning, blockchain-based security, edge AI, and digital twins are being scrutinized for their potential to solve the problems of scalability, privacy, and real-time responsiveness. Lastly, the unresolved research issues and future prospects are pinpointed, thus offering a well-organized basis for the creation of security measures that can resist intrusions, change according to the environment, and efficiently use limited resources in the case of next-generation CAVs.

## **A LOW-COST EEG-BASED SYSTEM FOR HUMAN EMOTION RECOGNITION**

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Emotional state monitoring plays a crucial role in understanding mental well-being, yet most existing EEG-based systems remain expensive and inaccessible for large-scale or community-level use. This project presents a low-cost EEG-based emotion detection system designed to make brain-computer interface technology more affordable and practical for real-world applications. The proposed system integrates a lightweight EEG acquisition setup with signal processing and machine learning techniques to analyse brainwave patterns associated with human emotions. EEG signals are captured using cost-effective hardware components and are preprocessed to remove noise and artefacts. Key features are extracted from different frequency bands, including delta, theta, alpha, beta, and gamma waves. These features are then used to classify emotional states such as calm, stress, focus, and relaxation using machine learning models. The system emphasises simplicity, scalability, and ease of deployment, making it suitable for educational, research, and preliminary mental health monitoring purposes. Experimental results demonstrate that meaningful emotional patterns can be identified even with low-cost EEG hardware, achieving satisfactory classification performance. This work highlights the potential of affordable EEG systems in emotion analysis and opens opportunities for future applications in mental health support, human-computer interaction, and personalised assistive technologies.

## **A HYBRID CNN-BIL STM DEEP LEARNING ARCHITECTURE FOR ROBUST CLASSIFICATION OF MANGO LEAF DISEASES USING MENDELEY DATASET**

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Accurate and early detection of mango leaf diseases is critical for ensuring crop health and maximizing yield. Traditional visual inspection methods are subjective, time-consuming, and require expert intervention. This study proposes MangoLeafXNet, a novel explainable deep learning model for mango leaf disease classification. The model leverages convolutional neural networks (CNN) for feature extraction and integrates explainability techniques such as Grad-CAM and LIME to provide visual and textual justification for predictions. Experiments on a curated dataset of diseased and healthy mango leaf images demonstrate that MangoLeafXNet achieves high classification accuracy, superior generalization, and interpretable outputs. The results suggest that explainable models can support field-level decision-making and increase trust among farmers and agronomists.

## **SMART LI-FI BASED WIRELESS NOTICE BOARD FOR COMMUNICATION USING LASER AND DARK TUBE**

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Traditional notice boards used in educational institutions, hospitals and defence places rely on manual updates making the process slow and inefficient. Although Wi-Fi and Bluetooth-based digital notice boards are prone to radio-frequency interference, security risks, and unauthorized access. To overcome these limitations this project proposes a secure and efficient notice board system based on Light Fidelity Li-Fi technology. The proposed system employs optical wireless communication using a laser diode as the transmission medium controlled by ESP32 microcontrollers. At the transmitter side text messages are sent from smartphone application via Wi-Fi or Bluetooth to the ESP32 where the data is converted into binary form and modulated using techniques such as on-off keying OOK or Manchester encoding. The modulated optical signal is transmitted through a dark tube which effectively blocks ambient light and minimizes external interference ensuring reliable data transmission. At receiver end photodiode detects the incoming optical signals and convert them into corresponding electrical signals. These signals are decoded by the receiver ESP32 and displayed on LED matrix display. The enclosed tube-based design reduces noise caused by sunlight, indoor lighting, and reflections; it results in improved signal integrity and communication reliability. Since light waves cannot penetrate walls the proposed Li-fi system provides enhanced security by preventing unauthorized interference. This radio frequency free communication approach is particularly suitable for environments such as defence facilities, hospitals with sensitive medical equipment, educational institutions, and other interference-free operation. Experimental results confirm successful data transmission with low bit error rates and fast responses times demonstrating the effectiveness of optical wireless communication for secure notice board application.

## **A UNIFIED PHYSICS-INFORMED AND EXPLAINABLE MACHINE LEARNING FRAMEWORK FOR CROSS-ARCHITECTURE SEMICONDUCTOR DEVICE VARIABILITY ANALYSIS**

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The shift to sophisticated semiconductor device topologies at sub-5 nm nodes has exacerbated the influence of process variables on device performance. Traditional Technology Computer-Aided Design TCAD statistical simulations, although precise, are computationally excessive for extensive variability analysis. Current machine learning ML surrogates provide rapid performance but are plagued by physical instability, lack of transparency, and inadequate data efficiency. This research introduces an innovative Physics-Informed Machine Learning PIML architecture that integrates fundamental semiconductor equations directly into neural network training, thereby guaranteeing physically realistic predictions. The framework incorporates explainable AI XAI methodologies to assess sources of variability and utilizes an active learning approach to reduce TCAD simulation expenses by 60–70 percent. The model, executed via a MATLAB-TCAD co-simulation workflow, exhibits cross-architecture generalization across FDSOI, FinFET, and GAA device architectures. Validation demonstrates that the PIML framework attains less than 2 percent RMSE in comparison to TCAD, concurrently decreasing physical constraint violations by an order of magnitude. This study offers a systematic, interpretable, and data-efficient approach for analyzing variability in next-generation semiconductor technology.

## **A COMPREHENSIVE REVIEW OF WEARABLE TEXTILE ANTENNAS FOR BODY-CENTRIC WIRELESS COMMUNICATION**

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Wearable textile antennas have emerged as a key enabling technology for body-centric wireless communication systems, including healthcare monitoring, wireless body area networks WBAN, and smart textile applications. This review paper presents a comprehensive survey of recent developments in wearable antenna design, focusing on textile-based and flexible substrate implementations. Various conductive materials such as conductive fabrics, embroidered threads, and printed metallic inks are reviewed, along with commonly used flexible substrates including textiles, polymers, and elastomers. The impact of antenna topology, ground plane configurations, and integration techniques on performance metrics such as bandwidth, gain, radiation efficiency, and mechanical robustness is discussed. Special emphasis is placed on the effects of human body loading, bending, and crumpling, as well as specific absorption rate SAR reduction techniques. Challenges related to durability, fabrication repeatability, and performance stability are highlighted. Finally, emerging trends and future research directions for wearable antennas in healthcare, IoT, and smart clothing applications are outlined.

## **PHOTONIC CRYSTAL FIBER SENSOR FOR THE DETECTION OF CARBON MONOXIDE**

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Carbon monoxide CO is a highly toxic and invisible gas that poses severe risks to human health and industrial safety. This paper presents the design and numerical optimization of a hollow-core photonic crystal fiber HC-PCF tailored for high-performance CO gas sensing applications. The proposed fiber features a large gas-filled central core surrounded by multiple symmetrically arranged air-hole rings, enabling enhanced light-gas interaction while maintaining controlled confinement loss. Finite Element Method FEM simulations are carried out using COMSOL Multiphysics at the standard telecommunication wavelength of 1.55 micrometre. Key sensing metrics including effective refractive index, effective mode area, optical power fraction, and confinement loss are rigorously analyzed. The optimized structure exhibits an effective refractive index close to unity, strong modal confinement within the gas core, and improved sensitivity compared to previously reported PCF-based CO sensors. These results demonstrate that the proposed HC-PCF is a robust and promising platform for compact, high-sensitivity optical gas sensing systems.

## **EDGE BASED INTRUSION MITIGATION SYSTEM USING TINYML AND HARDWARE LEVEL FILTERING FOR IOT DDoS DEFENSE**

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The rapid proliferation of Internet of Things (IoT) devices has introduced significant security vulnerabilities, particularly susceptibility to Volumetric Distributed Denial of Service (DDoS) attacks. Traditional cloud-based security solutions often struggle with high latency and bandwidth overhead, making them ineffective for real-time mitigation in resource-constrained environments. This project presents Edge Based Intrusion Mitigation System using TinyML and Hardware Level Filtering for IoT DDoS Defense, a decentralized security architecture that shifts intelligence to the network edge. Utilizing an ESP32 microcontroller as a dedicated "Sentry Node," the system implements a quantized TinyML model to perform real-time traffic classification. Unlike high-complexity models that transform traffic into RGB images for heavy Convolutional Neural Networks, our approach optimizes the workflow for microcontrollers by extracting high-impact tabular features such as Inter-Arrival Time (IAT) and packet length. The system utilizes a structured pipeline comprising data cleaning, normalization, and Int8 quantization, enabling the deep learning model to reside within the ESP32's 520KB SRAM while maintaining high inference accuracy. Upon identifying adversarial signatures from internet-acquired datasets and local captures, the system executes an autonomous hardware-level packet drop mechanism. This ensures that malicious traffic is filtered at the physical layer before it can exhaust the target IoT device's resources. Experimental results demonstrate that this standalone "Sentry Shield" provides a low-latency, cost-effective, and scalable framework for securing autonomous IoT infrastructure against evolving cyber threats.

## **AGROECOLOGICAL SYSTEMS DESIGN TOWARDS PRECISION NUTRITION FARMING: AN APPROACH TOWARDS TRANSLATIONAL AGRO-HEALTHCARE**

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The work proposed here gives the Translation Agro Healthcare a novel approach towards integrating real-time agricultural data to personalized medicine through IoT, Data Science and AI. Here we propose a novel approach through a closed loop system to coil soil health parameters directly to clinical outcomes through which a food may become an alternative medicine, so that a healthy eco system can be maintained. The system presented here has IoT sensors which can give dynamic nutritional passports for approximately 47 farms. The machine learning model developed possesses 85 percent accuracy in predicting soil nutritional content. Significant improvement in health parameters HbA1c: 0.41 percent vs 0.18 percent,  $p=0.032$  has been observed through a 12-week clinical trial  $n=84$  in comparison to standard nutrition advice. The proposed work gives a new direction to healthcare saving by sustainable farming through a food as prescription in an economical model.

## **AI-INTEGRATED SMART WEARABLE BIOSENSOR FOR DOPING DETECTION AND HEALTH SURVEILLANCE**

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The AI-Integrated Smart Wearable Biosensor for Doping Detection and Health Surveillance represents a breakthrough innovation at the intersection of biotechnology, artificial intelligence, and sports science. This system leverages electrochemical biosensing, microfluidic sampling, and IoT connectivity to create a non-invasive, real-time monitoring platform capable of detecting doping-related biochemical markers in athletes while simultaneously tracking vital physiological parameters. Unlike conventional anti-doping methods that rely on invasive and infrequent blood or urine analyses, this wearable device continuously analyzes sweat or interstitial fluid to identify abnormal metabolic patterns indicative of performance-enhancing substance use. Embedded AI algorithms process the acquired data to differentiate between natural physiological variations and drug-induced anomalies, enabling adaptive learning for new and evolving doping agents. Encrypted IoT communication ensures secure transmission of sensitive biometric information to cloud-based analytics dashboards accessible to authorized sports authorities. By unifying continuous health monitoring with intelligent anti-doping detection, this system offers a proactive, athlete-friendly, and scalable solution that enhances fairness, transparency, and safety in competitive sports, setting a new paradigm for ethical athletic performance management.

## **A PREDICTIVE FRAMEWORK FOR BEHAVIORAL PATTERN ANALYSIS AND MEAL ANTICIPATION IN ORGANIZATIONAL CAFETERIA SYSTEMS**

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Institutional cafeterias are still trying to figure out the right line of food to satisfy their consumers in the ever, changing food consumption trend. Changes in a cafeteria’s customer flow are largely caused by the different behaviors of users, the academic calendar, seasonal preferences, and unexpected fluctuations, among others. Demand forecasting techniques based purely on past data average out the demand very poorly in such volatile, unforeseen scenarios. The present work focuses on the behavior, aware single forecasting system that mixes the prediction of an individual's meal preference with the machine learning, based demand estimation at the dish level. The system is loaded with 10, 000 transaction records that are amplified through temporal, behavioral, demographic, and contextual variables. Random Forest classifier is identified as the one that sets the highest overall accuracy of 91.8%, which is, therefore, a quite high level of confidence in the systems reliability for real, world cafeteria operations. Moreover, this research further identifies the critical edge cases such as cold, start users, event, induced anomalies, new menu launches, seasonality, and data corruption and at the same time suggests adaptive strategies including similarity, based inference, anomaly, aware modeling, seasonal encoding, and sliding, window retraining. Tremendous operational gains are reported in the aspects of less wastage, better procurement planning, happier users, and perfect integration in the smart campus ecosystem.

