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UNIVERSITY OF ENGINEERING AND TECHNOLOGY, MULTAN
FIRST PUBLIC SECTOR ENGINEERING UNIVERISYTY IN SOUTH PUNJAB

In Collaboration With

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International Conference on Advances in Applied Artificial Intelligence (ICAAI-2026)

ABSTRACT BOOK

15-18 June, 2026

Venue: Bara Gali Summer Camp
(University of Peshawar)
Main Galiyat Road

Organized by:

Office of Research Innovation and Commercialization(ORIC)

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2026

MNS UNIVERSITY OF ENGINEERING & TECHNOLOGY, MULTAN, PAKISTAN.

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Introduction to MNS University of Engineering & Technology, Multan

Muhammad Nawaz Sharif University of Engineering & Technology (MNS-UET), Multan is a premier public-sector institution dedicated to excellence in engineering, technology, applied sciences, and innovation. Since its establishment in 2012, the University has remained committed to producing competent professionals, promoting high-quality research, and fostering an environment that supports innovation, entrepreneurship, and sustainable socio-economic development. Through its state-of-the-art academic programs, research initiatives, and strong industry linkages, MNS-UET continues to contribute significantly to the advancement of higher education and scientific knowledge in Pakistan.

In pursuit of its mission to cultivate a vibrant research culture, MNS-UET regularly organizes national and international conferences, seminars, workshops, and academic forums that facilitate knowledge exchange, interdisciplinary collaboration, and meaningful engagement between academia, industry, and policymakers. These scholarly events provide an excellent platform for researchers, faculty members, professionals, and students to present their latest findings, share innovative ideas, and establish collaborative research partnerships.

The **International Conference on Advances in Applied Artificial Intelligence (ICAAI-2026)**, organized by the **Office of Research, Innovation & Commercialization (ORIC)**, reflects the University's commitment to promoting impactful research and academic excellence. Centered on the theme **Applied Artificial Intelligence**, the conference brings together distinguished researchers, academicians, industry experts, and practitioners from across Pakistan and around the world to discuss emerging challenges, technological advancements, and innovative solutions related to conference theme.

This Abstract Book showcases the keynote talks and accepted research contributions presented during the conference. The collection represents a diverse range of original research, innovative methodologies, and practical applications that contribute to scientific advancement and address contemporary challenges across engineering, technology, applied sciences, and related disciplines. Each abstract has undergone the conference's review process to ensure academic quality and relevance.

MNS-UET extends its sincere appreciation to the keynote speakers, invited experts, authors, reviewers, organizing committee members, sponsors, and participants whose valuable contributions have made this conference a success. It is hoped that the research presented in this Abstract Book will inspire further collaboration, stimulate future innovations, and contribute meaningfully to scientific progress and sustainable national development.

Message from Patron in Chief, ICAAI-2026

It is my great privilege and honor to welcome you to the **International Conference on Advances in Applied Artificial Intelligence (ICAAI-2026)**, organized by **Muhammad Nawaz Sharif University of Engineering & Technology (MNS UET), Multan**.

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, redefining the boundaries of innovation across engineering, healthcare, agriculture, education, manufacturing, finance, and public services. As nations strive towards knowledge-based economies and sustainable development, the role of applied AI in addressing complex societal and industrial challenges has become increasingly significant. In this evolving landscape, institutions of higher education have a profound responsibility to foster research, encourage innovation, and cultivate collaborations that translate scientific discoveries into practical solutions.

ICAAI-2026 serves as a vibrant forum for researchers, academicians, industry leaders, entrepreneurs, and young scholars from around the world to share pioneering ideas, present high-quality research, and explore emerging trends in Applied Artificial Intelligence. Beyond the dissemination of knowledge, this conference aims to strengthen interdisciplinary collaboration, promote responsible and ethical AI practices, and inspire innovations that contribute meaningfully to national development and global progress.

At MNS UET Multan, we are committed to creating an academic ecosystem that values excellence in research, technological advancement, and industry engagement. Through initiatives such as ICAAI-2026, we reaffirm our dedication to nurturing intellectual curiosity, supporting cutting-edge research, and preparing future leaders capable of addressing the challenges of an increasingly AI-driven world.

I extend my heartfelt appreciation to the Conference Chairs, Organizing Committee, Technical Program Committee, keynote speakers, reviewers, sponsors, and all contributors whose unwavering commitment and collective efforts have made this conference a reality. Their dedication reflects the spirit of academic excellence and collaboration that defines this event.

I also warmly welcome all participants and congratulate the authors whose valuable research contributions are included in this Abstract Book. I am confident that the exchange of ideas and the collaborations fostered during ICAAI-2026 will generate lasting academic partnerships, inspire future innovations, and contribute significantly to the advancement of Applied Artificial Intelligence.

I wish you a rewarding conference experience and every success in your scholarly endeavors.

Prof. Dr. Tauseef Aized

Patron-in-Chief, ICAAI-2026

KEY NOTE TALK 01

AI in Medicine: A University Malaya Flagship Initiative for Intelligent, Inclusive and Nationally-Integrated Healthcare

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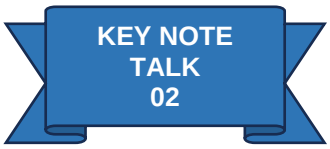
Abstract

Universiti Malaya (UM), Malaysia's oldest and highest-ranked comprehensive university (QS World Ranking #56, 2027), houses a Faculty of Medicine with over 500 academic staff and operates the Universiti Malaya Medical Centre (UMMC) as its teaching hospital. This unique convergence of engineering excellence, medical scale, and clinical infrastructure positions UM as a natural home for the AI in Medicine (AIM) initiative — a flagship programme awarded by the Ministry of Higher Education Malaysia to accelerate the integration of artificial intelligence into the national healthcare ecosystem. The AIM initiative is structured around four interlocking pillars. First, a robust infrastructure layer comprising a High-Performance Computing (HPC) facility and a Data Safe Haven for secure clinical data management underpins all research and development activities. Second, capacity building is delivered through microcredential modules, annual summer schools, and bootcamps that train interdisciplinary cohorts of undergraduate and postgraduate students in solving real-world healthcare problems using AI. Third, targeted research projects address high-impact clinical domains including diagnostics, disease prediction, health resource and economic planning, expert training, public health analytics, and patient navigation. Fourth, an integrated national AIM roadmap links four federal ministries to propose policy-aligned AI deployment across the healthcare system. The AIM initiative directly addresses structural challenges facing Malaysia's healthcare sector, including chronic underfunding, workforce shortages, rising disease burden, and capacity strain, by deploying AI as a strategic and transformative force. Looking ahead, AIM is positioned to drive progress in medicine security, AI-accelerated drug design, medical device and software innovation, and system-level improvements in healthcare outcomes, towards a resilient, people-centred, and Malaysian-made future for health.



Integrated Sensing Communication and Computing for Cognitive Cities

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Abstract

The evolution of urban environments towards cognitive cities requires a fundamental shift from isolated communication systems to tightly integrated sensing, communication, and computing infrastructures. This talk explores how next-generation wireless technologies, particularly Reconfigurable Intelligent Surfaces (RIS), are enabling this convergence and redefining the role of electromagnetic environments. RIS leverages programmable meta surfaces composed of sub-wavelength elements to dynamically control the amplitude, phase, and polarization of electromagnetic waves. This capability enables intelligent manipulation of the wireless channel, supporting energy-efficient communication, high-accuracy sensing, and enhanced localization. In communication, RIS improves coverage and spectral efficiency, particularly in Non-Line-of-Sight environments, while maintaining low power consumption and hardware complexity. For sensing, RIS enables contactless monitoring of vital signs such as respiration and heartbeat, even in challenging conditions. In localization, it enhances machine-learning-based positioning by mitigating multipath effects and enabling adaptive propagation control.

