Preface

Warm greetings from **University POLITEHNICA of Bucharest,** Romania.

This edition of the ECAI 2026 is organized by **National University of Science and Technology POLITEHNICA Bucharest, Pitesti University Centre** - Faculty of Electronics, Communications and Computers, and **IEEE ROMANIA SECTION**, and hosted by the **National University of Science and Technology POLITEHNICA Bucharest, Faculty of Transports.**

The buildings of the **Faculty of Transports** will host the entire conference activities this year, and attendees will be able to tour and experience the program's state-of-the-art facilities. New broadcasting facilities in computer labs and all classrooms were the latest in educational technology that is from now the standard for all buildings on campus.

Conference sessions will cover a wide range of research subjects, including areas of the electronic and electric equipment, communication, automatic control, applied informatics, in- formation technology and computer science. The conference will include plenary and regular sessions, special sessions for young researchers, e – session, workshops, discussions' groups and social events.

The conference will conclude with a special invited panel and in the closing session will be included the comments and observations of the participants about the scientific impact of ECAI 2026 edition, considering that this edition will be IEEEXplore indexed.

This volume contains the papers presented at ECAI-2026: 17th Edition of International Conference on Electronics, Computers and Artificial Intelligence held on July 02-03, 2026 in Bucharest.

There were 345 submissions. Each submission was reviewed by at least 2, and on the average 4.5, program committee members. The committee decided to accept 306 papers. The program also includes 4 invited talks. The following workshops are organized under ECAI-2026

- **International Workshop on Applied Electronics-IWAE'26 ,** Organizers: Mihai Oproescu and Iana Gabriel
- **International Workshop on Systems Safety & Security-IWSSS' 26,** http://iwsss.org
- **International Workshop on Virtual Ubiquitous and Intelligent Computing (VUICON),** Organizers: Nicu Bizon, Bhargav Appasan and Bharati Ainapure
- **International Workshop on Technology and Materials Engineering - IWTME' 2026,** Organizers: Adriana-Gabriela Șchiopu and Mohammed Sallah
- **The Ro-Fr Workshop on Automotive: Advanced techniques to increase the autonomy of the plug-in electric vehicles - AT2APEV** with technical sponsorship of the IEEE Romanian section and IAS Ro&Fr Chapters; Organizer: Nicu Bizon.
- **International Workshop "Trends and Opportunities in Engineering Career" IWTOEC' 2026,** Organizers: Departament of Teacher's training by Adriana-Gabriela Șchiopu, Mihai Oproescu and Ionut Bulgaru
- **International Workshop on Robots and Ethics in Cyberspace**, Organizers: Ioana Corina BOGDAN, Emil SIMION, Thibaut RAHARIJAONA
- **Workshop on Electromagnetic Compatibility and Biocompatibility**, Organizers: Dumitru Cazacu (dumitru.cazacu@upb.ro)
- **International Workshop on Future Energy Market Based on Advanced Computing and Communication Technologies for Smart Grids (TechEnergy Market) ,** Organizers: Nicu Bizon and Florentina Magda Enescu

- **International Workshop on Artificial Intelligence of Things for Efficient Energy Generation and Management (AI-Energy),** Organizers: Nicu Bizon , Bhargav Appasani and Florentina Magda Enescu
- **International Workshop on Advanced Medical Imaging Techniques using Generative Artificial Intelligence (AI-Medical),** Organizers: Nicu Bizon and Bhargav Appasani
- **International Workshop on Emerging Technologies for Future Smart Grids (TechSmartGrid),** Organizers: Nicu Bizon and Bhargav Appasani
- **International Workshop on IoT, Energy Internet, Blockchain Technology and Smart Contracts-IoT'25,** Organizers: Nicu Bizon, Bhargav Appasani and Florentina Magda Enescu
- **International Workshop on Hybrid power systems and migrogrids-HPS&Mg'25,** Organizers: Nicu Bizon and Mihai Oproescu
- **International Workshop on Hydrogen and fuel cell applications-HyFC'25,** Organizers: Nicu Bizon and Mircea Raceanu
- **International Workshop on Electric and hybrid vehicles-EHV'25,** Organizers: Nicu Bizon and Mihai Oproescu
- **Special Session on Artificial Intelligence and Embedded Systems for Next-Generation Energy Conversion,** Organizers: Mourad Yessef and Hatim Ameziane

E-session information

The e-session sections of the ECAI 2026 Conference take place through the TEAMS platform. The time of the sections is Romanian time: https://www.thetimenow.com/romania

Don't miss out on what promises to be an engaging and dynamic event. We are looking forward to seeing you in Bucharest, at **University POLITEHNICA of Bucharest**, during the conference days. If you have any questions, please do not hesitate to contact the organizers at office@ecai.ro.

June 06, 2026

Pitesti

Mihai Oproescu
Gabriela Schiopu
Vlad-Ionut Oproescu

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INTERNAL ACADEMIC SABOTEUR AND ACADEMIC PERFORMANCE IN DIGITAL ENVIRONMENTS: THE ADAPTIVE SELF-REGULATED MONITORING MODEL AS A VOLITIONAL PROTECTIVE FACTOR

Crenguta Elena Preda and Mădălin Ciprian Enescu

***Abstract*—The rapid pace of digitalization and the emergence of Generative Artificial Intelligence (GenAI) in higher education have shifted the responsibility for cognitive monitoring entirely to students. This context can trigger the Internal Academic Saboteur (IAS), a dysfunctional self-protective pattern that predisposes individuals to cognitive offloading and an illusion of competence. This study evaluates the effectiveness of the Adaptive Self-Regulated Monitoring Model (ASRMM), implemented through a weekly digital journal kept over a 10-week period. The study employed a quasi-experimental design with repeated measures on a sample of N = 159 psychology students (M_age = 20.25 years; SD=1.52), divided into an experimental group (n = 79) and a control group (n = 80). The results partially refuted the initial hypothesis, revealing an unexpected positive correlation between IAS and pre-test performance ($r = .38$, $p < .001$), which can be explained by mechanisms of maladaptive perfectionism and strategic pessimism. However, the mixed ANOVA analysis revealed significantly greater academic progress in the post-test phase for the experimental group ($F = 60.11$, $\eta p2 = .277$). Furthermore, hierarchical regression analysis confirmed a robust moderating effect ($\Delta R2 = .078$, $\beta = .286$, $p < .001$), demonstrating that high adherence to the ASRMM log mitigates and neutralizes the negative impact of IAS on academic progress. In conclusion, the weekly log ceases to be a passive tool and becomes a form of digital scaffolding that prevents the transition from latent vulnerability to defensive avoidance strategies, thereby facilitating deep learning.**

Keywords—Academic performance, ASRMM, Internal Academic Saboteur, Cognitive load, Self-regulation of learning

DOMAIN-DRIVEN DESIGN AND ANNOTATION PROCESSING IN JAVA

Radu Bucea-Manea-Țoniș and Adrian Beteringhe

***Abstract*—Domain-Driven Design (DDD) structures complex business software around the domain model, making it particularly effective in finance, healthcare, and e-commerce. Java's strong typing and mature ecosystem enable robust DDD implementations. This paper examines how compile-time and runtime annotation processing complement DDD: compile-time processors enforce structure and generate boilerplate, while runtime validation (e.g., Bean Validation) enforces business rules without polluting domain classes. We present patterns, code snippets, and trade-offs for eventless DDD aligned with modular monoliths and microservices.**

Keywords—Domain-Driven Design (DDD), Data-Oriented Design (DOD), Data Transfer Object (DTO), Spring Boot, REST API

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IMPACT OF BOTNET DDOS ATTACKS ON UDP AND TCP PERFORMANCE IN IOT NETWORKS

Andrei Frâncu, Gabriel Predusca, Denisa Circiumarescu, Angelescu Nicoleta and Puchianu Dan Constantin