## **JUGULAR VEIN DETECTION FOR RELIABLE EMERGENCY RESPONSE**

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Establishing rapid and reliable venous access is a critical requirement in emergency medical care; however, high failure rates in intravenous cannulation persist due to poor vein visibility, patient variability, and time constraints. These challenges are particularly significant during External Jugular Vein (EJV) access in pre-hospital and ambulance environments, where delayed treatment can adversely affect patient outcomes. Although various vein visualization techniques using visible light, near-infrared (NIR), and thermal imaging have been reported in literature, existing solutions are often expensive, bulky, and not specifically optimized for jugular vein detection. This project presents the design and development of a low-cost, portable, and non-invasive jugular vein detection system based on dual-wavelength NIR imaging. The system utilizes 850 nm and 940 nm NIR illumination, selected based on established biological optical window studies and comparative wavelength analyses reported in prior research. An IR-sensitive CMOS camera with an optical IR-pass filter captures reflected NIR images, which are processed in real time using Python and OpenCV. Contrast enhancement is achieved using Contrast Limited Adaptive Histogram Equalization (CLAHE) to improve vein-to-tissue discrimination. The extracted vein pattern is projected directly onto the patient’s neck using a pico-projector, enabling intuitive and accurate vein localization.

## **INTELLIGENT MULTI-DISEASE PREDICTION FRAMEWORK USING HYBRID ENSEMBLE MODELING, SHAP EXPLAINABILITY, AND CLOUD-BASED DEPLOYMENT**

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The increased adoption of data-driven and digitally-enabled health-care practices has resulted in a surge of smart diagnostic systems capable of diagnosing and predicting disease earlier than ever before. In this study, we present a flexible machine learning solution to predict four significant chronic illnesses heart disease, diabetes, breast cancer, and liver disease using a hybrid ensemble structure comprising diverse machine learning techniques, including XGBoost, LightGBM, CatBoost, Random Forest, Logistic Regression, and a shallow neural network. Interpretability of our solution is based on a number of Explainable AI approaches, particularly those that are model-agnostic and provide a level of increased transparency to support clinical decision-making. The hybrid ensemble solution may enable real-time medical inference through a cloud-based solution, thereby keeping patient data safe. Experimental results indicate that the hybrid ensemble machine learning solution significantly outperforms traditional machine learning techniques and achieves a higher degree of accuracy in predicting breast cancer and heart disease.

## **HYBRID CNN-RNN FOR MULTI-SPEAKER SPEECH SEPARATION**

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Monaural speech separation is a challenging task due to overlapping speakers, background noise, and the absence of spatial information. Recent deep learning approaches using parallel CNN-RNN architectures effectively capture both local acoustic features and long-term temporal dependencies. In this work, an existing CNN-RNN based framework is enhanced using lightweight model optimizations and a post-separation noise reduction module. The proposed system improves efficiency, real-time usability, and perceived speech quality while maintaining strong separation performance on the Libri2Mix dataset.

## **FROM DATA FUSION TO POLICY OPTIMIZATION: REINFORCEMENT LEARNING APPROACHES FOR CLIMATE-SMART IRRIGATION**

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In the agricultural field, to address the issues of water limitation and environmental climatic variability, adaptive ways of irrigation that exceed static thresholds and standard machine learning approaches are necessary. In this article, a fusion-driven reinforcement learning framework for drip farming and rice Alternate Wetting and Drying (AWD) precision irrigation is suggested. Through combining multi-source data from IoT soil sensors, images from satellites (Sentinel-1 SAR, Sentinel-2 optical, Landsat thermal, SMAP), and weather forecasts using Kalman filter-based fusion, the data from soil and crop can be obtained. A Proximal Policy Optimisation (PPO) reinforcement learning algorithm that utilises these fused states as data to learn an irrigation process that reduces water use, lowers the price of energy, and preserves produce from agriculture, all while keeping to safety requirements. A decision support system (DSS) that suggests system outputs to farmers to make decisions with accurate and confident steps, which in turn promotes transparency and adoption. As proven for various irrigation methods, this technique gives accuracy with noisy data and missing modules. By highlighting the aspects of fusion and RL, it offers scalable and suitable irrigation solutions. This study extends the issue of climate-smart agriculture and global food security.

## **AN EDGE-OPTIMIZED EXPLAINABLE VISUAL ASSISTANCE FRAMEWORK FOR LOW-POWER EMBEDDED DEVICES**

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On low-power embedded platforms, visual assistance systems must function in real-time while maintaining accessibility and energy efficiency. However, deploying deep learning models on CPU-only devices often results in interpretability restrictions and latency. This paper introduces Ex-Vision, an edge-optimized, fully offline visual aid framework for the Raspberry Pi 4 Model B. The system uses a lightweight on-device face recognition pipeline along with a quantized YOLOv8-Nano detector that is accelerated utilizing the NCNN inference engine for real-time object detection. Ex-Vision uses an asynchronous capture-now, explain-later approach to generate LIME-based explanations outside of the primary perception loop, maintaining responsiveness while promoting transparency. Immediate proximity alerts for safety-critical obstacles are given by a high-priority ultrasonic watchdog. The experimental results demonstrate feasibility for wearable and handheld assistive devices by showing a constant throughput of up to 25.7 FPS with minimal power consumption and solid post-hoc interpretability.

## **CHROMATIC REBORN: DEEP LEARNING–DRIVEN RESTORATION OF VINTAGE PHOTOGRAPHS**

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The transformation of grayscale imagery into perceptually realistic color photographs has evolved from manual-assisted editing into a fully automated learning problem. Deep learning has greatly accelerated this shift by enabling neural networks to model contextual cues, object semantics, and global scene composition. This paper presents a comprehensive survey of automated image colorization approaches, focusing on convolutional neural networks (CNNs), generative adversarial networks (GANs), hybrid attention-driven techniques, and recent transformer and diffusion-based models. It reviews key datasets, training methodologies, evaluation metrics, and practical application domains while highlighting persistent challenges such as ambiguity, dataset bias, hallucinated colors, and limited controllability. The goal is to provide a consolidated reference for researchers and practitioners aiming to understand the evolution, current trends, and future directions of learning-based image colorization.

**Keywords:** Image Colorization, Deep Learning, GAN, CNN, Transformers, Computer Vision.

## **ADVERSARIAL IMAGE COLORIZATION: A GAN-BASED APPROACH FOR CONVERTING GRAYSCALE IMAGES TO VIVID COLOR**

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Converting black and white images to color is a challenging task in computer vision. Generative Adversarial Networks (GANs) have revolutionized image synthesis, offering promising ways to generate realistic colored images from grayscale. This project focuses on a novel GAN-based approach for black and white to color image conversion. The method trains a generator network with adversarial learning to produce vibrant and plausible colors. Extensive experimentation and evaluation on diverse datasets verify the effectiveness of the colorization process. Results demonstrate the potential of the proposed approach, producing coherent and vibrant colored images that capture the original grayscale semantics. This advancement in image colorization has applications in historical image restoration, film colorization, and artistic transformations, showcasing GANs power in pushing the boundaries of computer vision and image processing

**Keywords:** (GANs), Image colorization, Grayscale to Color conversion, Historical photo Restoration, Colorization, Contextual image Processing.

## **AI-DRIVEN MULTI-HAZARD PREDICTION AND DECISION SUPPORT SYSTEM FOR FLOOD AND FIRE DISASTER MANAGEMENT**

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The growing frequency of forest fires and floods calls for sophisticated systems with precise forecasting and effective disaster response capabilities. An AI-driven disaster prediction and decision support system with an emphasis on managing forest fires and floods is proposed in this work. In order to predict disaster risks early on, the framework incorporates machine learning models that evaluate historical and current environmental data, such as rainfall, water levels, temperature, humidity, and vegetation indicators. When the system detects possible threats, it immediately sends out alerts and uses geospatial evacuation routing to provide decision assistance, directing impacted people to safe shelters in the vicinity. To facilitate coordinated catastrophe response among regular users, government officials, and non-governmental organisations (NGOs), a role-based web framework is created. While NGOs manage relief efforts and provide reaction status updates, regular users receive warnings, evacuation instructions, and support requests. Through a centralised interface, government representatives oversee resource allocation, disseminate alarms, and keep an eye on crisis circumstances. The suggested method increases situational awareness, decreases response times, and improves overall catastrophe resilience for flood and forest fire scenarios by fusing AI-based prediction with real-time evacuation planning and multi-stakeholder coordination.

## **INAUDIBLE AUDIO WATERMARKING BASED ANTI-PIRACY SYSTEM FOR OTT AND STREAMING PLATFORMS**

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The rapid growth of OTT and streaming platforms has significantly increased the problem of digital content piracy, resulting in major revenue losses for content creators and distributors. Traditional protection techniques such as visible logos or audible watermarks degrade user experience and can often be removed through simple post-processing techniques. This project presents an inaudible audio watermarking-based anti-piracy system designed specifically for OTT and streaming platforms. The proposed system embeds a unique, user-specific watermark into the audio stream using a Direct Sequence Spread Spectrum (DSSS) technique, ensuring imperceptibility to listeners while maintaining robustness against compression, re-encoding, streaming, and screen recording. The embedded watermark enables reliable tracing of pirated content back to the original user, thereby acting as both a deterrent and an investigative tool for content piracy.

## **AN IOT-ENABLED MACHINE LEARNING FRAMEWORK FOR REAL-TIME ROAD DEFECT DETECTION**

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The rapid deterioration of road infrastructure poses significant challenges to public safety, vehicle maintenance, and urban mobility. Traditional manual inspection methods are labor-intensive, subjective, and unsuitable for large-scale or continuous monitoring. Recent advances in the Internet of Things (IoT) and machine learning, particularly deep learning, have enabled automated and real-time road defect detection systems deployed on edge devices. This paper presents a comprehensive review of state-of-the-art IoT-enabled machine learning frameworks for real-time road condition monitoring. We analyze diverse sensing modalities, including RGB cameras, inertial and depth sensors, and multi-sensor fusion strategies. Key deep learning architectures such as YOLO-based object detectors, crack segmentation networks, and emerging transformer-based models are discussed. Prominent public datasets and annotation standards used for benchmarking road defect detection are reviewed. Furthermore, we examine practical edge and IoT deployments using platforms such as Raspberry Pi and NVIDIA Jetson, highlighting data communication protocols and model optimization techniques including quantization and hardware acceleration. Comparative performance metrics such as accuracy, latency, and throughput on embedded systems are summarized. Finally, open challenges related to data scarcity, sensor noise, synchronization, and scalability for smart-city applications are identified. This work aims to present a unified technical overview of sensing, learning, and deployment strategies for automated road condition monitoring.

## **A GENAI-DRIVEN FAULT DETECTION AND AUTOMATED CLEANING FRAMEWORK FOR SCALABLE SOLAR PANEL MAINTENANCE**

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This work proposes a Generative AI (GenAI)-based fault detection and resolution system integrated with an automated, water-efficient solar panel cleaning robot for large-scale solar farms. It utilizes real-time sensor and image data—collected via drones and robot-mounted cameras—to monitor, diagnose, and maintain PV performance with minimal human intervention. The system architecture consists of five layers: data, communication, processing, application, and action. A luminance-aware normalization mechanism corrects lighting variations for accurate image-based fault detection of defects like micro-cracks, hotspots, and soiling. A fail-safe validation cross-verifies environmental data with weather APIs to ensure reliable operation. The cleaning robot’s adaptive design fits various panel configurations while optimizing water use. Experimental results on a Raspberry Pi prototype demonstrate high fault detection accuracy, predictive reliability, and scalable, sustainable performance.