KEY NOTE TALK 03

In the Pursuit of Savings and Net Zero: Leveraging Machine Learning for Operational Excellence in Large Process Industry Complexes

Prof. Dr. Ghulam Moeen Uddin[1]

[1]Department of Mechanical Engineering, University of Engineering & Technology Lahore, Pakistan.

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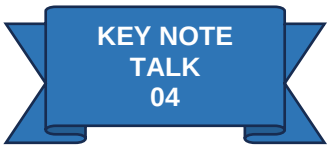
Abstract

Large process industry complexes, such as power plants and fertilizer facilities, etc., operate as integrated engineering systems where sequential value additions are driven by complex, non-linear physical interactions. Traditionally, the optimization of these "tricky beasts" has relied on operator experience or analytical models that often fall short due to the sheer volume of real-time sensory data, often exceeding hundreds of thousands of points per day, and the non-uniform distribution of that data. This research presents a robust nine-step framework for transforming industrial operations from experience-based to data-driven decision-making. The methodology utilizes Artificial Intelligence (AI) to cleanse and model complex input spaces, creating an "AI XBOX" (a robust process model). By hybridizing these AI models with statistical tools like Monte Carlo and Response Surface Methodology (RSM), we demonstrate the ability to conduct high-fidelity sensitivity and interaction analyses. Key applications discussed include strategic-level performance enhancement of a 660 MWe supercritical power plant, where AI-driven operational strategies led to measurable reductions in emissions and improvements in heat rate. Furthermore, the framework is applied to component-level prognostics, specifically using deep learning to predict the Remaining Useful Life (RUL) of rolling element bearings through multi-dimensional feature extraction. Ultimately, this approach provides a scalable path for industrial complexes to achieve significant cost savings while meeting international Net Zero targets.



Entropy Minimization with Source Anchoring for Test-Time Adaptation

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Abstract

Test-time adaptation methods have become increasingly complex in order to handle distribution shifts effectively. In this paper, we revisit a much simpler approach: augmenting entropy minimization with a single L2 anchor term that penalizes deviation from the source model's classifier weights. Despite its simplicity, this method, requiring no architectural changes, no per-sample gradient computation, and a single scalar hyperparameter, achieves substantial gains over unanchored entropy minimization across corruption severities on Tiny-ImageNet-C. We further show that the anchor provides a stability floor that more complex methods implicitly rely on, and that its benefit is largest precisely where complex methods struggle most: under severe corruption where the entropy signal becomes unreliable. Our results suggest that the source anchor is an underappreciated component of TTA, and that a carefully tuned anchor alone recovers a large fraction of the accuracy gains attributed to far more sophisticated methods.

KEY NOTE TALK 05

Applied Artificial Intelligence for Energy Systems

Dr. Attique Ur Rehman[1]

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Abstract

The global energy sector is rapidly evolving with the integration of renewable resources, decentralization, and increasing system complexity. These changes demand smarter, more adaptive solutions to ensure reliability, efficiency, and sustainability. This keynote will explore how applied artificial intelligence (AI) is transforming energy systems by enabling accurate forecasting, intelligent grid management, predictive maintenance, and optimized energy consumption across the value chain. The talk will highlight real-world applications of AI in renewable energy forecasting, smart grids, and energy markets, while also addressing key challenges such as data quality, system integration, and operational reliability. It will conclude with a forward-looking perspective on autonomous energy systems and the role of AI in accelerating the transition toward a resilient, low-carbon energy future.

KEY NOTE TALK 06

Integrating Multi-Transient Seismic Inversion and AI-Guided Logic with Nodal Analysis for Oil and Gas Reservoir Optimization

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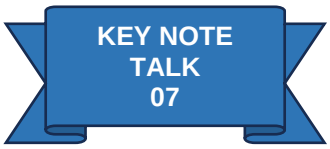
Abstract

Seismic reflection methods remain the primary geophysical framework for high-resolution subsurface imaging. Recent computational shifts from ray-based tomography to Full Waveform Inversion (FWI), alongside the deployment of Wide-Azimuth (WAZ) acquisition geometries and time-lapse (4D) monitoring, have significantly enhanced the signal-to-noise ratio and spatial resolution of reservoir heterogeneities. The current paradigm shift involves the integration of Deep Learning (DL) architectures—specifically Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs)—into the seismic processing pipeline. These AI-driven workflows facilitate high-fidelity automated structural interpretation, including multi-scale fault detection and horizon tracking. Furthermore, ML-augmented seismic inversion enables the transformation of acoustic and elastic impedance volumes into quantitative lithology and fluid-saturation probability maps with reduced non-uniqueness. To bridge the gap between static reservoir characterization and dynamic production, these data are integrated into Nodal Analysis and well-performance modeling platforms such as WellFlo. By honoring seismic-derived geomechanical and petrophysical constraints, these models simulate complex multiphase flow dynamics and pressure temperature gradients across the completion string. The application of AI-assisted predictive modeling within this framework optimizes artificial lift parameters and identifies localized bottlenecks in the production system under transient operating conditions.



Fuzzy Logic-Based Control of Electromechanical Systems

Dr. Muhammad Usman Asad[1]

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Abstract

We present the application of 'Takagi-Sugeno (TS) Fuzzy model based scheme (TSFMBS)' and 'Fuzzy knowledge based scheme (FKBS)' for the control of various electromechanical systems with uncertain parameters. In case of TSFMBS, various controller structure are employed including Servo controller, Integral controller and Controller based on nonlinear regulation theory for which the control gains are found as solution of linear matrix inequalities (LMIs) thereby proving the stability of closed loop system. In case of FKBS, controller is designed based on the human experience about the plant to be controlled. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. In case of FKBS, controller is designed based on the human experience about the plant to be controlled. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. In case of TSFMBS, various controller structure are employed including Servo controller, Integral controller and Controller based on nonlinear regulation theory for which the control gains are found as solution of linear matrix inequalities (LMIs) thereby proving the stability of closed loop system. In case of FKBS, controller is designed based on the human experience about the plant to be controlled. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. In case of FKBS, controller is designed based on the human experience about the plant to be controlled. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot. Case studies include the control of ball and beam system, dc series motor, single link manipulator, and mobile robot.

KEY NOTE TALK 08

Explainable AI for Modeling Magnetic Flux Distribution in MCCB Actuators: A Configuration-Aware Analysis

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[2]Department of Electronics and Automation, Adapazarı Vocational School, Sakarya University, 54050 Serdivan, Turkey.
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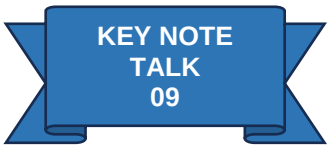
Abstract
This study presents an Explainable Artificial Intelligence (XAI)–based analysis of the three-dimensional magnetic flux density components (B_x, B_y, B_z) generated in magnetic actuators used in molded case circuit breakers (MCCBs). The analyses were conducted on a dataset obtained from electromagnetic simulations performed in CST Studio Suite, comprising a total of 1,186,066 samples across 27 different actuator configurations. The dataset includes 17 input features, covering design parameters, spatial coordinates, and physical field quantities. To investigate how the model benefits from different levels of information, three feature modes were compared: (i) Full Mode, which includes all variables; (ii) Design–Spatial Mode, which incorporates design parameters and spatial coordinates; and (iii) Design-Only Mode, which relies solely on design parameters. To prevent data leakage, the evaluation was carried out using a configuration-based group splitting strategy, and model stability was assessed through repeated experiments. The results show that the Full Mode, as the most physically informative representation, achieves the highest accuracy, particularly for the B_y and B_z components. The Design–Spatial Mode, despite its simpler feature structure, largely preserves this high performance. In contrast, the Design-Only Mode exhibits a significant drop in performance. These findings highlight that spatial information is critical for the point-wise prediction of local magnetic flux density components, whereas relying solely on design parameters is insufficient. Furthermore, feature importance analysis and SHAP-based explanations indicate that the model's decisions are grounded in physically meaningful variables. Overall, the findings demonstrate that, in data-driven modeling of electromagnetic systems, not only predictive accuracy but also the level of information and interpretability play a crucial role.