***Abstract*—The rapid expansion of Internet of Things (IoT) infrastructures has increased their exposure to Distributed Denial of Service (DDoS) attacks originating from Botnet infected devices. Due to limited computational resources and weak security mechanisms, IoT nodes are highly vulnerable to such attacks, which can severely degrade network performance and compromise service availability. This paper presents an experimental evaluation of the impact of Botnet driven DDoS attacks on an IoT network using the NetSim simulation environment. In this study, we analyse multiple attack scenarios that include one, two, and three compromised nodes, and we compare the behaviour of UDP and TCP transport protocols under different traffic-generation rates. We quantify network performance using standard QoS metrics such as throughput, end-to-end delay, and jitter. The results reveal a strongly nonlinear degradation pattern under attack conditions and highlight significant limitations of TCP in congestion prone IoT environments. While UDP sustains a higher throughput, it experiences substantial packet loss, whereas TCP becomes ineffective under intense traffic and attack conditions. The study underscores the necessity for advanced traffic control and security mechanisms capable of ensuring reliable IoT operation under DDoS threats.**

Keywords—Botnet, DDoS, attacks, IoT, NetSim, TCP, UDP

PROVABLY ULTRA-LIGHTWEIGHT AND POST-QUANTUM BIOMETRIC MUTUAL AUTHENTICATION PROTOCOL FOR SECURE IOHT ENVIRONMENTS

Enas Abood, Ali A. Yassin, Zaid Ameen Abduljabbar, Vincent Omollo Nyangaresi, Ali Hasan Ali and Abdulla J. Y. Aldarwish

***Abstract*—Securing user authentication while keeping device resources low remains an open problem in the Smart Environment of Things, particularly for the highly anticipated Internet of Health Things (IOHT). In this paper, we introduce a biometric-based, ultra-lightweight mutual authentication protocol for resource-constrained IoT. In addition to a lightweight cryptographic hash function and XOR operations, Kyber post-quantum lattice-based structures are used to secure the permission phase between a patient and a doctor, thereby allowing access to the EHR. Using the automated symbolic tool ProVerif, formal security verification shows that the protocol guarantees perfect session key secrecy, strong client-to-server mutual authentication, non-repudiation, and complete resistance to replay and man-in-the-middle attacks. Performance evaluations show that our scheme achieves efficient performance with a communication cost of 1344 bits, an ultra-low computation time of 0.0654 ms, and low energy consumption (0.43164 mJ). Network analysis also demonstrates remarkable performance, with total latency under 0.2 ms and server throughput exceeding 30,000 authentications per second. These observations validate that the newly suggested protocol offers a good trade-off between high security and scalability, making it an ideal candidate for real-world high-density IoT scenarios.**

Keywords—Post-Quantum Cryptography (PQC), Mutual Authentication, IOHT, Lightweight cryptographic methods

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MACHINE LEARNING-BASED PREDICTION OF SETTLED WATER TURBIDITY FOR OPTIMIZING ALUM DOSAGE IN DRINKING WATER TREATMENT

Dulashi Fernando, Samadhi Cooray, Praveen Jeyachandran, Dileesha Jayakodi, Prasanna Sumathipala and Salih Fousdeen

***Abstract*—Efficient chemical dosing is essential in drinking water treatment plants to ensure effective turbidity removal while minimizing chemical consumption and operational costs. Conventional alum dosing methods rely on manual jar tests and operator experience, which are time-consuming and often inadequate for handling rapid variations in raw water quality. Key parameters such as turbidity, pH, and electrical conductivity significantly influence the coagulation process, making accurate dosage determination a complex and dynamic challenge. This study proposes a machine learning–based approach to support optimal alum dosage selection by predicting settled water turbidity using historical treatment data. The dataset includes raw water turbidity, pH, conductivity, and applied alum dosage, which are used to train regression models capable of capturing nonlinear relationships between input parameters and treatment performance. Multiple algorithms, including Gradient Boosting, Random Forest, XGBoost, and LightGBM, were explored alongside feature engineering techniques to improve model effectiveness. Experimental results demonstrate that the Random Forest model achieves superior performance, with an R^2 score of 0.7909, RMSE of 0.5197, and MAE of 0.3166, indicating strong predictive reliability under varying water quality conditions. The trained model enables simulation of different dosing scenarios, allowing identification of the alum dosage that produces the lowest predicted turbidity under varying raw water conditions. The proposed approach provides a practical decision-support solution for improving treatment efficiency, reducing chemical overuse, and supporting more reliable operation of drinking water treatment processes.**

Keywords—Alum dosage optimization, Machine learning, Water treatment, Turbidity prediction, Explainable artificial intelligence, Conformal prediction, Water quality analysis

DEEP AUTOENCODER-DRIVEN NONLINEAR FEATURE COMPRESSION FOR ROBUST DDOS DETECTION IN IOT NETWORKS

Hayder Nabeel Jalo, Adnan Hussein Ali, Maaly Amer Mohammed, Anmar Yahya Taher, Saad Mutashar and Safaa Aqeel Khazraji

***Abstract*—The growing scale and complexity of Distributed Denial-of-Service (DDoS) attacks continues to pose a significant threat to modern IoT & networked systems by impacting service availability. While deep learning–based intrusion detection systems have showed great promise, their effectiveness is usually constrained by high-dimensional and redundant features of network traffic. To overcome this challenge, the proposed paper introduces an efficient DDoS detection framework based on a deep autoencoder–based dimensionality reduction followed by a neural network classifiers. The proposed method makes use of a deep autoencoder to learn compact and informative latent representations from high-dimensional network traffic flows. The extracted latent features will be the input for MLP and DNN classifiers to perform binary DDoS detection. The proposed framework is validated on the CICDDoS2019 dataset and the performance is measured through standard evaluation metrics such as accuracy, precision, recall and F1-score. Experimental results show that using autoencoder-based dimensionality reduction improves training stability and detection performance. The reduced feature space is beneficial for both classifiers; nevertheless, DNN showed performance superiority over MLP in all evaluation metrics with improved detection accuracy and robustness. Results confirm that the neutralisation of nonlinear features improves the performance of neural net–based DDoS detection with respect to more complex hybrid architectures. Deep representation learning for high-dimensional network traffic data enlightening DDoS solution in IoT networks state-of-the-art model of scalable, effective and reproducible framework.**

Keywords—DDoS Detection, Deep Autoencoder, Dimensionality Reduction, DNNs, IoT Security, CICDDoS2019

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MODELING AND EVALUATION OF RESILIENCE IN 5G CRITICAL COMMUNICATIONS USING COMPOSITE METRICS AND MULTI-ACCESS EDGE COMPUTING ARCHITECTURES

Constantin Alin Copaci

***Abstract*—This paper investigates how fifth-generation mobile networks integrated with Multi-Access Edge Computing sustain operational resilience during critical communication failures. By partitioning the network into distinct radio access, transport backhaul, core, and edge processing layers, our modeling approach maps end-to-end latency to isolate specific processing bottlenecks. We use Packet Delivery Ratio as the core reliability metric to fulfill Third Generation Partnership Project Ultra-Reliable Low Latency Communications requirements. To evaluate system performance under stress, we develop two distinct analytical frameworks: the Mission Continuity Score for tracking temporal service persistence during load spikes, and the Resilience Elasticity Index for measuring degradation paths and self-healing speed. Our methodology relies on extensive Monte Carlo simulations to analyze architectural stability under volatile traffic profiles and congestion. This iterative stochastic approach generates probability density functions that reveal tail latency behaviors during cascading network outages. The resulting statistical distributions prove that positioning user-plane functions at the network edge curtails transport delays and stabilizes system predictability. These findings define the structural limits of resilient, edge-based computing frameworks designed for time-critical operations.**

Keywords—composite metrics, Fifth-generation networks, Monte Carlo simulation, Multi-Access Edge Computing, network resilience