## **A SMART IOT-BASED KNEE JOINT MONITORING AND ANALYTICS SYSTEM FOR CONTINUOUS REHABILITATION AND INJURY PREVENTION**

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Monitoring knee joint movement plays an important role in recovery after surgery, injury prevention in sports, and rehabilitation therapy. However, existing methods mainly rely on periodic clinical checkups, which do not allow continuous observation or immediate feedback. To address this limitation, this work introduces a smart knee monitoring and analytics system built using an ESP32 microcontroller integrated with multiple sensors. The system continuously measures key biomechanical parameters such as knee bending angle, muscle activity, leg movement, and applied force. The collected data are transmitted wirelessly to a cloud platform using Firebase Realtime Database, enabling real-time visualization, alerts, and long-term analysis through a web-based dashboard. Instant alerts are generated when any parameter exceeds predefined safe limits, supporting timely intervention. In addition, the stored historical data assist clinicians in evaluating patient progress over time. The proposed system is cost-effective, non-invasive, scalable, and remotely accessible, making it suitable for continuous knee health monitoring and data-driven medical decision-making.

## **DESIGN AND SIMULATION OF MEMRISTOR-BASED ANALOG CIRCUIT FOR LOW-POWER EDGE APPLICATION**

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The necessities of the current better performance of energy-efficient neuromorphic and analog computing further boosted the renewed interest in the development of the memristive device on the natural link between the computation and memory capabilities. Yet the unavailability constraints of the aforementioned devices call for the development of a CMOS-compatible circuit solution. The next section covers the discussion on the circuit for analog computing using the memristor device and the SC circuit alternative. It explains the impact of the step input signal upon the state, bias, and output nodes of the circuit of the memristive device. It was also noted that the switched capacitor circuit alternative is correct with regard to the steady-state performance of a memristor circuit, and the smooth process occurs without the clock cycle operation. It reveals the intrinsic application of memristors to enable a technology for memory and a technology for neuromorphic computing that is an analog process. In this paper, it was further explained with more precision the effective application of the Switched-Capacitor based circuits to emulate the memristor behavior. The benefit to this approach was already reiterated to have better size and reduced switching cycles for the neuromorphic model.

**Keywords:** Memristor, Neuromorphic Computing, Analog Computation, Switched-Capacitor Circuits, CMOS-Compatible Design, Energy-Efficient Circuits

## **PORTABLE LUMBER GRADING SYSTEM BASED ON ACOUSTIC TOMOGRAPHY AND VISION ANALYSIS**

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Quality grading has become the core part of the construction and timber business as lumber defects determine the structural integrity almost directly and the market derived commercial value. Manual inspection is subjective while X-ray/laser systems are expensive and non-portable. This paper will offer a proposal of a low-cost portable lumber grading system that integrates both internal faults by acoustic sensing and external faults by a camera-based fault imaging system. Surface inspection depends on smartphone cameras, internal responses are measured using piezoelectric sensors and the detection of voids, internal cracks, and decay, and external defects, such as knots and surface cracks, is also detected by means of digital image processing. Integrating the two modalities would allow objective grading in a non-destructive manner that can be applied in small and medium sawmills.

**Keywords:** Portable lumber grading, Acoustic tomography, Internal defect detection, Piezoelectric sensors, Solenoid excitation, Image processing, Surface defect detection, Smartphone-based inspection, Non-destructive testing (NDT).

## **EDGE-BASED NON-INTRUSIVE LOAD MONITORING USING ESP32 FOR RESIDENTIAL ENERGY DISAGGREGATION**

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Modern energy grids require fine-grained insights into household electricity consumption to enable efficiency optimization, demand response, and user awareness. Conventional smart meters provide only aggregate energy usage, while appliance level monitoring typically requires intrusive and costly sensor deployment. This paper presents a low-cost Edge-based Non-Intrusive Load Monitoring (NILM) system that performs appliance identification using a single sensing node installed at the household distribution point. The proposed hardware integrates an ESP32 microcontroller with an SCT-013 current transformer and a ZMPT101B voltage sensor to capture high-resolution electrical signatures. Instead of cloud-centric machine learning, a lightweight heuristic algorithm is implemented locally to classify appliances based on transient inrush characteristics—specifically peak magnitude and decay duration—combined with steady-state harmonic features. Feature extraction and harmonic analysis are executed at the edge, reducing latency, preserving data privacy, and minimizing bandwidth requirements. Experimental results demonstrate reliable differentiation between common inductive and resistive household appliances, validating the feasibility of a scalable and low-cost framework for autonomous home energy management.

## **IOT-DRIVEN RFID SMART PARKING WITH REAL-TIME MONITORING AND SECURE ACCESS**

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In our smart parking system using RFID, QR codes, sensors, and mobile applications that will provide an automated and efficient parking experience. The RFID sensors scan the vehicle at entry and issue a token with a QR code. The barriers lock the car in a specific slot. Through the mobile application, users are able to track parking details, pay fees, and process exits. The common entrance machine can also be used for payment, although camera-based QR code scanning is only allowed for premium users. For luxury cars, premium slots feature extra perks such as access to camera-based scanning and better security for high-end vehicles. Sensors track the car location, fuel level, as well as the physical movement entering and leaving the slot with real-time monitoring and added security. The system has been reduced to human intervention, high-speed processing, and promotion of cashless transactions that it offers a secure, efficient, and user-friendly experience both from standard and premium users but with increased transparency and reliability. Additional features include integration with smart city infrastructure, enhancing overall urban mobility.

## **BLOCKCHAIN-ENABLED MULTI-LAYERED PRODUCT AUTHENTICATION AGAINST COUNTERFEIT PRODUCTS**

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A multi-layered, strong verification system is required to protect international supply chains due to the spread of counterfeit goods. This study offers an Intelligent Multi-Layered Authentication Framework that combines Deep Learning-driven physical verification with Blockchain-enabled immutability. The solution employs a three-tier defense an NFC-integrated hardware layer guarantees physical unclonability a Blockchain-linked QR code offers a decentralized digital log for end-to-end traceability. Lastly, the Convolutional Neural Network CNN inference engine uses granular picture analysis to find minute irregularities in packaging textures, typography, and branding. The system overcomes the drawbacks of independent digital tags that are vulnerable to cloning by bridging the gap between digital ledger integrity and physical product aesthetics. The incorporation of AI-driven feature extraction makes proactive detection of complex forgeries that elude conventional scanning techniques possible. By offering a truthful cross-verification of a product's digital and physical identities, this multi-modal method greatly improves brand protection and consumer trust. Additionally, the decentralized architecture makes it easier for suppliers, manufacturers, and retailers to work together seamlessly along the supply chain and keep an unchangeable record of product movement. In the end, this comprehensive solution creates a scalable, intelligent benchmark for the upcoming generation of anti-counterfeit technologies while simultaneously reducing the multi-trillion dollar impact of product counterfeiting.

## **A SURVEY ON CHANGE DETECTION TECHNIQUES FOR LEO OBSERVATION SATELLITE IMAGES**

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Change detection using satellite imagery plays a vital role in monitoring structural transformations such as urban expansion, infrastructure development, agricultural modification, and disaster-induced damage assessment. With the increasing availability of high-resolution images from Low Earth Orbit (LEO) observation satellites, automated and accurate detection of surface changes has become a significant research area in remote sensing. This survey presents a comprehensive review of the existing methods applied to satellite remote sensing images, with particular emphasis on structural change detection techniques. Various classical, machine learning, and deep learning-based approaches are analyzed and compared in terms of their accuracy, computational efficiency, and applicability to different terrains and environmental conditions. The paper aims to highlight the advantages, limitations, and future research directions for achieving more robust and adaptive change detection frameworks in LEO satellite imagery analysis.

## **REAL-TIME ECG SIGNAL NOISE REDUCTION USING DIGITAL SIGNAL PROCESSING TECHNIQUES**

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Electrocardiogram ECG signals are highly sensitive to various noise sources such as power line interference, baseline wander, and muscle artifacts, which can affect accurate cardiac analysis. Although modern clinical systems incorporate filtering mechanisms, noise reduction remains a critical requirement in low-cost, portable, and real-time ECG monitoring applications. This work presents the design and implementation of a real-time ECG signal noise reduction system using digital signal processing techniques. An ECG sensor is used to acquire raw cardiac signals, which are then processed using digital filters to suppress unwanted noise components. Low-pass, high-pass, and notch filters are designed and applied to remove high-frequency noise, baseline drift, and power line interference respectively. The performance of the proposed system is evaluated through time-domain and frequency-domain analysis, demonstrating significant improvement in signal quality after filtering. The results indicate that digital filtering provides an effective and flexible solution for enhancing ECG signals in sensor-based monitoring systems. This approach is suitable for biomedical applications such as wearable health devices and remote patient monitoring.

## **NOVEL MACHINE LEARNING FRAMEWORK FOR REAL-TIME DRUG INTERACTION PREDICTION AND RISK ASSESSMENT IN A WEB-BASED INTERFACE**

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We present a web-based medical assistant that combines contemporary AI and machine learning to provide timely support for clinicians, patients, and healthcare systems. Users can upload prescriptions and personal health information the backend evaluates these inputs to flag probable drug interactions, suggest safer dosages, and recommend relevant specialists based on an individual profile. Concurrently, deep learning models such as CNN, ResNet, and U-Net automate interpretation of medical images X-rays, MRIs, CTs to identify abnormalities like tumors and lesions. By incorporating genetic markers and family history, the platform estimates disease risk, enabling earlier detection and more tailored treatment planning. The design prioritizes data protection, clear visual summaries, and near real-time feedback, aiming to bridge advanced technology with preventive, precision medicine.

## **CAREER GUIDANCE SYSTEM**

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The increasing gap between academic learning and industry requirements has made career planning challenging for engineering students. Existing platforms provide fragmented solutions for job search, learning, and resume building without personalized guidance or feedback. This project presents an AI-Powered Career Guidance System, a unified web-based platform designed to support students throughout their career development journey. The system integrates personalized career roadmaps, skill assessments, AI-based resume analysis with ATS optimization, mock interviews, and job application tracking. Built using modern full-stack technologies and Large Language Models, the platform delivers real-time, personalized feedback and learning recommendations tailored to the Indian job market. By centralizing career guidance, skill development, and recruitment support, the proposed system enhances employability and assists students in making informed career decisions.

## **AN EFFICIENT INTRUSION DETECTION MODEL FOR SMART HOME IOT USING MACHINE LEARNING**

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In this paper, we present a lightweight machine learning platform for anomaly detection in Smart Home IoT scenarios. It takes advantage of efficient-optimized ML algorithms transforming the detection performance versus computation load tradeoff. Utilizing well-known datasets and smart home traffic real-time, the model is trained to learn various types of network abuse with very small amounts of trained data. Due to feature selection and algorithm tuning this overhead is kept low and the system becomes feasible for low power IoT nodes. The on-device testing is more efficient and has fewer false positives than traditional IDS methods. The proposed model supports online processing and can be used to protect different IoTs in smart home.

## **A SUPPORT VECTOR REGRESSION FRAMEWORK FOR QUANTIFYING THE LLM EFFICIENCY DRAG COEFFICIENT**

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The rapid proliferation of Large Language Models L.L.M. across digital services has led to considerable increases in operational costs, time delays, and energy consumption. These effects are not limited to individual systems but are part of the broader sustainability impact on the global Internet. In this paper we present the L.L.M. Efficiency Drag Coefficient, a novel, dimensionless metric to quantify the excess energy, carbon footprint, time delay and financial overhead generated by L.L.M. based workloads. We develop a Support Vector Regression S.V.R. based framework to model from the post 2024 multi-regional L.L.M. workload data. Our S.V.R. model is able to capture the non-linear dependencies among workload intensity, carbon footprint of regional power grids, model size and monetary expenditures. We show that our model demonstrates strong predictive accuracy and robustness and that our models have a relatively low computational cost and therefore can be used for sustainability analysis without generating any additional environmental load. We find strong evidence that there exist geographic variations in where regions with clean energy sources exhibit lower efficiency drag than those dependent on fossil fuel generation. Our research presents the first systematic, system level method to measure the way in which L.L.M. usage affects the efficiency of energy use at an Internet-wide scale. Our results provide engineers, researchers, and policy makers with design options and strategies to build more environmentally friendly A.I. infrastructures and mitigate the long-term sustainability burdens associated with large scale deployments of L.L.M.s.