Computationally Fast Neuro-Fuzzy Networks

Dr. Umar Farooq[1]

[1]Post Doctoral Researcher, Dalhousie University, Canada.

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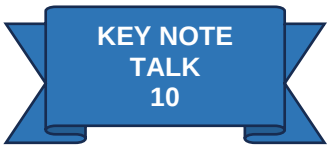
Abstract

In this talk, we will present the design of a class of computationally fast neuro-fuzzy networks. These networks are inspired from the emotional processing of the stimuli in the mammalian brain and thus have neurobiological basis. Various architectures resulting from the integration of emotional neural networks and neo-fuzzy neurons will be presented and their applications to time series prediction, pattern classification, and system identification tasks will be discussed.



Artificial Intelligence in Process Safety & Risk Management: From Reactive to Predictive Systems

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Abstract

The integration of Artificial Intelligence (AI) into industrial operations is transforming traditional approaches to safety, risk management, and operational excellence. In high-risk industries such as fertilizer, petrochemical, and energy sectors, conventional safety systems are often reactive, relying on incident reporting and post event analysis. How AI-driven technologies—including predictive analytics, machine learning models, and real-time monitoring systems—are enabling a shift toward proactive and predictive safety management. The discussion will highlight practical applications such as early hazard detection, predictive maintenance, intelligent alarm management, and risk-based decision-making. Drawing on industry experience in process safety management (PSM), enterprise risk management (ERM), and operational excellence, the session will also address implementation challenges, including data quality, change management, workforce readiness, and ethical considerations.

ABSTRACT ID
ICAAI-2026-01

Design and Development of An Artificial Intelligence (AI)-Based Virtual Assistant

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Abstract

Artificial Intelligence is changing how humans interact with computers by making systems smarter and more responsive. This project focuses on designing and developing an Artificial Intelligence based virtual assistant that works using voice input. The main goal of this system is to help users perform daily tasks easily through spoken commands. The assistant uses speech recognition to convert voice into text and Natural Language Processing to understand the user's command. After processing the input, the system performs actions such as telling the time and date, searching information on the internet, opening applications, and giving voice responses. This system is developed using the Python programming language along with libraries for speech recognition and text-to-speech. The design is simple and flexible, allowing future improvements and additional features. This project shows how Artificial Intelligence can be used to create helpful and interactive systems. In the future, the assistant can be improved by adding better voice recognition, support for multiple languages, and integration with smart devices. Overall, the Artificial Intelligence based virtual assistant provides an easy and efficient way to automate tasks using voice commands.

* *Corresponding Author*

ABSTRACT ID
ICAAI-2026-09

FROM DIGITAL OPPORTUNITIES TO SCALABLE VENTURE: A CAPABILITY-BASED MODEL OF ENTREPRENEURIAL ACTION IN EMERGING ECONOMICS

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Abstract

Digital technologies have expanded the scope of entrepreneurial activity by enabling new forms of venture creation, resource coordination, and market access. Yet the emergence of scalable digital ventures remains uneven, particularly across emerging economies where digital adoption has accelerated but institutional conditions often remain fragmented. Existing research largely emphasizes the enabling role of digital infrastructures and technological innovation, offering a limited explanation of how entrepreneurs translate digital opportunities into scalable ventures. This paper develops a capability-based model of entrepreneurial action that explains how digital opportunities evolve into a scalable digital venture. Drawing on insights from digital entrepreneurship and capability-based perspectives, the framework conceptualizes digital venture scaling as a process linking digital opportunities, structured entrepreneurial capabilities, entrepreneurial actions, and venture outcomes. The model identifies opportunity sensing capability, digital resources orchestration capability, and platform leverage capability as critical mechanisms through which entrepreneurs exploit digital opportunities. The framework also recognizes the institutional environment of emerging economies as a conceptual factor shaping the effectiveness of entrepreneurial action. By integrating these elements, the study advances a process-oriented explanation of digital venture scaling and outlines a research agenda for empirical research on scalable digital entrepreneurship in emerging economies.

* *Corresponding Author*

ABSTRACT ID
ICAAI-2026-13

Multi-Modal Explainable AI for Detection and Treatment Outcome Prediction of MDR-TB

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Abstract

Multidrug-resistant tuberculosis (MDR-TB) remains a critical global health challenge, particularly in low-resource settings. Early detection and effective outcome prediction are essential for improving patient survival and reducing transmission. Existing approaches rely on single- modal data and address these tasks independently, limiting their real-world applicability. This study proposes an Explainable Multi-Modal Artificial Intelligence framework integrating clinical data and chest X-ray images. Machine learning models are applied to structured data, while deep learning models analyze radiographic features. A hybrid fusion strategy is used to combine both modalities for enhanced prediction performance. The system also incorporates explainable AI techniques to provide interpretable insights for clinical decision-making. The proposed approach is designed to be scalable and efficient for deployment in resource-constrained environments. Expected outcomes include improved accuracy, sensitivity, and generalizability compared to traditional methods. This research contributes a unified and practical solution for MDR-TB detection and prognosis.

* *Corresponding Author*

ABSTRACT ID
ICAAI-2026-16

Spectrogram-Based Electrocardiogram Emotion Recognition Using Attention-Enhanced Transfer Learning

Muhamad Talha Jahangir[1,2*], *Muhammad Zain*[1], *Muhammad Hassan Aziz*[1], *Ahsan Khan*[1], *Hamza Nawaz*[1], *Muhammad Shoaib*[1]

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Abstract

Emotion recognition from physiological signals is an important research area for adaptive healthcare systems, affect-aware human-computer interaction, and real-time mental state monitoring. Our work presents a spectrogram-driven framework that identifies emotional dimensions from electrocardiogram recordings, with a focus on valence and arousal prediction. The method is developed on the DREAMER dataset, which contains recordings from 23 subjects during 18 emotion-eliciting video trials. A structured signal-conditioning pipeline is applied before learning: power-line interference removal using a 50 Hz notch filter, fourth-order bandpass filtering from 0.5 to 40 Hz, and channel-wise baseline correction to reduce subject-specific drift. Each two-channel electrocardiogram segment is then converted into time-frequency maps through short-time Fourier transform using a 256 Hz sampling rate, Hann windowing, 256-sample segment length, 90% overlap, and 512-point frequency resolution. For classification, transfer-learning backbones are compared with an attention-enhanced architecture, where channel-spatial refinement and partial fine-tuning are used to improve discriminative feature extraction. Experiments on held-out test sets for binary high-low valence and high-low arousal classification showed that the best-performing model, VGG19, achieved 82.83% accuracy with an F1 score of 85.16% for valence, and 84.21% accuracy with an F1 score of 84.13% for arousal. These results demonstrate that spectrogram representations of electrocardiogram signals carry robust affective information and can support reliable emotion recognition without handcrafted feature engineering, offering a practical and scalable pathway for intelligent affective computing applications.