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DECENTRALIZED STORAGE SYSTEM WITH ENFORCED USER CONTROL OVER DATA

Diana-Mihaela Negut and Stefan-Ciprian Arseni

***Abstract*—Cloud storage remains concentrated among a handful of infrastructure providers, leaving the confidentiality and governance of user data dependent on operators that users must trust not to read, lose, or restrict access to their files. Decentralized storage networks remove the single operator but treat stored content as opaque, while the Solid Protocol restores user-level access control yet binds storage to a single Pod provider and leaves content unprotected below the access-control layer. This paper presents a decentralized storage platform that unifies these directions by combining the Solid Protocol, the InterPlanetary File System (IPFS), and blockchain-based coordination under a client-side encryption model. Files are encrypted on the user's device before reaching any external component, so that no infrastructure operator observes content in the clear; a two-layer key scheme enables file sharing through elliptic-curve key agreement without exposing encryption keys to the platform; storage obligations between consumers and providers are enforced through smart contracts that release payment only after cryptographic verification of file availability; and provider identity is attested through verifiable credentials anchored on-chain. A working prototype was implemented and evaluated; off-chain operations met their performance targets, with on-chain confirmation latency bounded by the underlying test network rather than the architecture, and security tests confirmed correct rejection of unauthorized requests, expired signatures, and invalid credentials.**

Keywords—decentralized storage, Solid Protocol, IPFS, verifiable credentials, smart contracts, access control

TECHNOLOGY-DRIVEN AGRICULTURAL MARKETS: POLICY CHALLENGES AND REGULATORY FRAMEWORKS IN THE DIGITAL ERA

Mariana Mirela Jătaru, Mădalin Ciprian Enescu, Nicu Bizon and Prantik Basak

***Abstract*—Mobile marketplace applications, in conjunction with aspects of governance, food security, public policy and economic regulation on the one hand, and the impact on the power of economic actors within the supply chain on the other, establish a direct link between producers and consumers while eliminating intermediaries. The aim of this paper is to promote sustainable agriculture, transparency and responsible consumption by facilitating the sale of organic agri-food products directly from farm to consumer. The application was implemented using the .NET MAUI platform for the mobile interface and WCF services for server-side data management, supported by a SQL Server database. The system integrates IoT sensors for monitoring transport conditions, a fuzzy logic module implemented in MATLAB for data analysis, and a Dialogflow chatbot that provides assistance to users. As a result, a comprehensive digital solution is proposed that combines modern technologies, including cross-platform development, web services, artificial intelligence and the Internet of Things, thereby optimising the sales process for organic products and supporting local producers in connecting directly with consumers.**

Keywords—organic agriculture, marketplace platforms, public policy, SQL Server database, Internet of Things, fuzzy logic system, sustainability

OPTIMIZING DUAL-AXIS SOLAR TRACKING: A COMPARATIVE APPROACH BETWEEN SIMPLE LDR CONTROL, PID, AND FUZZY LOGIC WITH ENERGY MANAGEMENT

Cornelia-Mihaela Novac, Marius Codrean, Mihaela Codrean, Anamaria Mihaela Codrean, Ovidiu-Constantin Novac and Mircea Danut Pantea

***Abstract*—Maximizing the efficiency of photovoltaic (PV) systems is highly contingent upon the optimal orientation of the panels relative to solar radiation. Although dual-axis solar tracking systems significantly increase the gross energy harvesting yield, their net efficiency is frequently diminished by inefficient control algorithms. Building upon recent developments in Arduino-based automated tracking, this paper presents a comparative analysis between a baseline tracking system (utilizing simple LDR control and Proportional-Integral-Derivative (PID) algorithms) and an advanced hybrid architecture integrating Artificial Intelligence via a Fuzzy Logic Controller (FLC) and a Battery Management System (BMS). To ensure high hardware reliability and mitigate wiring interference, the system employs an Arduino Sensor Shield and features a redundant manual control system for fault management. While classical control suffers from instability and high parasitic power consumption under variable meteorological conditions (the "hunting effect"), the proposed AI-enhanced system utilizes contextual evaluation (differential illumination, global radiation, and battery state of charge) to make optimal actuation decisions. Experimental results demonstrate that the Fuzzy-BMS architecture reduces unnecessary actuator movements by approximately 73% during partially cloudy days and improves the net energy yield by 15-20%, ensuring continuous operation and maximizing long-term durability.**

Keywords—Solar tracking, Fuzzy Logic, Battery Management System (BMS), PID Control, Hardware Redundancy, Photovoltaic Systems, Arduino

CONTINUOUS AUTHENTICATION USING BEHAVIORAL BIOMETRICS: A FOCUSED REVIEW AND ILLUSTRATIVE IMPLEMENTATION OF KEYSTROKE DYNAMICS

Calin Sandu and Racuciu Ciprian

***Abstract*—The increasing reliance on interconnected digital systems has intensified the need for authentication mechanisms that extend beyond traditional, static methods such as passwords or one-time biometric verification. These conventional approaches are vulnerable to credential compromise and are limited in their ability to detect unauthorized access after initial login. As a result, continuous authentication based on behavioral biometrics has gained attention as a complementary security mechanism. This paper, which is the initial part of a broader research, presents a focused review of behavioral biometrics for continuous authentication, with particular emphasis on keystroke dynamics. The review discusses the fundamental principles of behavioral authentication, the temporal features commonly extracted from typing behavior and the machine learning techniques typically employed to model user-specific patterns. To complement the overview, the paper also describes an illustrative JavaScript-based implementation for collecting keystroke dynamics data, detailing the capture of key press and release events, timing intervals and key hold durations. The structure and interpretation of the resulting dataset are examined to demonstrate how raw interaction events can be transformed into behavioral features suitable for authentication models.**

Keywords—continuous authentication, behavioral biometrics, keystroke dynamics, machine learning, user authentication

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AN AGENTIC MULTI-MODAL UNSTRUCTURED DATA PREPROCESSING FRAMEWORK WITH LLM-GUIDED ORCHESTRATION AND QUALITY-DRIVEN VALIDATION

Amodhya Silva, Lavindi Endera Arachchi, Nanduni Weerakoon and Amanda Arangalla

***Abstract*—Data preprocessing remains a persistent bottleneck in production machine learning pipelines, particularly when inputs are heterogeneous in modality, quality, and linguistic origin. Fixed-sequence pipelines apply the same operations regardless of whether the input actually requires them, wasting resources and risking degradation of already-clean data. This paper presents an agentic multi-modal preprocessing framework that addresses these inefficiencies through two complementary decision mechanisms: a locally-hosted large language model (LLM) that dynamically selects and sequences text-processing agents based on input characteristics, and a rule-based decision engine for images that evaluates quantitative quality metrics— Laplacian variance for blur, mean luminance for brightness, and standard deviation for contrast—to select only the agents a given image actually needs. Both pipelines incorporate post transformation validation. Text outputs are validated against a typed Pydantic schema. Image transformations are accepted or reverted based on PSNR and SSIM thresholds, ensuring that no processing step degrades the signal it was meant to improve. The entire system is built around an Apache Kafka streaming backbone that decouples ingestion, routing, processing, and persistence, enabling row-level parallelism for large text files and asynchronous image processing without blocking the API layer. Results are persisted to MongoDB and streamed to a React frontend via Server-Sent Events. The framework demonstrates that combining LLM-guided planning, quantitative quality assessment, and per-step validation produces a more adaptive and resource-efficient alternative to static preprocessing pipelines.**

Keywords—agentic AI, LLM orchestration, image preprocessing, text preprocessing, Kafka streaming, PSNR, SSIM, named entity recognition, multi-modal processing

NN-ASSISTED EVENT DE-SPAMMING FOR CERF-BASED ENERGY-AWARENESS NOTIFICATIONS: A PROOF-OF-CONCEPT IMPLEMENTATION

Vlad Sanduleac, Andreea-Georgiana Iantoc, Alexandru Raduica, Mihai Sanduleac, Stefan Popa, Lola Alacreu, Diego Garcia, Pablo Bort and Dorel Stanescu

***Abstract*—Energy awareness is increasingly important for shaping user behavior in energy communities. The Common European Reference Framework (CERF) targets energy-saving applications for monitoring and managing end-user energy consumption. Within this framework, the present paper investigates notification-based mechanisms for increasing user energy awareness relative to an energy community. The proposed approach combines classical signal filtering with NN-assisted event de-spamming and has been evaluated within the Eclipse Digital project for the Romanian pilot site. The main objective is to reduce excessive daily notifications in order to avoid behavioral saturation while maintaining user engagement in voluntary energy-consumption adaptation. This paper presents a proof-of-concept implementation of an NN-assisted event filtering and notification prioritization mechanism designed to limit redundant alerts generated from smart-meter event streams. Preliminary results indicate that the proposed approach can reduce the number of notifications generated from smart-meter event streams while preserving the operational capability of the monitoring framework.**