## **NOVEL SPACY-BASED NAME ENTITY RECOGNITION FOR STRUCTURED MEDICAL DOCUMENTATION**

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All over the world in healthcare, we see a tremendous increase in how much clinical data is being created on a daily basis due to the rapid move to Electronic Medical Records EMRs and digitalizing diagnostic workflows. Despite this change towards using more digital tools, many doctors also have to manually enter information into their EMR systems. This leads to problems like higher costs for healthcare systems, increased time spent on documentation and lack of accuracy due to typo errors. A new approach to this challenge is being addressed through the use of OCR Optical Character Recognition technology for text extraction and NER Named Entity Recognition through Natural Language Processing. The approach proposed through this study will enable physicians to extract text from images-based medical records using the Pytesseract OCR engine, extract, structure, and identify clinically significant entities using a customized NER model built using the spaCy machine learning library these entities include Doctor ID, Date of Birth, Disease Code ICD, Department, Referral Information, Gender, and demographic information of patients. The proposed framework is designed to work in all the different patients specialties from the major hospitals in India. Examples of some of these specialties would be Cardiology, Gynecology, Oncology, and Pediatrics. Clinical document experimental evaluation provides substantial performance improvements over existing systems in terms of entity extraction and reduced manual effort on behalf of clinicians. Further, as a result of increased documentation consistency and improved access to the documentation, the proposed approach is a cost-effective and deployable solution for large-scale healthcare systems, addressing a major gap in the current medical documentation process.

## **AI FOR PERSONALIZED AND PREDICTIVE LEARNING**

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Traditional healthcare systems are mainly reactive and often fail to provide early disease detection and personalized treatment. With the rapid growth of healthcare data, Artificial Intelligence AI has emerged as an effective tool for enabling personalized and predictive healthcare. This work proposes an AI-based framework that utilizes machine learning models to predict disease risk using patient health parameters. Random Forest and Support Vector Machine SVM models are employed for disease prediction, while Logistic Regression is used as the existing system for comparison. The models are evaluated using standard performance metrics. Experimental results show that the proposed approach achieves improved accuracy and better personalization compared to traditional methods. The study demonstrates the potential of AI in supporting proactive, preventive, and patient-centric healthcare.

## **DESIGN OF HIGH SPEED AND AREA EFFICIENT VEDIC MULTIPLIER ARCHITECTURES USING FINFET TECHNOLOGY**

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In this research, a high-speed area-efficient Vedic multiplier design using Fin Field Effect Transistor technology is proposed. The multiplier is a basic digital block in modern digital electronics, and its speed/area efficiency significantly affects overall digital system performance in terms of speed and power consumption. The Vedic mathematics-based multipliers offer desirable advantages over other types of multipliers in terms of high-speed throughput due to its parallel calculation capability, which results in faster partial product calculation compared to other multiplication methods. In designing the proposed high-speed Vedic multiplier, the principles for speed-efficient Vedic multiplication using the Urdhva Tiryagbhyam sutra in Vedic mathematics are used. In addition, a hybrid approach in designing the addition operation in the multiplier is proposed to optimize speed/area efficiency in the design. The proposed high-speed multiplier is designed using advanced Fin Field Effect Transistor based standard cells for better electrostatic control, lower leakage current, and faster switching speed than in existing planar transistor technology. The results show that integrating principles from Vedic arithmetic and Fin FET Technology is an effective way to design an arithmetic circuit of high performance for future digital systems.

## **DESIGN OF PATCH ANTENNA FOR IOT APPLICATIONS**

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In recent years, the demand for compact, low-cost, and efficient antennas for IoT applications have driven research into innovative antenna designs and substrate materials. This project focuses on the design and simulation of patch antennas operating at 2.5 GHz, specifically optimized for IoT applications. Single-element, 2x1, and 4x1 patch antenna arrays were designed using CST Microwave Studio, utilizing both FR-4 and paper-based dielectric substrates. The study investigates how substrate material affects antenna performance metrics such as return loss S11, bandwidth, and gain. Paper, being a flexible and eco-friendly dielectric material with a relative permittivity of 2.31, is compared against the widely used FR-4 substrate  $\epsilon_r$  4.3. Each antenna design is analyzed and optimized for resonance at 2.5 GHz, and simulated results are evaluated to identify performance trade-offs between the two substrates. The return loss, radiation pattern, and impedance matching are evaluated for all three antenna configurations. The results demonstrate that paper-based substrates offer potential for low-cost and sustainable antenna design in future IoT systems.

## **INTELLIGENT INVISIBLE GUARDING SYSTEM FOR DETECTING ACCIDENT IN HIGHWAY AND CITY**

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Road accidents on highways often result in severe casualties due to delayed detection and slow emergency response. To address this issue, this paper presents an Intelligent Invisible Guarding System IIGS for highway accident detection using an STM32 microcontroller and LoRa communication protocol, designed as a black-box-like embedded unit installed inside vehicles. The proposed system continuously monitors vehicle parameters such as before 30 sec speed status, sudden impact, vibration, tilt angle, rapid deceleration, and airbag trigger status using integrated sensors including an accelerometer, gyroscope, and vibration sensor. Upon detecting an abnormal event that indicates a possible accident, the STM32 processes the sensor data in real time and triggers an emergency alert. Using LoRa long-range, low-power wireless communication, the accident data along with vehicle ID, location coordinates, and severity level is transmitted to nearby roadside LoRa gateways or highway control centers within a range of up to 25 km, even in remote or low-network areas. The system operates invisibly without driver interaction and consumes minimal power, ensuring reliability during critical situations. This intelligent guarding system significantly reduces accident response time by enabling automatic accident detection and instant communication, making it highly suitable for smart highway infrastructure in India. The proposed solution enhances road safety, supports emergency services, and can be integrated with intelligent transportation systems for future smart city applications.

## **DETECTION OF HEART ABNORMALITIES USING HEART SOUND**

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The heart functions continuously to maintain blood circulation, and even small disturbances in its activity can lead to serious health issues if not recognized early. Variations in valve motion and blood flow often produce subtle changes in the acoustic profile of heart sounds, making phonocardiogram PCG analysis a useful approach for early screening. This project presents a compact, low-cost system that records and analyses heart sounds in real time. A chest-piece microphone captures the sound signal, which is amplified, filtered, and digitized using an ESP32 microcontroller. Fast Fourier Transform FFT is applied to identify frequency patterns linked to normal function as well as abnormalities such as mitral stenosis, aortic stenosis, hypertension, and hypotension. Normal S1 and S2 components typically fall within 20-150 Hz, while pathological conditions exhibit distinct spectral shifts. The system displays the processed waveform and frequency spectrum on a laptop interface, offering an accessible and affordable solution for preliminary cardiac evaluation.

## **A UNIFIED PHYSICS-INFORMED AND EXPLAINABLE MACHINE LEARNING FRAMEWORK FOR CROSS-ARCHITECTURE SEMICONDUCTOR DEVICE VARIABILITY ANALYSIS**

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The shift to sophisticated semiconductor device topologies at sub-5 nm nodes has exacerbated the influence of process variables on device performance. Traditional Technology Computer-Aided Design TCAD statistical simulations, although precise, are computationally excessive for extensive variability analysis. Current machine learning ML surrogates provide rapid performance but are plagued by physical instability, lack of transparency, and inadequate data efficiency. This research introduces an innovative Physics-Informed Machine Learning PIML architecture that integrates fundamental semiconductor equations directly into neural network training, thereby guaranteeing physically realistic predictions. The framework incorporates explainable AI XAI methodologies to assess sources of variability and utilizes an active learning approach to reduce TCAD simulation expenses by 60-70 percent. The model, executed via a MATLAB-TCAD co-simulation workflow, exhibits cross-architecture generalization across FDSOI, FinFET, and GAA device architectures. Validation demonstrates that the PIML framework attains less than 2 percent RMSE in comparison to TCAD, concurrently decreasing physical constraint violations by an order of magnitude. This study offers a systematic, interpretable, and data-efficient approach for analyzing variability in next-generation semiconductor technology.

## **DESIGN OF AN FPGA BASED EYE CARE BLINK MONITOR USING MOORE FSM**

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We are in the era digital revolution and by directly or indirectly we are happened to consume screen time. The main concern is that the screen time exceeds several hours and in terms of professional life sure we should be available in front of the screen for more than 12 hours, due this there are several problems are arising to our eye. The major problems are Dry Eye Disease, Myopia, Eye muscle fatigue, headaches, and people are also getting sleep cycle disturbance melatonin suppression. The cure to this constant blinking of our eyes atleast 25 mins once and getting outdoor exposure. To remind us of blinking the eyes for repeated time we are proposing a eye blink monitor which will constantly remind us to blink after the limit we set, this will be achieved by integrating FSM with eye blink monitor for health care of the professionals.

## **SYMPTOM-DRIVEN EARLY DETECTION OF EMPHYSEMA EMPLOYING DEEP LEARNING TECHNIQUES**

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Emphysema is a chronic and progressive pulmonary disorder characterized by irreversible destruction of alveolar structures, leading to impaired respiratory function and reduced quality of life. Early detection of emphysema is challenging because initial symptoms are often mild, nonspecific, and easily overlooked in routine clinical practice. Timely diagnosis, however, is crucial for initiating preventive interventions, slowing disease progression, and reducing morbidity and healthcare costs. This study presents a deep learning-based framework for the early detection of emphysema using symptom-level data, aiming to support clinicians in identifying high-risk individuals before the disease reaches advanced stages. The proposed approach utilizes a symptom-driven dataset comprising clinical indicators such as chronic cough, shortness of breath, wheezing, chest tightness, fatigue, smoking history, and demographic factors. After preprocessing steps including data normalization, missing-value handling, and feature encoding, the dataset is used to train a deep neural network (DNN). The model architecture consists of multiple hidden layers with nonlinear activation functions, enabling it to capture complex relationships between symptoms and underlying disease patterns. To enhance robustness and reduce over fitting, techniques such as dropout regularization and early stopping are applied during training. Model performance is evaluated using standard metrics including accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC). Experimental results demonstrate that the deep learning model outperforms traditional machine learning classifiers in predicting early-stage emphysema, achieving high sensitivity and specificity. The findings indicate that symptom-based deep learning models can effectively identify subtle patterns that may not be apparent through conventional diagnostic methods. This study highlights the potential of deep learning algorithms as cost-effective, noninvasive decision-support tools for early emphysema detection. Integrating such models into primary healthcare and telemedicine systems could facilitate early screening, personalized risk assessment, and improved clinical outcomes.

## **CNN MODEL WITH FPGA FOR EYE DISORDERS PREDICTION**

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Health disorders increases day by day throughout the world. Liver cancer, skin disorder, kidney diseases, heart diseases and eye disorders are the most dangerous diseases on human health being. Early monitoring of these diseases can save human health. Proposed research uses deep learning models such as convolutional neural network CNN on Field programmable Gate Array FPGA for ocular diseases such as eye disorders prediction. CNN model shows highly accurate than machine learning algorithms. This research creates awareness on human eye disorders such as cataract, myopia and other diabetic eye diseases.

## **IMPLEMENTATION OF AN IOT-ENABLED SMART GAS STOVE SYSTEM FOR REAL-TIME LPG MONITORING AND HAZARD PREVENTION**

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This project proposes the development and implementation of an enhanced Smart Gas Stove system for domestic LPG cylinders in India, addressing issues like unexpected gas shortages and fire hazards. The system employs advanced sensors to monitor gas levels in real-time, offering accurate consumption data and timely refill alerts via a smart interface. In addition to tracking usage, the system includes temperature monitoring and gas leakage detection to ensure household safety. A major innovation in this project is the introduction of a thermal-insulating jacket made from silicone-coated fiberglass fabric, which wraps around the LPG cylinder to minimize heat absorption from external sources, thereby reducing the risk of pressure-induced explosions in high-temperature environments. Another key feature is the automatic release of CO<sub>2</sub> gas upon gas leak detection. This displaces oxygen in the surrounding air, significantly lowering the risk of ignition from electric sparks or static discharges. The system also integrates automatic safety responses, such as buzzers and extinguishing mechanisms, to prevent fire outbreaks. These combined features make the solution not only convenient and smart but also robustly safe, sustainable, and ideal for widespread household adoption in India's growing urban landscape.