* *Corresponding Author*

ABSTRACT ID
ICAAI-2026-17

Non-Invasive Blood Group Detection Using Fingerprints

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Abstract

Rapid identification of blood groups is critical in medical emergencies and crime scene investigations. Although traditional laboratory techniques provide high precision, they are often time-consuming and require invasive blood sampling. To overcome these limitations, an automated and non-intrusive method for blood group classification using fingerprint biometrics and deep learning was developed. In this research, a state-of-the-art convolutional neural network, specifically the DenseNet-121 architecture, was strategically employed for feature extraction and classification. The DenseNet-121 model demonstrated robust performance, achieving a validation accuracy of 87.25% by leveraging its high connectivity density, which facilitates effective information transfer between layers. The proposed system is capable of classifying fingerprints into eight blood groups: A+, A-, B+, B-, AB+, AB-, O+, and O-. These findings indicate that DenseNet-121 provides an optimal balance between computational efficiency and predictive accuracy for non-invasive biometric blood typing.

* *Corresponding Author*

ABSTRACT ID
ICAAI-2026-18

Automated Glaucoma Detection from Retinal Fundus Images Using Transfer Learning with Explainable Gradient-Based Visual Attention

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Abstract

Glaucoma is a leading cause of irreversible blindness worldwide, characterized by progressive optic nerve damage that often remains undetected until significant vision loss occurs. The limited availability of specialist ophthalmologists, high diagnostic costs, and time-intensive manual examination procedures highlight the need for automated, efficient, and accessible screening solutions. To address these limitations, this research introduces a deep learning framework for automated glaucoma detection from retinal fundus images. The system utilizes DenseNet121, a convolutional neural network pretrained on ImageNet and fine-tuned for glaucoma classification. A preprocessing pipeline incorporating adaptive histogram equalization, Gaussian denoising, gamma correction, and sharpening enhances optic disc visibility and normalizes image quality prior to classification. The model is trained and evaluated on a benchmark dataset with class balancing and stratified splitting. The framework achieves an accuracy of 94%, Area Under the Receiver Operating Characteristic Curve of 0.985, Cohen's Kappa of 0.88, sensitivity of 0.89, specificity of 0.99, and a false negative rate of only 1.5%. Gradient-weighted Class Activation Mapping is integrated to produce visual heatmaps highlighting the optic disc and cup boundaries, offering clinicians transparent insight into the model's diagnostic reasoning. The system is deployed as a lightweight web application with realtime inference capability, demonstrating its suitability for efficient and accessible glaucoma screening in resource-constrained clinical settings.

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ABSTRACT ID
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Finger Abnormality Detection in X-ray Images Using DenseNet201 Deep Learning Architecture

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Abstract

Accurate detection of finger abnormalities from radiographic images is critical in emergency radiology, yet remains challenging due to the subtle nature of finger pathologies and the small anatomical structures involved. Although traditional diagnostic methods rely on manual interpretation by clinicians, they are often time-consuming and prone to errors, particularly in high-volume emergency settings. To overcome these limitations, an automated and non-invasive method for finger abnormality classification using deep learning was developed. In this research, a state-of-the-art convolutional neural network, specifically the DenseNet201 architecture, was strategically employed for feature extraction and classification on the MURA v1.1 dataset containing 5,567 finger radiographs. The DenseNet201 model demonstrated robust performance, achieving a validation accuracy of 79.39%, an F1-score of 79.66%, and a ROC AUC of 85.57% by leveraging its compound scaling strategy, which facilitates effective information transfer between layers. The proposed system is capable of classifying finger radiographs into two categories: normal and abnormal, encompassing conditions such as fractures, dislocations, and degenerative changes. These findings indicate that DenseNet201 provides an optimal balance between computational efficiency and predictive accuracy for automated finger abnormality detection in musculoskeletal radiographs.

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ABSTRACT ID
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Enhanced Lane Recognition in Autonomous Driving with Advanced Computer Vision Techniques

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Abstract

Automated driving is gaining popularity because it eliminates serious driving risks in real-time. Autonomous vehicles are heavily reliant on sensors to detect lane markings and obstacles, as well as for environmental awareness. However, accurate lane identification remains a challenge because of factors like noise from shadows and poor views. This problem has not been fully solved despite advances in computer vision. It is a gap in current literature. This research aims to overcome these challenges by creating an improved lane-detection technology. The study combines advanced techniques such as semantic segmentation and edge detection with deep learning and multi-sensor data from cameras, LIDAR and radar to achieve this. The research uses this method to compare the accuracy, specificity, and processing speed of the proposed model with existing systems. Initial findings show that the combination between semantic segmentation, multi-sensor fusion and real-time scenarios improves lane recognition. The proposed model had a lane-detection accuracy of 97.8% and a specificity level of 99.28%. It also had an average processing time per epoch of 0.0047 second. This study addresses not only the limitations of current lane detection systems, but also provides insights into how to improve road safety for autonomous cars.

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ABSTRACT ID
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Hybrid Hydrodynamic and AI-Based Analysis of Coupled Offshore Installation Operations

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Abstract

The requirement for accurate and computationally efficient prediction of hydrodynamic behavior in marine installation operations is growing rapidly, which has in turn accelerated the adoption of artificial intelligence in offshore engineering research. The paper proposes a hybrid physics-informed and large language model (LLM)-assisted framework for analyzing fluid-structure interaction in offshore installation systems under nonlinear wave excitations. The proposed methodology couples traditional hydrodynamic and structural mechanics formulations with open-source Artificial Intelligence models to assist in mathematical modeling, simulation, parameter interpretation, automated code generation and engineering decision support during offshore installation processes. The framework is derived from first-principles governing equations based on continuum mechanics, variational dynamics and nonlinear potential-flow hydrodynamics. Special emphasis is placed on installation systems, e.g. floating lifting arrangements, subsea deployment mechanisms, offshore handling equipment, suspended payload systems and compliant marine installation configurations operating under wave dominated environmental conditions. Open source LLMs are integrated as smart research support tools to help with symbolic equation manipulations, boundary-condition understanding, numerical workflow creation, and data-driven analysis of coupled hydrodynamic responses. The use of freely available transformer-based AI architectures for offshore installation engineering applications enhances transparency, reproducibility, and accessibility. The proposed approach provides an integrated way to assess wave-induced loading, added-mass effects, radiation damping, cable-payload interactions, and coupled dynamic responses during offshore installation operations, relieving the computational and implementation burden of high-fidelity marine simulations. Non-dimensional analysis is also used to determine the relative importance of inertial, restoring, damping and hydrodynamic forcing mechanisms for typical offshore installation scenarios. The emphasis is on the role of AI-assisted workflows in accelerating numerical implementation, improving engineering interpretability, and enabling rapid development of reduced-order predictive models for installation safety and operational reliability. The methodology presented targets the practical use of openly accessible and customizable LLM technologies for research on scientific computing and marine installation engineering, instead of proprietary closed-platform AI solutions. The study demonstrates how open-source artificial intelligence tools can complement classical hydrodynamic theory in the support of intelligent simulation environments, digital engineering workflows, operational planning and future autonomous offshore installation systems. The proposed approach offers an open and scalable basis for future studies on AI-enabled nonlinear marine hydrodynamics and optimization of offshore installation systems.

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ABSTRACT ID
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Advanced Vibration Signal Analysis for AI-Augmented Fault Diagnosis of Rolling Element Bearings

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Abstract

Rolling element bearings are really important in machines that rotate. When they fail without warning it can cause a lot of problems. This includes losing a lot of production time spending money on maintenance and even safety issues. The usual methods of analyzing vibrations to find problems with bearings do not work well when the machine is running at different speeds or with different loads. This is because the signals that show there is a problem are hidden by noises and are not strong enough. This research is about a way to analyze vibration signals that uses multiple types of signal processing and artificial intelligence to find bearing faults early. We did experiments on a test rig with bearings that were either healthy or had been made to have faults in the inner race, outer race or rolling elements. Our method uses a lot of features from the vibration signals, including things like the root mean square, kurtosis and wavelet transform. These features are then used by intelligence to automatically identify faults, which is more accurate and reliable than the usual methods. The artificial intelligence part of our method can recognize patterns in the data when the machine is running under different conditions, which is something that human analysts may struggle with. We think our method will be better at finding faults especially when they are just starting to develop and will be able to tell the difference between types of faults. This research is important because it can help industries keep their machines running reduce downtime and save energy. Our method uses intelligence and data to manage the health of machines, which is in line, with the goals of Industry 4.0 and supports sustainable development.