Keywords—CERF, energy awareness, human behavior, Intelligent notification engine, end-user

EVALUATING THE IMPACT OF QUANTUM COMPUTING ON CONVOLUTIONAL NEURAL NETWORK PERFORMANCE FOR MAMMOGRAM-BASED BREAST CANCER DETECTION

Rusul Hanoon, Hameed Farhan and Arwa Taqi

***Abstract*—Breast cancer remains a highly deadly disease that spreads rapidly among women worldwide. A significant control measure is needed to limit its rapid spread and save women's lives. When tumor sensitivity is uncertain, early detection becomes critical. Various computer technologies and models have been developed to detect breast cancer at an early stage. This study presents a hybrid model that combines a classical Convolutional Neural Network (CNN) with quantum deep learning, using the INbreast mammography database across three models. The first model is a fully CNN classifier. The second integrates CNN feature extraction with adjustable quantum-classification circuits, thereby forming a CNN-quantum hybrid model. The third model improves performance by combining a CNN with a quantum classifier. The first has achieved an accuracy 97.5%, the hybrid has achieved 99.16%, and the third achieved 99.58% accuracy with flawless sensitivity. These consequences highlight the impact of quantum machine learning on the recognition of complex patterns in medical imaging data and support additional research using superior datasets and advanced quantum systems.**

Keywords—Deep Learning, Breast Cancer, Hybrid Models, Artificial Intelligence (AI), Quantum Machine Learning (QML).

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DESIGN CONSIDERATIONS FOR OBTAINING FERRITIC GEOPOLYMERS FOR MAGNETIC FLUX ROUTING AND CONCENTRATION IN WPT SYSTEMS

Mihai Oproescu, Victor Florin Burcea, Gabriel-Vasile Iana, Ioan Lita, Valentin Alexandru Stan, Gheorghe Nistor, Ovidiu-Constantin Novac and Cornelia-Mihaela Novac

***Abstract*—This paper proposes a conceptual design methodology for ferrite geopolymer composites intended to guide and concentrate magnetic flux in WPT systems. The proposed materials are based on a metakaolin geopolymer matrix modified with magnetic and functional oxides, including Fe_3O_4, MgO, ZnO, TiO_2, and CuO. The geopolymer matrix provides high electrical resistivity and good mechanical stability, while the embedded magnetic phase contributes to increasing the effective magnetic permeability and improving the magnetic coupling between coils. Key design parameters such as magnetic phase volume fraction, particle size and dispersion, and the geometry and thickness of the magnetic layer are analyzed in relation to their influence on electromagnetic performance. To evaluate the potential impact of the proposed materials on system performance, a parametric simulation approach is implemented in Matlab/Simulink. The effect of the geopolymer-ferrite layer is modeled through variations of the magnetic coupling coefficient as a function of material composition and layer thickness. The proposed methodology is initially validated for low-power WPT systems (10 W), with the possibility of extending the approach to higher-power applications. The results highlight the potential of ferrite geopolymer composites as structurally robust and functionally adaptable materials for improving magnetic flux management in wireless power transfer systems.**

Keywords—Wireless Power Transfer (WPT), ferrite geopolymers, magnetic flux concentration, inductive coupling coefficient, electromagnetic simulation

MARKETMATIC: MULTI-TENANT CUSTOMER SUPPORT SMART ASSISTANT WITH RAG FOR SMALL AND MEDIUM ENTERPRISES

Sanuda Sandipa, Sachinthya Rajapakshe, Gimhani Jayasuriya, Ishara Wijayarathna, Dr.Kapila Dissanayaka and Ms.Fathima Fanoon

***Abstract*—This paper presents the design, implementation, and evaluation of MarketMatic, an AI-powered multi-tenant Smart Assistant leveraging Retrieval-Augmented Generation (RAG) to deliver accurate, context-grounded customer support for Small and Medium Enterprises (SMEs). Each business tenant uploads domain-specific knowledge base documents (PDF, DOCX, TXT), which are processed through a section aware text chunking pipeline, embedded using the Nomic Embed-Text model (768 dimensions), and stored in per-tenant ChromaDB vector collections enforcing strict data isolation. User queries are resolved through an adaptive nine-stage retrieval pipeline: semantic vector search with dynamic threshold adjustment, near-duplicate deduplication via overlap coefficient filtering (threshold = 0.88), diversity-aware chunk selection, keyword-based fallback retrieval, and optional cross encoder reranking using BAAI/bge-reranker-base. Response generation employs LLaMA 3.1 8B on a Modal A10G GPU, with transparent failover to the Groq Cloud API. The platform further incorporates a three-tier role-based access control model, an agentic tool layer with five configurable business intent tools, cross-session persistent memory through LLM extracted fact distillation, AI-generated session analytics, and automated knowledge-gap detection. Experimental evaluation across eight business domain categories demonstrates a mean retrieval confidence of 0.81 and a 13.2 % improvement over fixed-window chunking, with high functional accuracy on domain-specific queries with complete source traceability, though broader evaluation across additional domains remains a direction for future work.**

Keywords—Retrieval-Augmented Generation, Multi-Tenancy, Large Language Models, SME Customer Support, Agentic AI

LIGHTWEIGHT SKELETON-BASED DRIVER DISTRACTION DETECTION USING GEOMETRIC FEATURES AND SUBJECT-INDEPENDENT LEARNING

Abakar Abbas Abakar and Yacine Yaddaden

***Abstract*—Driver distraction is a leading cause of road traffic fatalities worldwide. While deep learning-based approaches have significantly advanced the field, most existing methods rely on end-to-end convolutional architectures that are computationally demanding, difficult to interpret, and sensitive to variations in scale and viewpoint. This paper presents a lightweight geometric framework for binary driver distraction detection. Upper-body keypoints are extracted using a High-Resolution Network (HRNet)-based pose estimation model, from which 31 geometric features are derived, including 21 normalized pairwise Euclidean distances and 10 joint angles. The multi-class distraction problem is reformulated as a binary classification task distinguishing normal driving (c0) from all distracted states (c1--c9), and evaluated under a Leave-One-Subject-Out Cross-Validation (LOSO-CV) protocol. Experiments conducted on the State Farm Distracted Driver Detection dataset and the AUCDD (American University in Cairo Distracted Driver) benchmark achieve mean accuracies of 94.60\% (Area Under the Curve -- Receiver Operating Characteristic, AUC-ROC = 0.9806) and 83.17\% (AUC-ROC = 0.9028), respectively. These results demonstrate that compact skeleton-based geometric representations provide an interpretable, scale-invariant, and computationally efficient alternative to deep convolutional models for real-time driver monitoring applications.**

Keywords—Driver distraction detection, Binary classification, Human pose estimation, HRNet, Skeleton-based representation, Feature engineering, Scale normalization, Intelligent driver monitoring

IoT-Integrated Hybrid Machine Learning for Short-Term Raw Water Quality Forecasting

Dulashi Fernando, Samadhi Cooray, Praveen Jeyachandran, Dileesha Jayakodi, Prasanna Sumathipala and Salih Fousdeen