## **RESPONSE BASED LIVENESS AUTHENTICATION USING RANDOMIZED MICRO-PATTERNS AND CORNEAL REFLECTION LATENCY ANALYSIS**

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Traditional biometric authentication systems are vulnerable to spoofing attacks using static images, recorded videos, or high-quality display replays. To address these limitations, this paper presents a response-based liveness authentication system that verifies user presence through randomized visual micro-patterns and involuntary ocular response latency analysis. The proposed method introduces brief, unpredictable micro-stimuli on the display and measures the time-delay between stimulus onset and the first statistically significant eye-region motion, captured using a standard RGB camera. Unlike existing blink-based or texture-based liveness detection techniques, the system computes latency using a dynamically learned post-stimulus noise baseline, enabling robust detection even on low-resolution consumer webcams. The framework integrates voluntary blink verification with involuntary eye-response latency to enhance resistance against replay and deepfake attacks. Experimental evaluations show that genuine users exhibit consistent latency responses within a physiological range, while spoofed inputs fail to produce valid response patterns. The proposed approach is fully software-based, hardware-independent, and suitable for real-time deployment in mobile and desktop authentication systems, offering a secure and cost-effective solution for next-generation biometric liveness verification.

## **SMART COMMUNITY HEALTH SURVEILLANCE AND EARLY WARNING FRAMEWORK FOR WATER-BORNE DISEASES USING CONTINUOUS WATER INTEGRITY MONITORING**

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This paper proposes an integrated smart system for continuous water quality monitoring and community health protection by merging real-time environmental sensing with predictive analytics. The solution combines sensor-based water quality analysis, visual monitoring for illegal effluent discharge, and secure data logging to ensure end-to-end water integrity from industrial outlets to public usage points. By analyzing water parameters alongside health data trends, the system provides early warnings for potential water-borne disease outbreaks. Tamper-proof evidence generation and automated alerts strengthen regulatory enforcement and accountability. Designed for local deployment without cloud dependency, the system is cost-effective, scalable, and suitable for rural, semi-urban, and industrial environments, enabling proactive pollution control and public health safeguarding.

## **AUTOMATIC IGNITION CONTROL SYSTEM FOR DRUNKEN DRIVERS USING ESP32 AND MQ3 SENSOR**

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In this research, a high-speed area-efficient Vedic multiplier design using Fin Field Effect Transistor technology is proposed. The multiplier is a basic digital block in modern digital electronics, and its speed/area efficiency significantly affects overall digital system performance in terms of speed and power consumption. The Vedic mathematics-based multipliers offer desirable advantages over other types of multipliers in terms of high-speed throughput due to its parallel calculation capability, which results in faster partial product calculation compared to other multiplication methods. In designing the proposed high-speed Vedic multiplier, the principles for speed-efficient Vedic multiplication using the Urdhva Tiryagbhyam sutra in Vedic mathematics are used. In addition, a hybrid approach in designing the addition operation in the multiplier is proposed to optimize speed/area efficiency in the design. The proposed high-speed multiplier is designed using advanced Fin Field Effect Transistor based standard cells for better electrostatic control, lower leakage current, and faster switching speed than in existing planar transistor technology. The results show that integrating principles from Vedic arithmetic and Fin FET Technology is an effective way to design an arithmetic circuit of high performance for future digital systems.

## **SMART METERING INFRASTRUCTURE FOR EFFICIENT ENERGY USAGE**

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In the era of Digital Health, the reliability of electrical infrastructure is paramount for patient safety, particularly for energy-dependent life-support systems in hospitals and home-care settings. This paper presents an AI-driven IoT Smart Metering System designed to ensure uninterrupted power quality for critical medical assets. Unlike traditional metering solutions, this system integrates predictive anomaly detection using Machine Learning (Random Forest Algorithm) to forecast power instabilities before they disrupt sensitive medical equipment. The hardware architecture utilizes an ESP32 microcontroller with high-precision sensors to monitor voltage, current, and total harmonic distortion (THD). Key features include automatic priority load shedding which isolates non-essential hospital loads during grid instability to preserve backup power for ventilators and ICUs and bidirectional monitoring for hospital microgrids. Experimental results demonstrate a 98.2% accuracy in predicting voltage sag events and a latency of under 200ms for emergency load isolation. This research bridges the gap between Energy Systems and Biomedical Engineering, proposing a scalable solution for the "Smart Hospital" ecosystem.

## **NOVA: NEXT-GEN OFFLINE VOICE AUTOMATION**

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The NOVA (Next-Gen Offline Voice Automation) framework represents a fundamental shift in access control, moving away from high-latency cloud dependencies and limited embedded systems toward a robust "Heavy Edge" architecture. By utilizing powerful local processors like the Raspberry Pi, the system can execute high-fidelity audio processing and semantic reasoning entirely offline, ensuring user privacy and operational continuity. At its core, NOVA integrates the SpeechBrain toolkit to perform advanced Speaker Diarization and verification using the ECAPA-TDNN model. This allows the system to accurately identify authorized users even in noisy, multi-user environments, effectively creating a biometric "gatekeeping" layer. The system employs Quantized Finetuned Large Language Models (LLMs) to handle intent classification. By reducing model precision to 4-bit, NOVA enables complex, "desktop-class" semantic understanding on edge hardware, allowing the system to interpret natural language commands such as "It's a bit dark in here" into structured digital actions. These commands are then executed via a Radio Frequency (RF) Star Topology, which was chosen specifically for its deterministic low latency and energy efficiency compared to mesh networks. While this "Heavy Edge" approach introduces some inference latency, it provides a highly secure, private, and intelligent solution for modern home automation.

## **MULTI-MODAL AI AND VISION-ASSISTED HARDWARE ARCHITECTURE FOR PRELIMINARY EYE HEALTH ASSESSMENT**

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The increasing prevalence of eye-related disorders due to prolonged screen exposure highlights the need for accessible and affordable eye screening solutions. This project presents a low-cost AI-based preliminary eye screening system designed for early identification of potential eye health risks in non-clinical environments. The system integrates hardware-assisted vision testing, computer vision-based eye image analysis, and symptom-based assessment to support early awareness and preventive care. The proposed approach employs a multi-modal screening framework consisting of a digital Snellen chart for visual acuity evaluation, real-time eye image capture using a USB webcam, and a structured symptom questionnaire. Eye images undergo preprocessing and feature extraction to analyze parameters such as eye openness and visible redness. To enhance reliability, public eye image datasets covering multiple eye conditions are utilized to enable effective matching and comparison with real-time captured images. Additionally, eye-related medical journals and research literature are reviewed to identify common eye diseases and their associated symptoms, which are structured and integrated into the application for accurate symptom correlation. The combined analysis of visual test results, image features, and user-reported symptoms is used to classify the eye health risk level and generate a preliminary screening report with recommendations for medical consultation, if required. Developed using Python and computer vision libraries, the system serves as a supportive screening tool rather than a diagnostic system, offering a scalable, cost-effective solution for early eye health assessment in educational institutions, workplaces, and community health programs.

## **RESOURCE OPTIMIZATION IN OFDM SYSTEMS USING LATERATION-BASED ALLOCATION**

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Orthogonal Frequency Division Multiplexing (OFDM) is a widely used modulation technique in mobile communication systems due to its high spectral efficiency, bandwidth flexibility, and robustness to channel impairments. In OFDM network planning, efficient bandwidth allocation is essential to meet the demanded broadcasting rates of multiple mobile connections, which is achieved by allocating a variable number of subcarriers and selecting appropriate modulation levels. In this project, the Lateration technique is applied at the OFDM base station to enable fair and efficient bandwidth allocation based on the requirements of individual mobile nodes. By using this approach, bandwidth resources are optimally utilized, making the allocation process purely frequency-dependent and improving the overall performance of the mobile network.

## **HYBRID DADDA MULTIPLIER DESIGN FOR HIGH-SPEED AND LOW-POWER DIGITAL SIGNAL PROCESSING APPLICATIONS**

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Multipliers are fundamental arithmetic units in digital systems, essential for signal processing, control, machine learning, and image processing applications. As system complexity and data rates rise, conventional exact multipliers suffer from high power use, larger area, and longer critical paths, limiting their suitability for energy-efficient, high-performance systems. This work presents an 8×8 hybrid approximate Dadda multiplier with a controllable approximation mechanism. The design integrates approximate compressor logic into lower-significance columns of the Dadda reduction tree, reducing hardware complexity while maintaining adequate accuracy. A control signal (approx\_en) dynamically adjusts the approximation level, enabling minimum- and enhanced-approximation modes. The RTL implementation in Verilog HDL is verified through functional simulation in Xilinx Vivado without FPGA hardware. Results show that higher approximation increases output deviation, especially for large operands, while minimum-approximation mode preserves higher accuracy with reduced logic complexity. The proposed hybrid multiplier achieves an effective trade-off between accuracy and hardware efficiency, making it suitable for error-tolerant domains like image processing, video analytics, and machine-learning accelerators. This work confirms that runtime-configurable approximation in Dadda-based multipliers is practical and effective at the RTL level.

## **NALAM: EMPATHETIC AI FOR MEDICATION ADHERENCE**

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Medication non-adherence remains a major challenge in preventive and community health, leading to avoidable complications, hospitalizations, and increased healthcare burden. NALAM is an empathetic AI-driven solution designed to move beyond conventional reminder-based systems. Instead of simple alarms, NALAM engages patients through intelligent, context-aware conversations that help understand why a medication dose was missed. The system delivers timely reminders, confirms medication intake, and empathetically explores reasons such as forgetfulness, side effects, or unavailability of medicines. Interactions are conducted in the patient’s native language, ensuring inclusivity, trust, and accessibility, especially in rural and community settings. NALAM supports both low-tech platforms such as WhatsApp and offline-capable mobile applications, effectively bridging the digital divide. Patient responses are transformed into actionable insights through a unified dashboard for healthcare providers, enabling targeted interventions like urgent medical follow-ups or medicine resupply. By integrating behavioral health principles with artificial intelligence, NALAM improves medication adherence, strengthens patient-provider communication, and enhances preventive community healthcare outcomes.

## **PHONOVEST: AN INTEGRATED WEARABLE SYSTEM FOR CONTINUOUS MULTI-PARAMETER PATIENT MONITORING**

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Continuous patient monitoring in hospitals and critical care units often relies on multiple independent devices, resulting in fragmented data, increased clinical workload, delayed diagnosis, and higher infection risk due to frequent patient contact. This paper presents Phonovest, an integrated wearable diagnostic system designed for real-time, multi-parameter physiological monitoring through a single unified platform. Phonovest incorporates cardiac, respiratory, hemodynamic, thermal, and structural assessment using MEMS-based acoustic sensors, inertial measurement units, oscillometric pressure sensing, infrared temperature sensors, and a compact low-cost ultrasound module embedded in a breathable, medical-grade textile vest. The modular and sterile design ensures patient safety, comfort, and ease of sterilization, making it suitable for ward, ICU, and remote monitoring applications. By consolidating multiple diagnostic functions into one wearable device, Phonovest reduces device dependency, minimizes manual data collection, lowers infection transmission risk, and enables faster clinical decision-making through real-time wireless data visualization. Future enhancements include AI-driven pattern recognition, ultrasound-assisted functional analysis, and secure cloud-based integration with electronic medical record systems, highlighting the potential of unified wearable diagnostics to improve efficiency, safety, and clinical outcomes in modern healthcare.

## **OPEN HEALTH CARE AND TECHNOLOGIES: UNIFIED MEDICAL SERVICES**

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Fragmented healthcare systems remain a major challenge in India and worldwide, resulting in delayed diagnoses, duplicated medical tests, poor care coordination, and increased healthcare costs due to disconnected data sources, limited interoperability, and reactive treatment models. This paper presents Unified Medical Services (UMS), an open healthcare platform that integrates electronic health records, wearable sensor data, insurance information, and clinical documentation into a unified system using secure cloud architecture and FHIR interoperability standards. Advanced artificial intelligence techniques, including Natural Language Processing and Machine Learning-based predictive analytics, are employed to structure unorganized clinical data, generate actionable insights, and predict potential health risks before critical events occur. Real-time clinical decision support, automated care coordination, and proactive health alerts further enhance medical response and operational efficiency. The proposed system demonstrates a shift toward preventive, patient-centric healthcare by combining AI-driven analytics with open digital infrastructure, ultimately improving patient outcomes and reducing system-wide inefficiencies.