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ABSTRACT ID
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AI-Assisted Fault Diagnosis of Disc-Stack Heavy Fuel Oil (HFO) Separators Based on Vibration and Temperature Measurements

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Abstract

Disc-stack Heavy Fuel Oil (HFO) separators are a critical auxiliary to diesel power plants to separate water and solid impurities from fuel prior to combustion in the engine. Failure or performance loss of these separators can have a negative impact on fuel quality, engine performance, operational reliability and maintenance cost. This paper proposes an Artificial Intelligence (AI) based fault diagnosis system for disc-stack HFO separators based on vibration and temperature measurements under different operating conditions. Portable vibration monitoring equipment and plant-installed temperature sensors were used to gather experimental data from an operational HFO separator. Vibration signals were recorded at specific points on the separator housing to capture the dynamic response of the system due to common mechanical faults, including rotor imbalance, shaft misalignment, and bearing degradation. The time-domain parameters such as Root Mean Square (RMS), kurtosis, and crest factor were used to assess the severity of the vibration and impulsive behaviour, and Fast Fourier Transform (FFT) analysis was employed to detect the characteristic fault frequencies and harmonic components. A correlation analysis was also conducted to explore the effect of the temperature changes of the HFO on the vibration characteristics of the separators. In order to improve the fault identification capability, an AI-based predictive analysis approach was added to classify operating conditions and to support the early fault detection under the changing process conditions. The results show that temperature and viscosity differences have a significant effect on the dynamic response of the separator and can obscure real mechanical problems if not carefully analysed. The proposed methodology shows that the use of vibration analysis, temperature monitoring, and AI-based predictive diagnostics can enhance the accuracy of condition monitoring and maintenance decision making for HFO separators in diesel power plants. The framework developed is effective in creating a predictive maintenance strategy to minimize unexpected shutdowns, enhance equipment reliability, and optimize the operational efficiency of the plant.

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ABSTRACT ID
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Generalized Ostrowski type integral inequalities via generalized polynomials on time scales with simulation

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Abstract

In this article, we have established a Montgomery identity tailored to generalized polynomials defined on arbitrary time scales. Building upon this identity, we derived a new class of generalized Ostrowski type integral inequalities that extend some results to the more general setting. Our results unify existing inequalities in the literature, covering a broad spectrum of discrete and continuous domains. To illustrate the correctness of the derived inequalities, we provide graphical representations of some examples that confirm the estimates. Furthermore, we demonstrate the applicability of our results to the mid point rule and several important special cases of time scales, including the continuous case, the discrete case, and the quantum case. As an application, we show how these inequalities can be used to obtain error bounds for numerical integration formulas on non-uniform grids, thereby offering tools for both theoretical and practical use in approximation theory and dynamic equations.

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ABSTRACT ID
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AI-Based Adaptive Mechanical Suspension Systems Without Physical Sensors for Improved Vehicle Stability

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Abstract

Traditionally, mechanical suspension systems use physical sensors to sense road conditions and adaptively change the damping forces. However, these sensor-based systems brought with them complexity, maintenance issues and failure risks in harsh environments. The researcher investigated an innovative method of adaptive mechanical suspension based on the use of artificial intelligence without relying on traditional sensors. The researcher used a data-driven approach with machine learning algorithms based on past datasets of vehicle dynamics. The researcher created a neural network model that can predict the road surface irregularities and load variations from only internal mechanical feedback signals like spring deflection patterns and actuator response times. The researcher also performed simulation-based experiments with MATLAB/Simulink to validate the proposed AI model for different road and speed conditions. Model performance was tested and compared to traditional sensor-based suspension systems. The results showed that the AI model was able to predict the surface disturbances with an accuracy of 87% and adjust the damping coefficients in real-time. The researcher found that the major problem of computational latency was still manageable and was solved with the help of model compression techniques. The researcher explained the implications of the practical elimination of physical sensors, such as the decrease in system weight, manufacturing expenses, and maintenance needs. The researcher also noted that there were limitations when the internal signal patterns were not sufficient to accurately predict in extreme off-road conditions. The researcher concluded that AI based adaptive suspension system without sensor was a viable and economical alternative to the conventional suspension system. Future research could involve increasing the size of the training dataset and testing the model on a variety of vehicle platforms to improve its generalizability and performance in the field.

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ABSTRACT ID
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Design, Evaluation, and Performance Analysis of an Automatic Tea Maker

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Abstract

Traditional tea preparation remains labor-intensive, inconsistent, and time-consuming, often resulting in variable taste and quality. This paper presents the design and implementation of a fully automated tea maker that addresses these limitations through an embedded system architecture. The proposed system integrates an ESP32 microcontroller, precision sensors, and electromechanical actuators to automate the entire brewing process—from boiling water to dispensing ingredients and serving. A stepper-motor-driven mechanism dispenses powdered ingredients with ±3% accuracy, while a PID-based temperature controller, tuned via the Ziegler-Nichols method, maintains thermal stability within ±0.4°C of the setpoint. An intuitive touchscreen interface enables users to customize cup quantity, tea strength, and sweetness level. Experimental validation over 20 brewing cycles demonstrates that the system achieves 95% consistency in tea preparation, reduces preparation time by 45%, and lowers energy consumption by 44% compared to manual methods. The automatic cleaning cycle further ensures hygiene and minimizes human intervention. This cost-effective, scalable solution is suitable for homes, offices, and smart kitchen environments, offering reliable, repeatable, and user-friendly tea preparation.

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ABSTRACT ID
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LLM based Literature Recommender System for Term Papers

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Abstract

The challenge of retrieving research papers has increased significantly because of the fast increase in the number of scientific literature in various fields. Conventional systems of retrieval largely also depend on matching based on keywords, a factor that does not produce the contextual sense, and semantic relation of documents. The most recent developments in Natural Language Processing (NLP) have brought in transformer-based models which can learn the deep context based knowledge but these models tend to be not interpretable and they lack user transparency. This paper aims to overcome these limitations by proposing a recommendational system that explains its recommendations, has semantic embeddings, looks at the key- word based retrieval, and sentiment-based ranking. The suggested structure makes use of Sentence-BERT embeddings to obtain semantic similarity of queries to the user and research abstracts, and TF-IDF to maintain keyword-level relevance. Moreover, a sentiment analysis system grounded on VADER is added that will adjust ranking scores based on the intent of the user and the emotional situation. In order to improve system transparency, it is augmented with an explainability module giving human-readable explanations as to why any recommendation was made. On a smaller sample of the arXiv data, experimental analysis of a subset indicates better retrieval rates and interpretability than with conventional methods. The findings provide insights into the success of semantic understanding, lexical matching, and sentiment awareness as a single recommendation system.