***Abstract*—Ensuring stable drinking water treatment operations remains a critical challenge due to highly dynamic raw water quality influenced by rainfall events upstream activities, and environmental variability. To better capture these effects, the system explicitly incorporates environmental, hydrological, and weather parameters such as rainfall, river flow, river level, temperature, and temporal indicators as predictive inputs. These fluctuations lead to difficulties in process optimization, chemical dosing, and timely decision-making in water treatment plants. This study presents an end-to-end, IoT- integrated hybrid machine learning framework for short- term raw water quality forecasting in a large-scale water treatment facility. The proposed system combines real-time sensor data acquisition with advanced predictive modeling using XGBoost, Long Short-Term Memory (LSTM), and a hybrid model to accurately forecast key water quality parameters, including turbidity, conductivity, and pH. Unlike approaches that rely solely on static historical datasets, this system operates on real-time data streams enriched with environmental inputs, reflecting actual treatment plant conditions. To enhance reliability and operational trust, the framework incorporates uncertainty quantification through Monte Carlo Dropout and explainability using SHAP-based feature attribution. The system further integrates a cloud- based data pipeline and an interactive dashboard for real- time monitoring, early warning, and decision support. Experimental results show that the hybrid model achieves strong predictive performance, with R^2 values exceeding 0.92 for turbidity and above 0.96 for conductivity and pH, effectively capturing both nonlinear feature interactions and temporal dependencies. The proposed framework offers a scalable and intelligent solution for improving treatment efficiency, enabling proactive interventions, and supporting data-driven water resource management in developing regions.**

Keywords—Hybrid Machine Learning, Short-Term Water Quality Forecasting, Explainable AI, IoT-Based Water Quality Monitoring, Monte Carlo Dropout

DETECTING MACRO NUTRIENTS DEFICIENCY IN PLANTS USING IMAGE PROCESSING

Nahita Pathania, Richa Jain, Navjot Kaur and Robin Kumar

***Abstract*—Maintaining agricultural productivity requires being able to identify nutritional deficits in plants. It takes a lot of time and energy to uncover these problems using traditional methods. With the help of image processing tools, this project proposes a unique method for identifying macronutrient shortages in plants. photos of plant leaves exhibiting signs of shortages, including deficiencies in potassium (K), nitrogen (N), and phosphorus (P). These images are upgraded and pre- processed in order to improve the dataset. Based on the processed pictures, a convolutional neural network (CNN) model named model is created using TensorFlow and Keras to categorise nutritional shortage groups. The model architecture consists of max-pooling, dropout, convolutional, and fully connected layers. The model's performance is evaluated using measures like Cohen's Kappa coefficient, F1-score, accuracy, precision, and recall. To further improve the robustness of the model, several filters are used such as Gaussian blur, median blur, and bilateral blur, along with picture augmentation approaches. Plant nutrient shortages may be accurately identified by the top-performing model, which obtains an accuracy of 92% on the test set. This technique offers a potentially effective way to identify and diagnose nutrient shortages in plants early on contributing to improved agricultural practices and crop yields.**

Keywords—Nitrogen deficiency detection in crops, Leaf chlorosis image analysis, Deep learning-based plant disease classification, Precision agriculture yield prediction models, CNN-based crop health monitoring

EFFICIENT COVERAGE AREA PREDICTION VIA WEIGHT-SHARING 1D RESIDUAL U-NET WITH SE-BLOCKS

Ugur Erbas, Tahir Bekiryazıcı, Gürkan Aydemir and Mehmet Baris Tabakcioglu

***Abstract*—Accurate and efficient prediction of signal coverage is of critical importance for wireless network optimization and base station planning. This study advances a baseline one-dimensional convolutional neural network (1D-CNN) architecture previously proposed by the authors by integrating a attention mechanism. The proposed multi-branch architecture is trained on a physically consistent dataset generated using the Uniform Theory of Diffraction (UTD) and Geometrical Optics (GO) methods. The results demonstrate that the integration of the attention mechanism reduces the average root mean square error (RMSE) from 1.267 dB to 0.954 dB, corresponding to a 24.7% improvement in overall performance. Furthermore, error distribution analyses reveal that the proposed model produces significantly more stable and lower-variance predictions, particularly in complex propagation scenarios. In addition, the model achieves more than 200,000× speed improvement compared to conventional ray tracing methods, providing a powerful solution for real-time coverage prediction at 1-meter spatial resolution.**

Keywords—coverage area, deep convolutional neural network, geometric optic, UTD, multi-branch neural networ, ray tracing

FEDA11YB: FEDERATED CONTEXT-AWARE ACCESSIBILITY FOR YOUTH ENTERTAINMENT

Ayah Jarour

***Abstract*—Smart city entertainment, including movies, concerts, and games in stadiums, is consumed by young people through kiosks and mobile flows amid changing lighting, noise, and crowds. To bridge this divergence between average acceptance and runtime behavior tuning, we present FedA11y B, a five-mode accessibility engine whose context-aware switching policy is realized via Federated Learning (FL) and tuned through a dropout-aware post-prediction layer with task completion predisposed into account. The design extends WCAG 2.2 and EN 301 549 as compared with prior designs by allowing for live, real-time policy control for public-facing ICT without compromising existing conformance objectives. We train the policy using FedAvg on a non-IID venue split and then discuss how it aligns with organizational privacy frameworks and differentially private training, as appropriate. In the controlled simulation for entertainment journeys, FedA11y B improves the time (s) from 43.000 to 40.870 and then to 37.430; reduces errors (count) from 2.560 to 2.140 and then to 1.700; and lowers dropout (probability) from 0.248 to 0.223 and then to 0.213 compared with non-adaptive and rule-based baselines. In addition, the worst group gaps are lower than before, enabling equitable access by youth.**

Keywords—Smart city entertainment, youth accessibility, federated learning

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ANALYSIS AND SIMULATION OF THE CAPACITIVE AND INDUCTIVE COUPLING OF PERTURBATIONS ON MIXED SIGNAL PRINTED CIRCUIT BOARDS

Sergiu-Leonard Tulbure

***Abstract*—Power to analog perturbation is a challenge in mixed signal PCBs, where high dv/dt switching signals run in traces near measurement paths. Based on my previous passive measurement study presented at ISSCS 2025, this work extends the analysis through detailed extraction and simulation of parasitic elements. Four PCB variants with different routing strategies are characterized by computing trace resistance, inductance, mutual capacitance, and trace to ground capacitance from layout geometry; these parameters are used to build SPICE aggressor-victim models. Simulations reproduce experimentally observed behavior. The results demonstrate that PCB geometry dominates the coupling mechanism and confirm that the proposed simulation approach reliably predicts power to analog interference in mixed-signal systems.**

Keywords—PCB, crosstalk, capacitive coupling, inductive coupling, parasitic elements, SPICE simulation

COMPARISON OF HUMAN AND AI CODE REVIEW: A CASE STUDY ON EFFICIENCY, ACCURACY, AND PRACTICAL IMPACT

Ovidiu-Constantin Novac, Cornelia-Mihaela Novac, Larisa-Maria Borlea, Laura Christiana Simionescu Dobrescu and Adrian-Alexandru Tulbure

***Abstract*—This paper presents a comprehensive comparative analysis between human and AI-assisted code review methodologies, focusing on efficiency, accuracy and their impact on software quality. As modern software development increasingly integrates artificial intelligence (AI) tools, the volume of generated code has significantly expanded, creating new challenges for quality assurance processes. While AI-based tools provide quick feedback and scalability, they often lack contextual understanding and produce lower-value suggestions. In contrast, human reviewers offer deeper insights into logic and architecture, but require significantly more time. This study evaluates both approaches through existing literature and practical analysis, highlighting their strengths and limitations. The findings suggest that a hybrid model combining automated and human review processes provides the most effective solution for maintaining code quality while preserving development speed.**

Keywords—code review, artificial intelligence, software quality, hybrid model, software engineering