## **OPEN HEALTHCARE TECHNOLOGIES: CROWD PANIC AND STAMPEDE RISK DETECTION**

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This project aims to reduce morbidity and mortality associated with stampedes and mass panic situations by integrating open healthcare technologies with real-time monitoring systems. The approach involves the use of a thermal radar crowd detector to identify abnormal crowd density and movement patterns, along with wearable biomedical sensors such as the Adrenaline Chip, Vital Chip, Galvanic Skin Response sensor, and non-invasive glucose sensor. These technologies continuously monitor vital physiological parameters including heart rate, oxygen saturation, body temperature, blood pressure, stress levels, and glucose concentration using AI-based data analysis. Abnormal crowd behavior or physiological distress triggers early alerts, enabling rapid preventive and medical intervention. The expected outcome is early detection of panic, prevention of crush asphyxia, reduction in cardiac and heat-related emergencies, and faster emergency response during mass gatherings. This integrated system is significant as it promotes AI-driven preventive healthcare, enhances public safety, improves disaster preparedness, and offers a non-invasive, scalable solution to reduce deaths during large-scale public events.

## **GUARDIA: TRANSFORMING WELLNESS THROUGH INTELLIGENT HEALTH MANAGEMENT**

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This project, developed by Team MedTech, introduces GUARDIA, a comprehensive mobile health platform designed to revolutionize elderly and assisted living through proactive, data-driven wellness management. Traditional healthcare often suffers from gaps where symptoms go untracked between clinical visits and early warning signs are missed until they escalate. To bridge these gaps, GUARDIA integrates Smart Symptom Assessment, Cognitive Orientation Monitoring, and Intelligent Medication Reminders into a single, user-centric ecosystem. The system utilizes memory-based algorithms to learn individual health baselines, allowing it to predict escalations and provide personalized insights.

Furthermore, the platform features voice-enabled cognitive assessments to detect early decline non-invasively and adaptive notification logic to maximize medication adherence. With a scalable design ready for wearable integration—enabling real-time biometric tracking and automated emergency protocols for irregularities like blood pressure spikes— GUARDIA empowers users with a dignified, independent, and secure approach to health. By shifting from reactive treatment to predictive wellness, this innovation ensures that healthcare adapts to the person, significantly enhancing the quality of life for the elderly and those requiring assisted care.

## **NON-INVASIVE BLOOD HEALTH TREND MONITORING FRAMEWORK USING ELECTRO-IMPEDANCE SPECTROSCOPY AND MACHINE LEARNING**

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Repeated blood testing is required for monitoring chronic health conditions such as dehydration, anemia, and metabolic imbalance. However, conventional blood testing techniques are invasive, painful, and unsuitable for frequent or community-level monitoring, particularly in home and rural healthcare settings. This paper presents a conceptual non-invasive blood health trend monitoring framework based on Electro-Impedance Spectroscopy (EIS) and machine learning. The proposed approach applies low-amplitude, multi-frequency electrical signals to biological tissue and analyzes the resulting impedance response to capture physiological trends associated with hydration status, hemoglobin-related variations, and electrolyte balance, with glucose-related behavior explored as a secondary research direction. Rather than providing diagnostic measurements, the framework focuses on screening-level alerts and longitudinal trend monitoring. A high-level system architecture comprising signal acquisition, impedance analysis, feature extraction, and AI-based interpretation is described. The proposed framework demonstrates the feasibility of EIS as a supportive, privacy-preserving health monitoring approach and establishes a foundation for future prototype development and clinical validation.

### **AROGTXT: MEDVERIFY CONNECT**

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Stampedes and mass panic events are major public health concerns that often result in serious injuries and deaths due to crush asphyxia, hypoxia, panic-induced cardiac events, and delayed medical care. Early detection of crowd risk and timely health monitoring are essential to prevent such outcomes. This presentation highlights the use of open healthcare technologies combined with intelligent crowd monitoring systems to reduce fatalities during stampede situations. A thermal radar-based crowd detection system is proposed to identify abnormal crowd density and movement patterns in real time. Additionally, wearable biomedical sensors such as Adrenaline Chips, Vital Chips, Galvanic Skin Response (GSR) sensors, and non-invasive glucose sensors enable continuous monitoring of vital and stress-related parameters. AI-based data analysis provides real-time alerts and supports rapid medical intervention. The integrated approach offers a promising strategy for improved emergency preparedness and reduced mortality during mass gatherings.

## **HOLI: A HOSPITAL LINKING APPLICATION FOR EFFICIENT HEALTH CARE MANAGEMENT**

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Efficient coordination between hospitals, patients, and healthcare providers remains a major challenge in modern health care systems, particularly in resource-limited settings. Delays in referrals, lack of real-time information on bed availability, specialist services, and emergency support contribute to suboptimal patient outcomes. To address these challenges, HOLI (Hospital Linking Application) was conceptualized as a digital platform aimed at improving hospital connectivity and health care management. HOLI is designed to integrate multiple hospitals into a single network, enabling real-time sharing of critical information such as bed availability, emergency services, specialist consultations, diagnostic facilities, and referral pathways. The application facilitates faster decision-making, reduces referral delays, and enhances continuity of care. Additionally, it supports hospital administrators by providing data for better resource allocation, workload distribution, and planning. The implementation of HOLI has the potential to improve patient access to appropriate care, reduce overcrowding in tertiary centers, and strengthen inter-hospital collaboration. By leveraging digital health solutions, HOLI contributes to a more efficient, transparent, and patient-centered health care system. The application represents a scalable and cost-effective approach to hospital management and health system strengthening in both urban and rural settings.

## **REAL TIME STOCK AND CROWD MONITORING PLATFORM**

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Long waiting queues, lack of visibility of stock availability, and loss of productive time are common problems in many public service distribution centers. People often waste time and wages due to uncertainty about crowd levels and item availability, especially when smartphone access or internet connectivity is limited. This project proposes a Real-Time Stock and Crowd Monitoring Platform that provides live information about queue length, estimated waiting time, and available stock using a public LED display. IR sensors are used to count the number of people entering and exiting the facility. An ESP32 microcontroller processes the sensor data to calculate crowd size and waiting time. Stock information is updated by the operator through a simple input interface. The displayed data helps users plan their visit efficiently, reducing overcrowding and unnecessary waiting. A GSM module transmits the collected information to a centralized server for monitoring and record keeping. The system is cost-effective, easy to deploy, and improves transparency, operational efficiency, and user convenience.

## **ARCHITECTURAL COMPLEXITY ASSESSMENT OF GRU AND MULTI-HEAD ATTENTION BASED ON MAC OPERATION REQUIREMENTS**

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This paper presents a detailed architectural comparison between a Matrix-Multiplication-based Gated Recurrent Unit (GRU) implemented using two Processing Element (PE) blocks and a Multi-Head Attention (MHA) engine employing Query, Key, and Value projections. In the proposed GRU design, Reset, Update, and Candidate gates are computed through structured Multiply-Accumulate (MAC) operations, with workload partitioning across dual PEs to optimize data reuse, pipeline depth and intermediate buffering. Conversely, the MHA module performs Q-K similarity estimation, softmax normalization and weighted V aggregation using parallelizable high-dimensional dot-product computations. The architectures are evaluated with respect to MAC intensity, memory bandwidth, PE utilization, latency and scalability. The analysis demonstrates that the GRU architecture provides lower control overhead and better performance for temporally correlated inputs, while MHA exhibits significantly higher computational parallelism and improved throughput for long-sequence feature extraction. These insights emphasize the design trade-offs in selecting recurrent vs. attention-based models for hardware-accelerated deep learning systems.

## **SMART DIABETIC FOOT ULCER MONITORING USING DEEP LEARNING**

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Smart Diabetic Foot Ulcer Monitoring using Deep Learning is an AI-assisted approach that aims to automatically identify, categorize, and monitor foot ulcers in diabetic patients. Diabetic Foot Ulcer (DFU) is a serious complication of diabetes that, when discovered late, can cause infection and even lead to amputation. Conventional methods of diagnosis involve human observation, which is a time-consuming process prone to human error. Conventional image processing methods, such as thresholding and edge detection, are often unreliable in providing accurate results because of the variability in skin tone and lighting conditions. The proposed system uses deep learning to overcome these limitations and provides continuous monitoring. Convolutional Neural Networks (CNNs) are used for ulcer detection, while transfer learning models like ResNet and EfficientNet enhance accuracy by utilizing prior knowledge. For accurate localization of ulcers, segmentation models like U-Net and SegNet are used. Image processing with OpenCV improves the clarity of images, and Explainable AI (XAI) methods, such as Grad-CAM, produce heat maps to highlight the affected area. The model, developed using Python with TensorFlow or PyTorch, is deployed using Flask or Streamlit for easy image uploading and processing. Cloud integration with AWS or Google Cloud provides scalability and ease of use. It introduces a trustworthy, explainable, and automated deep learning model for monitoring and managing smart diabetic foot ulcers.

## **A SUSTAINABLE REAL-TIME PUBLIC TRANSPORT TRACKING FRAMEWORK: A LOW-COST, VOICE-ENABLED IOT APPROACH FOR DIGITAL INCLUSION**

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Modern real-time passenger information systems (RTPIS) often fail in resource-constrained or rural environments due to high hardware costs, recurring operational expenses, and a lack of accessibility for non-technical users. This paper presents NAMMA BUS, a scalable and universally applicable IoT framework designed to democratize public transport tracking. The system utilizes an ultra-low-cost hardware unit—integrated with an ESP32 microcontroller and NEO-6M GPS—manufactured for under ₹800.

To ensure financial sustainability, the architecture introduces a cost-saving data transmission model that leverages the existing mobile connectivity of conductor POS devices, eliminating the need for dedicated SIM recharges. Furthermore, the system addresses the "digital divide" by prioritizing vernacular accessibility through Text-to-Speech (TTS) audio guidance, specifically assisting elderly and semi-literate commuters who struggle with traditional map-based interfaces. By utilizing a zero-API cost model based on OpenStreetMap (OSM) and incorporating hardware data buffering for signal-resilient tracking, this research offers a replicable model for municipal transport departments to implement inclusive, smart mobility solutions without the burden of high-cost infrastructure.

## **A DEEP LEARNING–BASED MULTI-CLASS CLASSIFICATION FRAMEWORK FOR TUBERCULOSIS, PNEUMONIA DETECTION USING CHEST X-RAY IMAGES**

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Chest X-ray (CXR) imaging plays a vital role in the diagnosis of pulmonary diseases such as Tuberculosis and Pneumonia. In this work, a deep learning–based automated classification system is presented for identifying lung diseases from chest X-ray images. The proposed system utilizes pre-trained Convolutional Neural Network (CNN) architectures, including EfficientNet, ResNet, and DenseNet, to extract discriminative features and perform accurate disease classification. The input images are preprocessed and augmented to enhance feature learning and support reliable model training. The convolutional layers learn high-level spatial patterns relevant to pulmonary disease detection. Experimental results show test accuracies of 94.76% for EfficientNet, 93% for ResNet, and 94.30% for DenseNet, while validation accuracies of 95.02%, 92.33%, and 97.47–98.10% are achieved respectively. These results demonstrate the effectiveness and consistency of deep learning models in automated chest X-ray–based disease classification, highlighting their potential role in supporting clinical diagnosis.

## **OPTIMISED POST-QUANTUM CRYPTOGRAPHIC ARCHITECTURE FOR SECURE IOT AND BLOCKCHAIN APPLICATIONS**

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The advent of large-scale quantum computers represents a significant risk to existing public-key cryptographic systems such as RSA and Elliptic Curve Cryptography (ECC), which form the backbone of modern Internet of Things (IoT) systems and blockchain infrastructure, as they can be effectively broken using quantum algorithms like Shor and Grover. This paper presents an optimised Post-Quantum Cryptographic (PQC) architecture that provides end-to-end security against quantum attacks for IoT ecosystems with blockchain integration using lattice-based cryptography primitives based on Learning With Errors (LWE) and Ring-LWE assumptions for secure key generation, encryption, decryption, and digital signatures. Post-quantum signatures enable a PQ-safe blockchain layer that is immutable, authenticated, and tamper-resistant, implemented in Python with optimisations such as vectorised operations, NTT-based polynomial multiplication, and entropy-based randomness generation for real-time IoT communication. Experimental results demonstrate effective key generation, low-latency encryption/decryption, high-quality randomness, and scalable blockchain validation time, proving the architecture to be a viable, lightweight, and quantum-resistant design for next-generation IoT, distributed ledger, and secure communication systems.