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ABSTRACT ID
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Deep Fusion of Color, Texture, and Shape Features for Visual Content Analysis

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Abstract

The fast growth of multimedia data has entrenched Visual Content Analysis (VCA) as a Foundation of modern computer vision. However, conventional single-model architectures often struggle to capture the full semantic complexity of images where color, texture, and shape vary separately. In this paper, we propose a Tri-model Deep combination structure designed to develop a cooperative feature space for pinpoint image classification. Our reach merge three heterogeneous measure datasets Oxford 102 Flower (fine grained textures), Caltech-101 (complex geometries), and Corel-1K (natural scenes) into a singular specialist integrated Dataset. The core of the structure, make use of three specialized deep learning backbones: ResNet50 for structural/shape formatting, DenseNet121 for textural detail analysis, and EfficientNetB0 for universal color pattern identification. Features removed from these models are concatenated into a high dimensional Unified merged Feature direction (4352 dimensions) and standardized via Z-score scaling. Final classification is performed using a Support Vector Machine (SVM) to optimize hypersurface separation in the high-dimensional rooting space. Exploratory results and verify that the suggested structure achieves a measure. Overall Accuracy of 94.29% and a remarkable Specificity of 99.95%. These findings validate that the strategic fusion of specialized deep features significantly outperforms single-model approaches and state-of-the-art fusion techniques, giving a strong and scalable solution for analyzing diverse visual substance in complex surrounding conditions.

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ABSTRACT ID
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Texture-Guided Frequency Residual Network for Underwater Image Enhancement

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Abstract

Underwater images suffer from severe degradation due to wavelength-dependent light absorption, scattering, color distortion, contrast loss, and fine texture-detail degradation. Although deep learning-based methods have shown significant progress, many existing methods still approach frequency components symmetrically and attempt simultaneous amplitude and phase correction, which can introduce unstable interactions because underwater degradation affects amplitude more severely than phase. To address this limitation, this study proposes the Texture-Guided Frequency Residual Network (TGFRN), a novel dual-branch spatial-frequency architecture for underwater image enhancement. The proposed model decomposes the input image into amplitude and phase components in the Fourier domain. The amplitude pathway serves as the primary restoration branch for spectral energy recovery, contrast enhancement, and color correction using a ResNet34 encoder with Fast Fourier Convolution blocks and wavelength-aware attention. Instead of directly correcting phase information, which may interfere with amplitude-dominant restoration, the phase branch is repurposed as a TextureGuidePathway that extracts high-frequency texture and structural cues through depthwise separable convolutions, multi-scale dilated convolutions, and spatial attention. These texture features are adaptively injected into a ConvNeXt-based spatial branch at the mid-stem level and guide a Structural Refinement Block after adaptive frequency-spatial fusion, forming a stable texture-guided refinement chain. A SeaThru-inspired consistency loss is also incorporated to promote physically plausible restoration. Experimental results demonstrate robust performance, achieving 26.41 dB PSNR and 0.9098 SSIM on the held-out validation set of the Large-Scale Underwater Image dataset, and 23.14 dB PSNR and 0.8940 SSIM on the Underwater Image Enhancement Benchmark dataset. By repurposing phase as complementary texture guidance rather than a direct correction target and maintaining amplitude dominance through adaptive fusion, TGFRN provides a more stable, interpretable, and effective framework for underwater image enhancement.

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ABSTRACT
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MedEye: A Production-Ready Deep Learning Framework for Automated Multi-Class Eye Disease Detection Using Retinal Imaging

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Abstract

Eye diseases such as diabetic retinopathy, glaucoma, and cataracts are among the leading causes of visual impairment and blindness worldwide. Early diagnosis is essential for effective treatment; however, access to specialized ophthalmic screening remains limited in many regions. This research presents MedEye, a production-ready deep learning framework developed for automated multi-class eye disease detection using retinal fundus imaging. The proposed system integrates multiple state-of-the-art deep learning and machine learning architectures to improve diagnostic performance, scalability, and deployment flexibility in real-world healthcare environments. A balanced dataset containing 4,217 retinal images was curated from publicly available clinical sources and categorized into four classes: diabetic retinopathy, glaucoma, cataract, and normal retinal conditions. To enhance model robustness and generalization, preprocessing techniques including image validation, augmentation, normalization, and stratified data splitting were applied. The framework incorporates ten classification models, including EfficientNetB3, DenseNet121, MobileNetV2, ResNet50, Xception, VGG16, InceptionV3, Support Vector Machine, Random Forest, and a custom convolutional neural network. Experimental evaluation demonstrated strong classification performance, with transfer learning architectures achieving high accuracy and efficient inference times suitable for practical deployment. In addition to predictive capability, the framework emphasizes software engineering principles such as modular architecture, reproducibility, automated logging, model checkpointing, and deployment compatibility for mobile and cloud-based systems. The proposed approach contributes to the advancement of medical artificial intelligence by providing an accessible, transparent, and open-source framework for retinal disease analysis. The system has the potential to assist healthcare professionals in early disease screening, support telemedicine applications in underserved areas, and provide researchers with a reliable foundation for future medical imaging studies. The findings demonstrate that balanced retinal datasets combined with transfer learning techniques can significantly improve automated ophthalmic diagnosis and enhance the reliability of AI-driven healthcare solutions.

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ABSTRACT ID
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Artificial Intelligence for Real-Time Modeling and Prediction of Ultrafast Laser Filamentation in Nonlinear Media

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Abstract

The propagation of ultrafast laser radiations in nonlinear media leads to complex phenomena such as self-focusing, plasma creation, and filament formation, which is governed by highly nonlinear Schrödinger wave equations. Solving these complex equations by the conventional numerical methods such as split-step Fourier techniques is intensive and time consuming. This work proposes a machine learning framework to model and predict ultrafast laser filamentation dynamics more efficiently. The primary objective is to develop a model capable to predict filament characteristics including filament length, width and surrounding unnecessary cracks based on the input laser and material parameters. Under the slowly varying envelope approximation, a dataset is generated by simulation of standard nonlinear propagation. This dataset is then employed to train supervised machine learning models that map the input parameters to the resulting spatiotemporal field evolution. This trained model precisely and efficiently demonstrates the nonlinear effects including self-focusing and plasma defocusing, with reduced time duration. Furthermore, for the controlled filament formation, this model enables to find the optimized laser parameters such as input energy, repetition rate and number of pulses. The proposed work highlights the potential of integrating artificial intelligence with nonlinear laser physics, offering an efficient framework for the real time prediction and optimization of ultrafast laser-matter interactions.

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ABSTRACT ID
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A Prescriptive Edge-AI Framework for Real-Time Crop Disease Diagnosis and Treatment

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Abstract

Agriculture is the primary driver of Pakistan's economy, contributing significantly to the national GDP. However, the sector is plagued by crop diseases that cause annual losses of approximately 25% to 35% across diverse ecological zones, from the cotton belts of Sindh to the citrus orchards of Punjab. Recent advancements in deep learning have shown promise in disease identification, yet a critical gap remains: the transition from automated diagnosis to actionable curative intervention for resource-constrained farmers. This research proposes a robust, mobile-centric Edge-AI framework designed for real-time diagnosis and prescriptive cure analysis tailored to the Pakistani context. The methodology utilizes a hybrid architectural approach, integrating MobileNetV2 for efficient classification and YOLOv8 for precise localized detection of disease spots on leaf surfaces. Unlike existing studies from 2024 and 2025 that focus solely on classification, this project introduces a "Prescriptive Engine" that maps identified pathologies specifically in Cotton, Mango, and Citrus to localized Integrated Pest Management (IPM) guidelines. To ensure national relevance, the model is trained on a comprehensive dataset encompassing public repositories (PlantVillage) and original field samples collected from diverse Pakistani regions. By utilizing Edge-AI, the system operates with minimal latency on mid-range mobile devices without requiring persistent internet connectivity. Based on comparative analysis with current benchmarks, this framework is projected to deliver a 15% to 20% improvement in inference speed and a 5% to 8% increase in overall classification accuracy over traditional ResNet-based architectures. Furthermore, the integration of the prescriptive engine provides a 100% functional advancement in user utility compared to purely diagnostic models. This study offers a scalable technological intervention to enhance food security and economic stability by providing farmers with immediate, evidence-based diagnostic and curative support.