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FAULT-TOLERANT HUMAN DETECTION USING RADAR-CAMERA FUSION

Ibrahim Toy and Akif Durdu

***Abstract*—This paper presents a fault-tolerant human detection system that integrates a 77 GHz FMCW radar module and a visible-light camera through a hybrid sensor fusion architecture. The camera subsystem employs YOLOv4-tiny to perform real-time person detection, while the radar subsystem, built around the Texas Instruments AWR1843 ES2.0 single-chip SoC, leverages on-chip signal processing to offload the host CPU and provides range, angle, and velocity measurements as a processed point cloud. Under normal operating conditions, detected bounding boxes from the camera are fused with projected radar point cloud data to estimate target distance. A three-criterion camera health monitoring mechanism continuously evaluates image quality through focus measure and edge density analysis. When the camera is deemed unreliable due to low illumination, occlusion, or hardware failure, the system autonomously transitions to a radar-only detection mode employing DBSCAN-based clustering and human signature classification, with mode switching completed within 333 ms. This hybrid approach ensures continuous human detection regardless of camera availability. Inter-module communication is established via a TCP-based real-time data stream using a lightweight JSON protocol. Experimental results demonstrate that sensor fusion raises detection confidence from 0.5 in radar-only mode at 1.7 m to 0.9 in fusion mode at 1.7 m, while providing metrically grounded distance estimates that neither modality can deliver alone. The complete system sustains approximately 30 Hz throughput on a CPU-only embedded platform, confirming that robust, fault-tolerant human detection is achievable without dedicated GPU hardware. These findings highlight the proposed system's potential for safety-critical ADAS and indoor monitoring applications.**

Keywords—Fault Tolerance, FMCW Radar, Human Detection, Sensor Fusion, YOLO Algorithm

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QUERY-CONDITIONED CLOSURE-FIELD WRITING UNDER A SINGLE-READ CONSTRAINT

Felix Koba and Stevan Cakic

***Abstract*—Ordered relational queries do not require a model to retrieve a single stored edge. Instead, they require following relations in a specific order to return the final endpoint. A correct endpoint does not confirm that the model executed the traversal, since the same answer could be guessed, copied, or produced through a hidden shortcut. We introduce a single-read diagnostic protocol. The model receives facts and a path query, builds a temporary associative field for that query, and the answer must be obtained in one read. Repeated reads, candidate search, and reader-side correction are not allowed. This setup distinguishes value selection, field writing, ordered traversal, and rejection under a wrong key. Experiments show that the read path is not the main issue. When the correct value is known, exact-write and clean one-hop conditions yield the answer in one read. Instability shows up earlier. The model must choose the right endpoint from the complete set of distractors before writing it. This failure occurs in one-hop full-distractor queries, before multi-hop composition becomes necessary. Longer training helps some runs, but does not stabilize the condition across random seeds. In this context, path length is not the main limitation as long as source-relation-target roles are available. An explicit step-by-step transition procedure solves chains up to length 32, including the supervised slot-grounded version. A separate boundary emerges after writing. A wrong key can retrieve the written endpoint through address overlap. Endpoint accuracy establishes endpoint reachability under the allowed read, but it does not identify the mechanism. Value selection before writing, ordered composition, canonical relation-label alignment, and wrong-key rejection remain separate checks.**

Keywords—relational state tracking, path closure, differentiable memory, vector-symbolic-inspired memory, associative retrieval, causal controls

VISION-BASED ATTENDANCE MARKING SYSTEM

Mohammed Badliwala, Lalit Rathod, Sumit Tapal, Aditya Doiphode and Vrishali Walanj

***Abstract*—This project aims to create an automated Vision-Based Attendance Marking System that is expected to replace the inefficient and inaccurate manual attendance systems currently used in educational and professional settings. The system is developed using Python and OpenCV for video processing and the Face Recognition library for identity verification using 128-dimensional facial embeddings. After the identity is confirmed, the attendance information of the individual (name, date, and time) is recorded automatically in a Microsoft Excel or Google Spreadsheet. Keywords: Computer Vision, Face Recognition, Python, OpenCV, Arduino, NumPy, Automated Attendance, IoT, Real-time Database.**

Keywords—Camera circuit, photo processing, Arduino, AI, contactless system

FUZZY-ADAPTIVE BAYESIAN HYPERPARAMETER OPTIMIZATION METHOD FOR XGBOOST

Nabaa Alsinayyid and Maytham Alabbas

***Abstract*—Abstract— Optimizing the hyperparameters of a machine learning model remains a critical bottleneck in achieving peak performance from a model. In this paper, we introduce Fuzzy-Adaptive Bayesian Hyperparameter Optimization (FABHO), a novel algorithm for automatically tuning the hyperparameters of an XGBoost model. FABHO was evaluated against six different approaches on four classification and two regression datasets. The results of the one-way ANOVA and Bonferroni's paired t-test tests show that FABHO achieves the highest predictive performance on three of the six datasets and the second-highest on the remaining three datasets. These results indicate that FABHO is a robust and generalizable approach for hyperparameter optimization in machine learning.**

Keywords—XGBoost, Hyperparameter Optimization, Bayesian Optimization, Fuzzy-Adaptive Bayesian, Hyperband

ADVANCED METHODOLOGIES FOR TESTING AND EVALUATING AUTONOMOUS VEHICLES: A STATE-OF-THE-ART REVIEW AND FUTURE DIRECTIONS

Ionut Georgian Stroie and Marius Minea

***Abstract*—The transition from Advanced Driver Assistance Systems (ADAS) to fully Autonomous Vehicles (AVs) has generated unprecedented challenges regarding safety validation and certification. Traditional testing methods, relying exclusively on distance-based testing (mileage-based), have proven statistically impractical for demonstrating a reliability superior to that of human drivers. This paper presents a critical analysis of the current state-of-the-art in autonomous vehicle testing methodologies, highlighting the limitations of existing approaches from the perspective of the Safety of the Intended Functionality (SOTIF - ISO 21448). The study evaluates the efficacy of hybrid testing environments, such as X in the Loop (XIL) architectures, and analyzes critical vulnerabilities caused by the Sim to Real gap. As its main contribution, this paper systematizes the research gaps within the specialized literature and proposes future research directions focused on developing a unified performance evaluation framework. This framework integrates dynamic risk metrics and real-time assessment of sensory degradation. Ultimately, this synthesis provides a robust foundation for future adaptive testing standards in autonomous vehicle engineering.**

Keywords—Advanced Driver Assistance Systems (ADAS), Autonomous Vehicles (AV), Machine Learning (ML), Operational Design Domain (ODD), Electrical and Electronic (E/E)), Original Equipment Manufacturer (OEM)

DESIGN AND EXPERIMENTAL VALIDATION OF AN OPEN-SOURCE IIOT ARCHITECTURE FOR ELECTRICAL CABINET MONITORING IN HYDROELECTRIC POWER PLANTS

Sorin Tălpășanu, Florin Argatu, Ioana-Raluca Adochiei, George Calin Seritan and Felix Constantin Adochiei

***Abstract*—The energy sector is undergoing an accelerated digitalization process in which continuous monitoring of critical infrastructure has become both a technical and operational requirement. Hydroelectric power plants, as strategic units within the national energy system, contain numerous electrical cabinets whose parameters must be permanently tracked to ensure operational availability and safety. This paper presents an Industrial Internet of Things (IIoT) open-source architecture dedicated to the supervision of such a cabinet. The system integrates a Janitza UMG 104 industrial power analyzer and an XY-MD02 temperature and humidity sensor through a Waveshare ESP32-S3 industrial gateway, with field-level communication carried out via Modbus RTU over an RS-485 bus. Data are aggregated by a Mosquitto MQTT broker running on a Home Assistant Operating System platform hosted on a Raspberry Pi 5, while remote access is provided through a Cloudflare tunnel with HTTPS encryption. The proposed solution offers low cost, high flexibility, and a security level adequate for an industrial application, while eliminating single-vendor dependency. Experimental validation demonstrated stable communication between field devices and the supervisory platform, reliable remote monitoring through encrypted HTTPS connections, and real-time actuator control with low operational latency. The proposed architecture represents a scalable and cost-effective alternative to proprietary SCADA solutions for medium-complexity industrial applications.**

Keywords—IIoT, SCADA, hydroelectric power plant, Home Assistant, Modbus RTU, MQTT, open source

LEARNING UNDER DATA SCARCITY: DO HYBRID QUANTUM-CLASSICAL MODELS GENERALIZE DIFFERENTLY?