## **ULTRA WIDE BAND ANTENNA WITH REDUCED SAR FOR MOBILE APPLICATION**

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Ultra-Wideband (UWB) antennas are widely used in modern wireless communication systems, particularly in mobile and body-centric applications, due to their ability to support high data rates over a wide frequency range. However, when antennas are placed close to the human body, a significant amount of electromagnetic energy is absorbed by biological tissues, leading to high Specific Absorption Rate (SAR) values that may exceed international safety limits, making SAR reduction a major design challenge. This project presents the design of a compact Ultra-Wideband antenna with reduced SAR for mobile applications operating in the 3.1–10.6 GHz frequency range, designed and simulated using CST Studio Suite to achieve wide impedance bandwidth, good return loss, stable radiation patterns, and acceptable gain and efficiency. SAR reduction techniques such as Defected Ground Structure (DGS), Artificial Magnetic Conductor (AMC), or Electromagnetic Band Gap (EBG) structures are incorporated, and SAR analysis using a realistic human body phantom is carried out to evaluate user safety. Key performance parameters including reflection coefficient ( $S_{11}$ ), bandwidth, radiation characteristics, gain, efficiency, and SAR distribution are analyzed, and the results confirm that the proposed antenna achieves low SAR values without degrading ultra-wideband performance, making it suitable for next-generation mobile UWB applications.

## **DESIGN AND IMPLEMENTATION OF BB84 QUANTUM KEY DISTRIBUTION PROTOCOL USING PYTHON AND NETSQUID**

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Quantum Key Distribution (QKD) enables provably secure communication by leveraging the fundamental principles of quantum mechanics. Unlike classical cryptographic key exchange methods, QKD guarantees security based on physical laws such as quantum superposition and the no-cloning theorem. This paper presents the design, simulation, and analysis of a quantum key distribution network using the NetSquid Python framework. The BB84 and Coherent One-Way (COW) protocols are implemented under realistic noise, loss, and fiber attenuation models. Performance is evaluated using Quantum Bit Error Rate (QBER) and key distribution efficiency over varying channel conditions. The results demonstrate the impact of channel imperfections on secure key generation and validate the effectiveness of NetSquid for quantum network research and analysis.

## **DESIGN OF LOW POWER HIGH SPEED CMOS D FLIP-FLOP USING HYBRID LOW POWER TECHNIQUES**

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The basic storage units used in digital and VLSI systems are D flip-flops (DFFs) and the proper operation of this element heavily relies on a steady supply voltage. Any little variation in the voltage can cause the internal transistors to enter the subthreshold region, which results in metastability, undefined logic state, timing errors and eventual corruption of stored data. Traditional voltage-sensing designs use fixed threshold comparators and only respond once a voltage perturbation has already affected the memory element, solving the problem, but not making them suitable in low power, noise prone systems of today. To overcome this shortcoming in this work, a deep-learning-based voltage stability detection model is proposed, and it is combined with a memory architecture built on DFF. The model monitors electrical signals including sampled supply voltage, temporal drift trends as well as environmental fluctuations to forecast instability prior to the DFF falling into a failure zone. When a fault is predicted, a rectifier system keeps the final valid value and removes the occurrence of undefined values in memory chain propagation. The presented architecture will increase the trustworthiness of DFF memory through integrating predictive voltage classification and a lightweight fault-holding scheme. The outcomes of simulations show that the system is stable and error free in terms of operation during voltage drops, wherein the standard DFF reacts to voltage drops with erratic logic levels. The solution has enhanced robustness, limited exposure to transient noise, and enhanced stability in output when undervoltage occurs. The technique demonstrates obvious promise that FPGA, ASIC and VLSI platforms need robust low-voltage operation, which will go towards more dependable memory subsystems in low-power electronic designs.

## **DUAL AXIS SOLAR TRACKING FOR OPTIMAL POWER GENERATION**

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Maximizing the efficiency of photovoltaic (PV) systems requires precise alignment with the sun's trajectory to minimize cosine losses. While dual-axis solar trackers significantly increase energy harvesting, conventional control strategies face distinct limitations: optical sensors (LDRs) suffer from instability under diffuse irradiation, while high-precision astronomical algorithms require floating-point computations that introduce latency in low-cost microcontrollers. This paper presents a novel Hybrid Dual-Axis Solar Tracker implemented on the ESP32 System-on-Chip (SoC), leveraging its dual-core 32-bit architecture to resolve these computational bottlenecks. The proposed system employs a FreeRTOS-based parallel processing architecture where Core 0 is dedicated to the computationally intensive NREL Solar Position Algorithm (SPA), achieving a theoretical accuracy of  $\pm 0.0003^\circ$ , while Core 1 manages real-time sensor fusion and motor control. A hybrid control strategy is introduced to dynamically switch between algorithmic positioning (during cloud cover) and optical feedback (during peak sun) to ensure robust operation. Experimental results demonstrate that this dual-core architecture eliminates motor jitter caused by computational blocking and achieves an energy generation increase of approximately 35–40% compared to fixed-tilt installations.

## **DETECTION OF HEART ABNORMALITIES USING HEART SOUND**

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The heart functions continuously to maintain blood circulation, and even small disturbances in its activity can lead to serious health issues if not recognized early. Variations in valve motion and blood flow often produce subtle changes in the acoustic profile of heart sounds, making phonocardiogram (PCG) analysis a useful approach for early screening. This project presents a compact, low-cost system that records and analyses heart sounds in real time. A chest-piece microphone captures the sound signal, which is amplified, filtered, and digitized using an ESP32 microcontroller. Fast Fourier Transform (FFT) is applied to identify frequency patterns linked to normal function as well as abnormalities such as mitral stenosis, aortic stenosis, hypertension, and hypotension. Normal S1–S2 components typically fall within 20–150 Hz, while pathological conditions exhibit distinct spectral shifts. The system displays the processed waveform and frequency spectrum on a laptop interface, offering an accessible and affordable solution for preliminary cardiac evaluation.

## **MULTIMODAL BREAST CANCER CLASSIFICATION USING INTERPRETABLE DEEP LEARNING**

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Breast cancer is still one of the most prominent causes of cancer-related deaths in women globally, and early and correct diagnosis is critical for the effective planning of treatment strategies. In recent years, deep learning has been identified as a promising paradigm for the automatic analysis of medical images, and there is immense potential for its use in assisting diagnosis. This work investigates the use of convolutional neural network (CNN)-based models for the classification of breast cancer from multimodal medical images, such as mammography, ultrasound, and magnetic resonance imaging (MRI) images. To overcome difficulties in the availability of annotated images and differences between modalities, transfer learning strategies are employed to enhance the generalization capabilities of the models. Furthermore, interpretability of the models is also considered by incorporating visual explanation techniques to highlight the important regions of the images that influence the outcome of the classification, thus improving clinical trust and transparency. The experimental findings suggest that CNN-based models have the ability to learn effective features from multiple imaging modalities and are thus feasible for use as assisting tools for radiologists. This work emphasizes the potential of interpretable deep learning models in breast cancer diagnosis and their relevance to being incorporated into future computer-aided diagnostic systems.

## **LORA DTS CONNECTIVITY BY DOPPLER EFFECT**

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Long Range (LoRa) modulation is increasingly considered for enabling direct-to-satellite (DtS) connectivity in low- power Internet-of-Things (IoT) applications using Low Earth Orbit (LEO) satellites. Despite its inherent robustness, the high relative velocity of LEO satellites introduces significant Doppler impairments that challenge reliable LoRa reception. This paper presents a unified investigation of the Doppler effect in LoRa DtS communications, combining analytical performance limit characterization with practical Doppler estimation and compensation strategies. We analytically distinguish the impact of Doppler shift and Doppler rate and evaluate their influence as a function of key system parameters, including spreading factor, bandwidth, payload length, carrier frequency, orbital altitude, and low data rate optimization (LDRO). Building on this analysis, we introduce low- complexity Doppler estimation and compensation schemes that exploit chirps embedded in the LoRa frame structure and require only software-based receiver modifications. Numerical results demonstrate that Doppler rate is the dominant impairment for long packets and high spreading factors, while midamble-based compensation enables near- ideal performance across a wide range of Doppler conditions. The presented results provide practical design guidelines for robust LoRa direct-to-satellite systems and confirm the feasibility of scalable satellite IoT connectivity.

## **IOT BASED INVISIBLE FENCE**

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This project presents an IoT-based Smart Safety Fence System designed to enhance safety and monitoring using modern wireless technologies. The system is developed using an ESP32 microcontroller, integrated with Wi-Fi and GPS modules to detect boundary violations and track location in real time. When an intrusion or unsafe condition is detected, alerts are sent instantly to the user through an IoT platform, enabling quick response and improved security. The proposed system is cost-effective, scalable, and suitable for applications such as restricted areas, agricultural land protection, and personal safety monitoring.

## **REDUCTION PULSE–BASED BODY DATA COMMUNICATION SYSTEM FOR SMART IN-PATIENT HEALTH MONITORING**

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This project presents a reduction pulse–based body data transfer system for efficient in-patient communication and health monitoring in hospital environments, aimed at improving patient care while minimizing response time and communication barriers. The proposed system consists of two intelligent nodes: a transmitter (TX) node worn by the patient and a receiver (RX) node worn by the nurse. The TX node continuously monitors the patient’s vital parameters, including body temperature and humidity using a DHT11 sensor and heart rate using a heartbeat sensor, enabling real-time health condition assessment. Along with automatic sensing, the system allows patients to communicate basic needs such as water, food, or emergency assistance through a simple Morse code–based input mechanism, making it highly suitable for patients with limited mobility or speech impairment. The collected sensor data and Morse code requests are encoded and transmitted as low-power reduction pulses through the human body, which acts as a secure and noise-immune communication medium when physical contact occurs between the patient and nurse. At the RX node, the received pulses are decoded and processed using a NodeMCU controller, which displays the patient’s health data and requests on an LCD for immediate nurse awareness. Furthermore, the NodeMCU uploads all received information to an IoT platform, enabling remote monitoring, data logging, and timely medical decision-making by healthcare professionals. By eliminating conventional RF-based communication, the system reduces electromagnetic interference, enhances data security, and operates with low power consumption. Overall, the proposed solution provides a reliable, cost-effective, and patient-friendly approach for continuous health monitoring and direct patient–nurse communication in modern smart healthcare systems.

## **NEURO-AUTONOMIC AWARE EXPLAINABLE DEEP LEARNING FOR EARLY COGNITIVE FATIGUE DETECTION USING WEARABLE EEG–ECG SIGNALS**

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Cognitive Fatigue Syndrome (CFS) is an emerging neurophysiological condition characterized by progressive deterioration of attention, working memory, and mental endurance, often preceding clinical burnout and neurological impairments. Existing assessment methods rely mainly on subjective self-reports and post-fatigue assessments, limiting their effectiveness for early intervention. This paper proposes an explainable deep learning framework for early detection of cognitive fatigue using multimodal EEG and ECG signals recorded from wearable sensors. The proposed system adopts a hybrid CNN–BiLSTM architecture that automatically learns spatiotemporal fatigue patterns from EEG rhythms and HRV features extracted from ECG signals. An adaptive preprocessing pipeline enhances the quality and robustness of learning before model training. Raw EEG and ECG signals are preprocessed with band-pass filtering and wavelet-based artifact suppression to reduce motion artifacts, baseline wander, and high-frequency noise. To address the intrinsic class imbalance in fatigue datasets, a physiology-aware oversampling strategy, dubbed Physio-SMOTE++, is proposed to synthesize temporally coherent and biologically plausible synthetic samples for minority fatigue classes. To enhance clinical interpretability and trust, an XAI module is integrated to identify fatigue-critical signal segments and physiological biomarkers that influence model decisions. Experimental evaluations show that the proposed framework outperforms conventional single-modal and non-explainable models in early-stage fatigue detection, while significantly reducing missed fatigue events. A cloud-based alerting mechanism is integrated to deliver real-time early warnings and fatigue notifications to patients and clinicians. The results underscore the feasibility of deploying the proposed system as a real-time, non-invasive cognitive fatigue-monitoring solution for high-risk occupations and mental health applications.