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ABSTRACT ID
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Predictive Energy Management and Safety Optimization for E-Bikes: A Sensor Fusion and Machine Learning Approach

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Abstract

In the broader context of sustainable micro-mobility, the operational efficiency and range reliability of electric bikes (e-bikes) face significant challenges, especially when rider and terrain conditions are unpredictable. This research introduces a smart, AI-based e-bike monitoring system that leverages multi- sensor data to address these limitations and also combines operational, biometric, and topographic data in real-time to create a thorough foundation for improved vehicle intelligence. Refined feature extraction and filtering approaches were therefore applied to modify raw sensor inputs from a multimodal dataset that includes rider weight, instantaneous speed, journey distance, battery discharge efficiency per kilometres and road inclination. Machine learning models that predict the number of battery charges needed for particular distances under dynamic riding situations were built on the basis of these processed data streams. Finally, the performance of these models were assessed with the dual goals of optimizing battery energy management and improving overall rider safety. By combining CNN (convolutional neural network) - based pre- processing with real-time sensor fusion, this study presents an effective approach for maximizing the performance of electric vehicles. The use of trained regression approaches enhances battery state of charge (SOC) estimation and charge-interval forecasting, which are essential for reducing range anxiety. Additionally, the system's capability to adapt to dynamic conditions ensures better rider safety on steep inclines. These findings highlight the importance of integrated sensing and machine learning in developing sustainable, next-generation energy-efficient electric bikes.

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ABSTRACT ID
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AI-Powered Cattle Identification Using Retinal Biometrics for Precision Livestock Farming

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Abstract

Individually identifying permanent cattle is essential to modern animal husbandry for disease surveillance, traceability, breeding programmes, insurance and cattle theft. The traditional tagging, branding, and RFID implant techniques have many drawbacks, including loss of tags, physical damage to the animal, risk of infection, vulnerability to tagging and high maintenance costs. To overcome these limitations, there is a pressing need for an improved, non-contact and tamper-proof identification system that is versatile enough to be implemented in a wide range of farm settings, including smallholder farmers, as well as large commercial farms. The present research aims to design a new artificial intelligence-based cattle identification system by having retinal biometrics as a very effective and humane alternative method. The pattern of the retinal blood vessels of each individual animal is unique from one animal to another, is stable over their lifetime, and is protected by anatomical barriers from external interference, thus making it an ideal biometric identifier for permanent authentication of cattle. The proposed system is designed in the following four stages: First, image acquisition is performed with a portable fundus camera particularly designed for harsh field use, followed by the preprocessing stage to enhance the contrast and to reduce noise in images captured under realistic farming conditions; the feature extraction phase is accomplished by a fine-tuned ResNet-50 architecture based on transfer learning; the final matching stage is implemented by a softmax classifier with adjustable threshold based verification that compromises between security and usability. A large collection of retinal images from cattle images is being used to train a deep convolutional neural network to make it robust and generalize across breeds, age ranges, and environmental conditions. The system is being developed to be easy to use and user-friendly, so that the person operating it doesn't need to be technologically savvy, and will work on mobile tablets as well as laptops. On- going work includes optimizing the model for low-cost edge computing platforms like the Raspberry Pi, allowing it to run without the need for an internet connection in remote rural areas, and reducing the barriers to uptake. Moreover, blockchains are being investigated for integration to ensure complete transparency in the supply chain, from farm to consumer, with an immutable record of each animal's identity and movement. This retinal biometric AI-based solution is a reliable, humane, scalable and commercially viable solution to precision livestock farming.

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ABSTRACT ID
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AI-Based Source Code Vulnerability Detection System

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Abstract

Software vulnerabilities remain one of the major challenges in modern software development due to the increasing complexity of applications, cloud systems, and web technologies. Static analysis tools have been employed extensively for detecting security threats; nonetheless, such approaches tend to produce high false positives and do not comprehend semantic information about how the source code performs. In contrast, purely artificial intelligence methods might lack consistency and structured program analysis. This research proposes a hybrid AI-driven source code vulnerability detection framework that combines deterministic static analysis techniques with transformer-based semantic learning models to improve vulnerability detection accuracy and explainability. The proposed system first performs static analysis to identify suspicious code regions, extract structural information, and reduce the overall search space. These suspicious code segments are then analyzed using transformer-based models such as CodeBERT and GraphCodeBERT for semantic vulnerability classification and Common Weakness Enumeration (CWE) mapping. Moreover, the architecture incorporates a layer of vulnerability reasoning and explanation that can provide human-readable explanations, risk analysis, and remediation techniques. Also, an interface that facilitates interaction with developers and users through a chatbot system is implemented. The design of this architecture is intended to decrease false positive detections, enhance the understanding of the context of code, and provide explanations of actions taken by the artificial intelligence model. It correlates with modern industry trends where static analysis is integrated with AI algorithms in the construction of secure software engineering systems.

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AgriVision-Bot: An AI-Powered Robotic System for Real-Time Detection of Healthy and Diseased Crops Using Computer Vision and Deep Learning

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Abstract

Crop disease poses a severe threat to global food security, causing significant yield losses particularly among small farmers. Manual inspection methods cost more labour and yet has the errors, making early and accurate disease detection a persistent agricultural challenge. This paper presents AgriVision-Bot, an intelligent autonomous machine that integrates Computer Vision, Deep Learning, and real-time image processing to identify healthy and diseased crops directly in the field. The system consists of a mobile ground robot equipped with a high-resolution camera and edge-computing hardware. An onboard EfficientNet-B4-based Convolutional Neural Network, trained on over 87,000 images spanning 14 crop species and 38 disease categories, performs multi-class classification of crop health conditions. Transfer learning and data augmentation techniques ensure robust performance across varying illumination, soil backgrounds, and plant growth stages. The robot navigates crop rows autonomously using LiDAR-assisted obstacle avoidance and GPS-guided path planning. Upon detecting a potentially diseased plant, it captures a close-up image, classifies the disease type and severity, and sends the location. This data is transmitted wirelessly to a cloud dashboard providing farmers with interactive disease heatmaps, treatment recommendations, and critic analytics. Field trials on wheat and tomato farms demonstrated a disease detection accuracy of 94.7%, with a mean inference latency of 38 milliseconds per frame. Notably, the system detected early-stage infections up to 72 hours before symptoms became visible to the human eye, enabling timely preventive intervention. Comparative evaluations confirm that the robot's close-proximity imaging outperforms drone-based and static-sensor approaches in early-onset and small-lesion detection scenarios. AgriVision-Bot offers a fast, cost-effective, and scalable AI-robotic framework for precision agriculture. By bridging Computer Vision and autonomous robotics, it delivers high-accuracy, low-latency crop health monitoring suited to real-world farm environments. The end-to-end pipeline from autonomous field traversal and image acquisition to cloud-based reporting shows strong potential for integration into smart farming infrastructure. Future work will explore multi-spectral imaging and reinforcement learning-based navigation to broaden crop variety coverage.