Zorana Štaka and Marko Mišić

***Abstract*—The goal of this study is to empirically investigate whether and in what way hybrid quantum-classical neural networks (QNN) generalize differently from classical neural networks under data scarcity. Rather than claiming a quantum advantage, the study focuses on providing a rigorous and reproducible framework to evaluate neural network performance under different data scarcity regimes. Two classical feedforward neural networks and two QNNs are evaluated across six datasets. This evaluation includes both fractional and absolute scarcity regimes to capture different low-data conditions. Evaluated characteristics include generalization, overfitting, stability, and degradation. Results show that while classical models do achieve higher accuracy, QNNs have a smaller generalization gap, remaining below corresponding theoretical upper-bound estimates. Additionally, QNNs display increased seed sensitivity. Overall, these findings suggest that classical and QNNs exhibit different generalization and degradation dynamics under scarcity, extending beyond predictive accuracy alone.**

Keywords—quantum machine learning, hybrid quantum-classical neural networks, data scarcity, generalization, model stability, supervised learning

DESIGN AND DEVELOPMENT OF A WEARABLE MULTIMODAL REHABILITATION BELT FOR CHRONIC LOW BACK PAIN

Saja B. Attallah, Dhiaa M. Abed, Dania H. Salman, Rusul K. Luaebee, Hussein M. Rashid, Rafif Aman Mahammed, Ali S. Abdulmohsin, Zaid Ameen Abduljabbar and Vincent Nyangaresi

Abstract*—Chronic low back pain (CLBP) is one of the leading causes of disability worldwide and significantly affects mobility, work productivity, and quality of life. Conventional rehabilitation approaches often rely on passive lumbar supports or single-modality therapies that provide limited long-term rehabilitation effectiveness. This study presents the design and development of a wearable multimodal rehabilitation belt integrating thermal therapy and vibration stimulation for non-invasive chronic low back pain management. The proposed rehabilitation system incorporates flexible heating pads, high-speed DC vibration motors, embedded microcontroller-based control, rechargeable power management, and ergonomic lumbar support within a lightweight wearable platform suitable for continuous home-based rehabilitation. The thermal subsystem operates within a controlled therapeutic temperature range of 37–45°C to improve blood circulation, reduce muscular stiffness, and promote muscle relaxation. Simultaneously, the vibration subsystem delivers localized mechanical stimulation for pain modulation and neuromuscular activation. An experimental evaluation was conducted using participants with different occupational backgrounds experiencing lower back discomfort caused by prolonged sitting, poor posture, or physical strain. The obtained results demonstrated noticeable improvement in rehabilitation comfort, pain reduction, and muscle relaxation, with satisfaction levels ranging from 50% to 85% and an average overall satisfaction score of 69%. The proposed system demonstrated several practical advantages, including portability, lightweight wearable design, rechargeable operation, adjustable therapeutic control, and suitability for continuous rehabilitation applications. Overall, the developed rehabilitation belt represents a promising wearable biomedical solution for chronic low back pain rehabilitation and supportive musculoskeletal therapy.

Keywords—Chronic low back pain, wearable rehabilitation belt, multimodal therapy, thermal therapy, vibration therapy, pain management, wearable biomedical system

DIRECT ITERATIVE FEEDBACK TUNING OF ANTI-WINDUP FUZZY CONTROL OF SMALL RESCUE MOBILE ROBOT

Radu-Emil Precup, Robert-Catalin Diaconu, Raul-Cristian Roman and Elena-Lorena Hedrea

***Abstract*—This paper first describes the development of a small, remote-controlled, mobile robot designed primarily to find victims in areas affected by natural disasters. The robot is equipped with an integrated video camera that can capture and send a continuous stream of images at speeds up to 60 FPS in real time. The camera position can be adjusted remotely and independently of the robot's movements. The most valuable feature of the mobile robot is its wireless connection, which facilitates communication with servers for statistical data and with the person controlling the robot. The paper also suggests the direct tuning of anti-windup Takagi-Sugeno-Kang (TSK) Proportional-Integral (PI) fuzzy controllers for angular position control of the two front wheels using Iterative Feedback Tuning (IFT). A back-calculation and tracking anti-windup scheme is included in order to mitigate integrator windup while compensating for the process dead-zone and saturation effects. The direct data-driven tuning approach performs experiment-based parameter tuning of the TSK PI fuzzy controller and anti-windup tracking gain in a few iterations of IFT. The experimental results demonstrate the application of the data-driven fuzzy control approach and represent a step forward in designing low-cost rescue mobile robots.**

Keywords—data-driven fuzzy control, Iterative Feedback Tuning, Proportional-Integral fuzzy control, rescue mobile robots, sensors

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SECURE, TRANSPARENT DATA RETRIEVAL: A REVIEW OF BLOCKCHAIN-INTEGRATED SEARCHABLE ENCRYPTION IN CLOUD ENVIRONMENTS

Salim Sabah Bulbul, Mohammed Abdulridha Hussain, Zahraa Abdullah Ali, Zaid Ameen Abduljabbar, Vincent Nyangaresi, Hamid Ali Abed Al-Asadi, Ali Hasan Ali, Abdulla J. Y. Aldarwish and Zaid Alaa Hussien

***Abstract*—Although cloud computing has become an important aspect of data storage and retrieval, it is associated with significant issues of confidentiality, integrity, and trust in centralized service providers. Searchable encryption (SE) is a potentially appealing solution, as it supports keyword searches of encrypted data; however, existing SE systems still suffer from problems such as leakage of sensitive information, the production of non-verifiable results, and limited transparency. Recent studies have shown that a combination of blockchain and SE can enhance security through decentralization, immutability, auditability, and a verifiable search operation. The review presented in this paper provides a systematic categorization of blockchain-based SE schemes published between 2022 and 2025, including symmetric-based, public-key DE, attribute-based DE (ABDE), fuzzy private sets, and AI-aided models, as well as post-quantum-based approaches. We propose an efficiency-, security-, and practice-oriented comparative evaluation framework, and point out some of the most significant challenges, such as pattern leakage, blockchain overheads, smart contract risks, scalability bottlenecks, and multi-authority management. Motivated by these requirements, we argue for a unified next-generation design that includes on/off-chain verifiability, dynamic privacy, decentralized key management, post-quantum security, Layer 2 scaling, and hybrid exact–fuzzy searching. The aims of this survey are to present an in-depth assessment of the current state of the art and to provide a framework for the future development of secure, transparent, and practical blockchain-based SE systems that can support large-scale real-world cloud applications.**

Keywords—privacy protection, blockchain, cloud computing, searchable encryption, lattice cryptography, log system

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INFRAAGENT: A MULTI-AGENT AI FRAMEWORK FOR PREDICTIVE DEPLOYMENT FAILURE DETECTION AND AUTONOMOUS REMEDIATION IN MULTI-CLOUD ENVIRONMENTS

Harish Apuri, Shikher Goel, Madhan Mohan Chinthala and Charani Yepuri

***Abstract*—Managing modern cloud-native infrastructure is, frankly, a problem that has grown faster than our tools for handling it. Continuous delivery pipelines, ephemeral containers, and sprawling multi-cloud IaC ecosystems create an operational surface that expands combinatorially with organisational scale and static rule-based monitoring simply cannot keep up. This paper presents InfraAgent, a five-agent agentic AI framework de- signed for predictive infrastructure management and autonomous deployment operations in heterogeneous multi-cloud settings. The framework brings together: a Temporal Graph Attention Network (T-GAN) agent that jointly models infrastructure de- pendency topology and multi-variate telemetry for deployment failure prediction across 1 hour, 6 hour, and 24-hour horizons; an LLM-powered Remediation Planning Agent (RPA) that generates context-aware IaC patches, rollout prescriptions, and rollback directives directly from risk scores; a Deployment Safety Agent (DSA) that enforces configurable pre-flight autonomy gates; a Capacity Forecasting Agent (CFA) built on a Temporal Fusion Transformer (TFT) for probabilistic 24 hour to 72 hour demand forecasting; and a Continuous Operational Intelligence Orchestra- tor (COIO) that provides closed-loop governance, cryptographic auditability, and online model adaptation. We evaluate InfraAgent on 47,800 deployment events and 310,000 telemetry snapshots drawn from AWS, Azure, and GCP production environments. The results are encouraging where a Mean Time to Detection of 4.3 minutes (an 85.2% reduction over rule-based baselines), a deployment failure prediction F1 of 0.931, a 76.8% reduction in production incidents per 100 CI/CD runs, and 91.4% capacity forecast accuracy at the 72- hour horizon. Together, these numbers suggest that coordinated agentic reasoning grounded in graph-temporal learning can meaningfully shift cloud operations from reactive firefighting toward continuous, self-correcting infrastructure assurance.**