## **DIGITAL TRANSFORMATION OF HEALTHCARE VIA AI, IOT, AND DATA-DRIVEN INTELLIGENCE**

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Digital transformation in healthcare is driven by the integration of Artificial Intelligence, Internet of Things, and data-driven intelligence. IoT enables real-time data collection, data science extracts insights, and AI supports predictive analytics and clinical decision-making, improving patient care, efficiency, and accessibility in modern healthcare systems.

## **AN AI-DRIVEN CLINICAL DECISION SUPPORT SYSTEM FOR EARLY ANTIBIOTIC SELECTION USING CARE-24**

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In clinical practice, initial antibiotic decisions are made under intense pressure and incomplete information, before full lab reports like culture sensitivity arrive. When the first choice fails, patient outcomes worsen rapidly—mortality rises, recovery delays, and resistance grows—especially in comorbid patients facing severe complications and extended hospitalization.

To bridge this gap, CARE-24 is an AI-driven decision support system for early antibiotic selection. It integrates diverse features—demographics, specimen type, pathogens, MIC values, resistance genes, and costs—via a confidence-aware ranked ensemble of machine learning models. Even with incomplete data, it delivers interpretable recommendations plus predicted success probability, recovery time, cost, and confidence levels, helping physicians balance efficacy and economics in resource-limited settings.

Comorbidities were synthetically generated using Indian health statistics to ensure realism and privacy. CARE-24 reduces trial-and-error prescribing, cuts treatment failures and resistance, and eases clinician stress, showing how human-centered AI fosters trust, better outcomes, and timely therapy in real-world clinics.

## **REAL-TIME GROUNDING FAULT DETECTION AND ALERT SYSTEM**

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Earthing is essential for electrical safety as it provides a low-resistance path for fault currents. However, earthing performance can deteriorate due to factors such as soil moisture variation, environmental conditions, and electrode degradation. Traditional earthing inspection methods are manual and periodic, making them inefficient for continuous monitoring and early fault detection. To address this limitation, this project proposes an IoT-based Earthing Health Monitoring System for real-time condition assessment.

The system uses an ESP32 microcontroller to monitor soil moisture levels around the earthing electrode, as moisture directly affects earth resistance. The measured data is transmitted to the Blynk cloud platform for real-time remote monitoring. A threshold value of 35% is set to identify weak earthing conditions, triggering alerts through visual indicators and a GSM (SIM800L) module for remote notification. Powered by a 3.7 V lithium-ion battery, the system offers a portable, reliable, and efficient solution for continuous earthing monitoring in electrical installations.

## **ADVANCED SPATIAL TEMPORAL FEATURES ENHANCED NETWORK FOR CONTINUOUS SIGN LANGUAGE RECOGNITION**

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Continuous Sign Language Recognition (CSLR) requires effective modeling of complex spatial configurations and long-range temporal dependencies present in sign gestures. Variations in signer appearance, co-articulation effects, and motion dynamics further increase the recognition challenge. This paper proposes an Advanced Spatial–Temporal Features Enhanced Network for robust continuous sign language recognition. The proposed framework integrates deep spatial feature extraction with temporal modeling to capture both fine-grained hand–body relationships and long-term motion patterns. Multi-scale spatial representations are learned using convolutional neural networks, while temporal dependencies are modeled through recurrent and attention-based mechanisms to preserve contextual continuity across sign sequences. Feature enhancement modules are introduced to strengthen discriminative cues and suppress redundant motion information. Extensive experiments on benchmark continuous sign language datasets demonstrate that the proposed network achieves superior recognition accuracy and lower word error rates compared to existing state-of-the-art approaches. The results confirm the effectiveness of advanced spatial–temporal feature fusion for improving CSLR performance in real-world scenarios.

**Keywords:** Continuous Sign Language Recognition; Spatial–Temporal Feature Learning; Deep Learning, etc,

## **SMART GRID ENERGY MANAGEMENT WITH ELECTRIC VEHICLES BASED ON MULTI-LEVEL NEURAL NETWORK CLASSIFICATION**

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The increasing integration of electric vehicles (EVs) into smart grids introduces significant challenges in energy management, load balancing, and system reliability. This paper proposes an intelligent smart grid energy management framework based on image processing and multi-level neural network modeling to efficiently coordinate energy flow between the grid and EVs. Image processing techniques are employed to extract meaningful features from grid status visualizations, load distribution maps, and EV charging patterns, enabling enhanced situational awareness of grid conditions. These extracted features are then utilized as inputs to a multi-level neural network that performs classification and decision-making for optimal energy scheduling, demand response, and charging control. The proposed approach adapts dynamically to varying load demands, renewable energy availability, and EV penetration levels, improving overall system efficiency and stability. Simulation results demonstrate that the proposed model reduces peak load stress, minimizes energy losses, and enhances charging coordination compared to conventional energy management strategies. The findings indicate that integrating image processing with multi-level neural networks provides a robust and scalable solution for intelligent energy management in future smart grid environments with high EV adoption.

## **AN ACCURATE IDENTIFICATION SYSTEM OF EYE DISEASE DETECTION USING CONVOLUTIONAL NEURAL NETWORKS OVER K-NEAREST NEIGHBOR**

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Developing an accurate identification system for eye disease detection by leveraging Convolutional Neural Networks (CNN) over K-Nearest Neighbor (KNN) algorithm, utilizing advancements in machine learning and medical imaging for improved diagnostic accuracy.

**Materials and Methodologies:** Materials include Python, TensorFlow/Keras, scikit-learn, and a small eye image dataset, with methodologies involving preprocessing, training a simple CNN for feature extraction, training KNN with low K, metric evaluation, cautious optimization, acknowledging limitations, and considering a proof-of-concept. **Result:** The Convolutional Neural Networks achieved a higher accuracy of 98.30% in Eye disease detection compared to the K-nearest Neighbor, which had an accuracy of 75.97%. Additionally, there is a notable difference in Accuracy between the two groups. **Conclusion:** CNNs excel in eye disease detection over KNN, leveraging their capability to automatically learn complex features from data, resulting in superior accuracy and robustness in identification systems.

## **SCALABLE QUANTUM FACE RECOGNITION UNDER NOISY INTERMEDIATE-SCALE QUANTUM DEVICES**

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Quantum machine learning has emerged as a promising paradigm for addressing computational challenges in high-dimensional pattern recognition tasks. Among these, face recognition demands efficient feature representation, robustness to noise, and scalability across large datasets. This paper presents a scalable quantum face recognition framework designed for Noisy Intermediate-Scale Quantum (NISQ) devices, leveraging hybrid quantum-classical learning architectures. Classical preprocessing is employed for face feature extraction and dimensionality reduction, followed by quantum state encoding using variational quantum circuits optimized for shallow depth. To address hardware noise and decoherence inherent in NISQ systems, noise-aware circuit design and error-resilient training strategies are incorporated. Experimental evaluations conducted on quantum simulators with realistic noise models demonstrate that the proposed approach achieves competitive recognition accuracy while significantly reducing circuit complexity. The results highlight the feasibility of deploying quantum-enhanced face recognition on near-term quantum hardware and provide insights into scalable design principles for practical quantum vision applications.

## **ADVERSARIAL IMAGE COLORIZATION: A GAN-BASED APPROACH FOR CONVERTING GRAYSCALE IMAGES TO VIVID COLOR**

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Converting black and white images to color is a challenging task in computer vision. Generative Adversarial Networks (GANs) have revolutionized image synthesis, offering promising ways to generate realistic colored images from grayscale. This project focuses on a novel GAN-based approach for black and white to color image conversion. The method trains a generator network with adversarial learning to produce vibrant and plausible colors. Extensive experimentation and evaluation on diverse datasets verify the effectiveness of the colorization process. Results demonstrate the potential of the proposed approach, producing coherent and vibrant colored images that capture the original grayscale semantics. This advancement in image colorization has applications in historical image restoration, film colorization, and artistic transformations, showcasing GANs’ power in pushing the boundaries of computer vision and image processing

## **PREDICTIVE SYSTEM FOR EARLY DETECTION AND CLASSIFICATION OF PANCREATIC CANCERS USING DEEP LEARNING TECHNIQUES**

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Pancreatic cancer is characterized by high mortality rates primarily due to delayed diagnosis and complex tumor morphology. Early detection and precise classification are essential for improving clinical outcomes. This paper proposes a predictive system for the early detection and classification of pancreatic cancer using deep learning methodologies integrated with the Gradient Descent optimization algorithm. The proposed framework employs convolutional neural networks (CNNs) for automated feature extraction from medical imaging data such as computed tomography (CT) and magnetic resonance imaging (MRI). Preprocessing techniques including noise reduction, contrast enhancement, segmentation, and data augmentation are applied to improve image quality and model generalization. The Gradient Descent optimization method is a novel machine learning approach proposed for detecting pancreatic tumors. It utilizes an ensemble classifier to enhance classification performance. The Gradient Descent optimization algorithm optimizes network parameters by minimizing classification loss through regularization and iterative convergence, thereby enhancing training stability, reducing overfitting, and accelerating convergence speed. The system performs multi-class classification to distinguish between normal pancreatic tissue, benign lesions, and malignant tumors. Experimental evaluation demonstrates improved performance in terms of accuracy, precision, recall, F1-score, and area under the ROC curve (AUC) when compared with conventional optimization techniques. The proposed predictive system provides a robust and efficient computer-aided diagnosis (CAD) tool to support clinicians in early pancreatic cancer detection and informed clinical decision-making.

## **AN INTELLIGENT MOBILE IMAGING SYSTEM FOR RAPID IDENTIFICATION OF SICKLE CELL ANEMIA**

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Sickle Cell Anemia (SCA) is a hereditary blood disorder requiring early and accurate diagnosis to reduce morbidity and mortality, particularly in low-resource settings. This paper presents an intelligent mobile imaging system for the rapid identification of Sickle Cell Anemia using smartphone-based microscopy and artificial intelligence. Peripheral blood smear images are captured through a low-cost mobile imaging attachment and processed using an automated image analysis pipeline. The system performs red blood cell segmentation, morphological feature extraction, and classification using a lightweight deep learning model optimized for mobile deployment. Characteristic sickle-shaped erythrocytes are identified with high sensitivity and specificity, enabling reliable screening outside conventional laboratory environments. Experimental evaluation demonstrates that the proposed system achieves competitive diagnostic accuracy while significantly reducing cost, time, and infrastructure requirements. The proposed approach offers a scalable, portable, and user-friendly solution for point-of-care screening of Sickle Cell Anemia, with potential impact in rural healthcare, mass screening programs, and telemedicine applications.

## **EMBEDDED VISION SYSTEM FOR SUSPICIOUS ACTIVITY DETECTION**

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The increasing demand for intelligent surveillance systems in public and critical infrastructures has motivated the development of automated solutions capable of detecting suspicious activities with minimal human intervention. This paper presents an embedded vision-based surveillance system designed to identify abnormal human activities in real time. The proposed system integrates a camera module with a low-power embedded processor to continuously capture video streams and perform on-device image processing. Computer vision techniques such as background subtraction, motion estimation, object tracking, and activity pattern analysis are employed to extract meaningful features from video frames and distinguish normal behavior from suspicious events. The system is designed to operate in real time with limited computational resources, making it suitable for deployment in cost-sensitive and resource-constrained environments. When abnormal activity patterns are detected, the system automatically records the event and generates alerts containing relevant visual and temporal information. These alerts are transmitted to authorized personnel or monitoring centers through a wireless communication interface, enabling timely response and improved situational awareness. The modular architecture of the proposed system allows easy integration with existing surveillance infrastructure and supports scalability for large-area monitoring.



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