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Thienyl Core-Substituted Arylimides as Heavy Atom-Free Triplet Photosensitizers

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Abstract

Thienyl substituted naphthalenediimides (NDI) heavy atom-free triplet photosensitizers were synthesized to study the effect of thienyl group on ISC of NDI. The photophysical properties of compounds were studied with steady state and time-resolved spectroscopies. Negligible red-shift UV-visible absorption spectra of MT-NDI and MP-NDI and no significant bathochromic shift in emission were observed. We proposed that no synergetic effect in absorption and emission was observed for multiple electron pushing substituents on NDI core. However, fluorescence quenching with increased solvent polarity as well as electronic transition from HOMO to LUMO suggest that the excited state is with intramolecular charge transfer (ICT) character in thienyl core-substituted NDIs. Long triplet excited state lifetime (□T = 103.2 μs), high singlet oxygen quantum yield (ΦΔ = 41%) and high molar extinction coefficient (□ = 2.6 × 104 M□1 cm□1) was observed which makes it good triplet photosensitizer. fs-TA study reveals that MT-NDI and DT-NDI undergo solvent relaxation and internal conversion process within 10 ps time range and no triplet state was observed due to slow rate of ISC. Also no radical anion of NDI or radical cation of thiophene was observed with fs-TA experiment in polar as well as non-polar solvents, therefore the ISC is not via CS/CR. Quantum chemical calculations were performed for monosubstituted NDI compounds. The results matched well with experimental values which show the rationalization of our DFT/TDDFT computation. The theoretical calculations revealed that the ISC is enhanced by Sn/Tm energy matching in MT-NDI. Delayed fluorescence of P-type (TTA-DF) was also observed for MT-NDI which demonstrates its applications as luminescent bioimaging material. Triplet-triplet annihilation upconversion was performed by using MT-NDI as triplet photosensitizer and perylene as emitter and high upconversion quantum yield (ΦUC) of 2.1% were observed.

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Mechanistic Understanding of How AI-Adaptive Rehabilitation Gaming Drives Neuroplasticity for Long-term Sustainability, Adherence and Home-based Deployment

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Abstract
Artificial intelligence (AI)-adaptive rehabilitation gaming is a revolutionary modality in neurorehabilitation that uses an adaptive algorithm that processes the on-line data to engage and stimulate neuroplastic processes. Although AI-powered gaming is increasingly applied clinically, the mechanisms by which AI-driven gaming works to induce neuroplasticity are yet to be sufficiently synthesized. The purpose of this systematic review was to address the following research question: What are the mechanisms by which AI-adaptive rehabilitation gaming induces neuroplasticity and how can these mechanisms contribute to long-term sustainability, patient adherence and feasibility of home-based implementation? Based on PRISMA guidelines, 35 studies were selected from the published studies for the period 2022–2025. The outcomes show three related thematic fields. First, AI-adaptive game induces neuroplasticity by specifically targeting the Hebbian learning principles, activity-dependent remodeling of synapses, cortical remapping, and activation of reward circuits through dopaminergic pathways with a system's ability to adjust challenge levels in the optimal difficulty range. Second, real-time adaptive control mechanisms (such as closed-loop feedback, difficulty scaling based on performance, and the use of multimodal sensorimotor integration), allow to design adaptive rehabilitation using individual feedback and appropriate difficulty steps to standardize training and enhance the effectiveness of rehabilitation. Second, the adaptive control mechanisms (closed-loop biofeedback, performance-based difficulty scaling, and multimodal sensorimotor integration) facilitate the provision of personalized, responsive rehabilitation, where rehabilitation is tailored to the individual and involves repeated training sessions of the same task at varying difficulty levels. Third, gamification design elements such as intrinsic motivation, goal setting, and reward scaffolding, coupled with AI personalization and the infrastructure for telerehabilitation, all contribute to long-term adherence, engagement and scalable implementation at home. There is still some degree of methodological variation across the studies, such as in the design, outcomes measured, and AI architectures, which reduces the ability to draw general conclusions. Additional studies are required to develop consistent neuroimaging and behavioral endpoints, long-term retention of neuroplastic, and equity/accessibility of home deployment models.

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A Two-Stage YOLOv8 and EfficientNet-Based Retail Product Recognition Framework for Smart Shopping Cart Systems

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Abstract

Reliable and accurate product recognition is an essential requirement for smart shopping cart systems, self-checkout applications, and automated retail environments. However, recognizing retail products from camera images remains challenging because many products have similar packaging, color distributions, shapes, and visual textures. In this study, a two-stage deep learning framework is proposed for retail product recognition in smart shopping cart scenarios. The first stage uses YOLOv8 to detect and localize products within an input image, while the second stage applies an EfficientNet-based classifier to the cropped product regions for fine-grained recognition. This separation allows the detection model to focus on object localization and the classification model to learn subtle visual differences among similar product categories. The dataset was prepared with labeled product images and bounding box annotations, and several data augmentation techniques, including brightness adjustment, flipping, rotation, and noise addition, were applied to improve robustness under different visual conditions. The proposed framework was evaluated using class-wise precision, recall, F1-score, accuracy, and confusion matrix analysis. Experimental results show that the two-stage YOLOv8 and EfficientNet pipeline achieved 98.28% overall accuracy across 60 product classes and 1,221 test samples. The macro and weighted performance metrics also indicate balanced recognition behavior across different classes. Compared with a YOLOv8-only structure, the hybrid approach reduced confusion among visually similar products and produced stronger class separation. These results demonstrate that combining real-time object detection with fine-grained classification can provide a practical and effective solution for barcode-free product recognition, automatic cart analysis, and intelligent retail automation systems.

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AI-Driven Heart Disease Detection Through the Integration of Deep Learning and Large Language Models

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Abstract

Heart disease remains one of the leading causes of mortality worldwide, emphasizing the need for accurate and timely detection methods. Recent advances in artificial intelligence (AI), wearable healthcare technologies, and data-driven medical analytics have created new opportunities for the early identification and monitoring of cardiovascular conditions. This research proposes an AI-driven heart disease detection framework through the integration of deep Learning and large language models (LLMs) to enhance the accuracy, interpretability, and clinical usefulness of heart disease prediction systems. The proposed framework utilizes data including heart rate, electrocardiogram (ECG), blood oxygen saturation (SpO_2), blood pressure, and physical activity levels. Deep learning models are employed to automatically extract complex temporal and physiological patterns from these data streams and classify patients into normal or abnormal cardiac conditions. In this research, EfficientNet, MobileNetV3, VGG19, CapsNet deep learning models, and the large language model Clinical-Bert were used. The study evaluates the performance of the proposed framework using standard metrics, including accuracy, precision, recall, and F1-score. The proposed framework achieved an overall 99.0% accuracy. The proposed framework contributes to the development of intelligent, explainable, and patient-centered cardiovascular healthcare solutions.

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Wavelet-Based Physics-Constrained Representation Learning for Anomaly Detection in Rotating Machinery

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Abstract

Anomaly detection in rotating machinery is essential for predictive maintenance, yet existing approaches typically rely either on purely data-driven models or handcrafted signal processing techniques. Data-driven methods, such as deep neural networks, typically require large labeled datasets, often lack interpretability and may fail under distribution shifts, while traditional signal processing approaches are limited in modeling complex, non-stationary patterns. To address these limitations, we propose WP-CAD, a wavelet-based anomaly detection framework that integrates representation learning with physics-inspired constraints. The proposed method transforms raw vibration and electrical signals into time–frequency representations using the wavelet transform, enabling localized analysis of spectral behavior. An autoencoder is trained to capture normal operating patterns in this representation space. To incorporate physical knowledge, we introduce a physics-constrained loss that enforces consistency in harmonic energy distributions, temporal periodicity, and cross-modal relationships between vibration and electrical signals. This regularization guides the model toward representations that reflect the underlying physical structure of rotating systems. Anomaly scores are computed by combining reconstruction error with physics-based deviation, allowing robust detection of faults that disrupt expected signal patterns. We evaluate WP-CAD on a benchmark induction motor dataset and demonstrate improved detection performance compared to standard autoencoder baselines, along with enhanced stability and interpretability.

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