Keywords—Agentic AI, Infrastructure Management, Autonomous Deployment, Predictive Remediation, Multi-Agent Systems, Cloud Operations, Temporal Graph Attention Networks, Large Language Model Agents, CI/CD Automation, Site Reliability Engineering, Capacity Forecasti

MONTE CARLO SAMPLING AND GRADIENT-BASED OPTIMIZATION FOR AN OIL-WATER SEPARATION PROCESS

Sanda Florentina Mihalache, Marian Popescu and Marian Todoran

***Abstract*—This paper addresses the optimization of an oil-water separation process that is an integral part of an onshore crude oil extraction, collecting, and treatment plant. The process receives three-phase emulsion streams from primary well separators, combines them in a collector tank, and routes the mixture through a heating separator before delivering treated crude oil to distribution clients. A simplified mathematical model is developed that captures the key process variables - individual well flowrates (Q1, Q2, Q3) and separator operating temperature (T) - through exponential impurity decay kinetics, Darcy-Weisbach pressure-drop equations, and a temperature correction factor for fluid viscosity. An economic objective function is formulated to maximize the operational profit, subject to a nonlinear quality constraint limiting residual water content to at most 15%. Three complementary optimization strategies are applied and compared: Random Sampling Monte Carlo (RS-MC), Latin Hypercube Sampling Monte Carlo (LHS-MC), and gradient-based optimization via MATLAB's fmincon with an interior-point algorithm. The stochastic methods are evaluated over six sample sizes with 30 independent replications each, while fmincon is launched from five distinct starting points to reduce sensitivity to local minimum. The optimization method converges to the optimal profit of 208.44 $/h, representing a 39.3% improvement over the conservative baseline operating point. Method fmincon is fully deterministic and achieves this optimum with zero variance across runs, whereas both Monte Carlo methods exhibit decreasing variability with increasing N, with LHS-MC showing superior space-filling coverage and comparable mean profit to RS-MC at equivalent sample budgets. The results support a hybrid strategy for industrial deployment: LHS-MC for global exploration of the feasible space, followed by fmincon for precise local refinement. The analysis also reveals that multiple parameter combinations yield the same maximum profit, highlighting practical flexibility in operating point selection for the separation plant.**

Keywords—oil-water separation, process optimization, Monte Carlo sampling, Latin Hypercube Sampling, gradient-based optimization, interior-point method, fmincon, constrained nonlinear optimization, upstream oil processing, operational profit maximization

ANN AND ANFIS-BASED MPPT CONTROL FOR PMSG WIND TURBINE: A COMPARATIVE STUDY WITH CONVENTIONAL PI CONTROL

Zineb Kadiri, Jérôme Bosche, Abdelhamid Rabhi and Badre Boussoufi

***Abstract*—Lately, WECS has achieved more than 11% of the world's energy demand. With this growing demand, the wind turbine system requires a high-efficiency technique to extract the maximum wind power. However, this new study remains a challenge; it proposes a comparative analysis between the MPPT-based ANN and ANFIS with PI. These techniques aimed to enhance the power extraction. All the MPPT approaches were developed through simulation in the MATLAB/SIMULINK environment under realistic wind speed data compared with PI. The intelligent strategies demonstrated great improvement. The obtained results show that both intelligent techniques achieve fast convergence time by approximately 70%, and reduce the steady state error by more than 90%. These findings confirm the effectiveness of an AI-based technique in improving the overall system performance.**

Keywords—ANFIS, ANN, Maximum power point tracking, Wind Electrical Conversion System

AUTOMATED MULTICLASS IOT NETWORK TRAFFIC CLASSIFICATION USING AUTOAI

Mironela Pirnau, Iustin Priescu, Daniela Joita, Catalina Mihaela Priescu and Claudiu Pirnau

***Abstract*—The paper presents the use of the IBM watsonx.ai AutoAI platform for the automatic classification of benign and malicious IoT traffic. The experiment was conducted using the CIC IoT-DIAD 2024 dataset, which was preprocessed in Python and organized into a balanced subset of 10,000 records corresponding to five traffic classes: Benign, DDoS_HTTP_Flood, DNS_Spoofing, DoS-TCP_Flood, and MITM-ArpSpoofing. The optimal model selected by AutoAI was Pipeline 14, based on the Batched Tree Ensemble Classifier, achieving 99.3% accuracy on the holdout set. The results were evaluated using performance metrics, feature importance analysis, the confusion matrix, and ROC curves. The model was subsequently deployed through the Online Deployment service and tested on 500 new observations, confirming its ability to generate automated predictions with high confidence.**

Keywords—AutoAI, cyberattack detection, machine learning, IoT security

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ITS-BASED REVERSIBLE LANE MANAGEMENT ON A SEASONAL COASTAL ROAD: CAPACITY ANALYSIS FOR DN39 EFORIE NORD, ROMANIA

Cristina Bica and Valentin Alexandru Stan

***Abstract*—This paper presents an operational capacity assessment of the reversible lane system on DN39 national road, Eforie Nord sector (km 12+370 – km 14+250, L = 1,880 m), Romania — a three-lane coastal corridor traversing a Black Sea resort with pronounced seasonal traffic asymmetry. Traffic monitoring data for 2025 document an Annual Average Daily Traffic (AADT) of 28,200 vehicles per day and a seasonality ratio of 2.08 between summer peak and winter baseline, with absolute daily peaks reaching 52,060 vehicles/day. The central lane currently operates under a Generation I manually reversible scheme. This study analyses the transition to an ITS-based automated management system integrating overhead Lane Control Signals, Variable Message Signs, and coordinated signalization of the sector's intersection and pedestrian crossings. Capacity and Level of Service assessments are conducted under the AND 584-2012 normative framework, cross-referenced against HCM 7 and NCHRP Synthesis 340. The ITS upgrade yields a 20.7% increase in effective lane capacity, a 17.1% reduction in volume-to-capacity ratios, and a Level of Service improvement from F to E on both directional flows under normative design conditions. A seasonal congestion duration analysis demonstrates a reduction from approximately 153 to 92 congested days per year (−40%), positioning the ITS upgrade as the optimal short-to-medium term intervention on this structurally constrained corridor.**

Keywords—Reversible, tidal_flow, ITS, dynamic lane management, Level of Service, traffic, electric signalling

DIGITALIZATION OF QUALITY MANAGEMENT IN KNOWLEDGE-BASED ORGANIZATIONS: CHALLENGES AND ARTIFICIAL INTELLIGENCE-BASED SOLUTIONS

Sorin Constantin Nacu and Aurel Mihail Titu

***Abstract*—The digitalization of quality management has become a critical priority for knowledge-based organizations operating in environments characterized by rapid change, high complexity, and continuously expanding data volumes. This paper examines the key challenges faced by such organizations in their efforts to digitally transform quality management systems. Major obstacles include resistance to organizational change, fragmentation of information systems, insufficient data standardization and data quality, as well as gaps in digital and artificial intelligence (AI) competencies among employees. Against this background, the study highlights the role of artificial intelligence as an essential enabler for enhancing quality management practices. AI-based solutions support automated data processing, advanced decision-making, predictive identification of nonconformities, and systematic performance improvement. The paper discusses both managerial and technical approaches to addressing these challenges, including AI-oriented training and reskilling initiatives, data governance frameworks designed to support intelligent algorithms, modular IT architectures, and agile methodologies for the implementation of AI-driven solutions. Furthermore, the analysis emphasizes that fostering an organizational culture centered on innovation, continuous learning, and the responsible use of artificial intelligence is a fundamental prerequisite for the sustainable integration of digital technologies into quality management processes.**

Keywords—digitalization, quality management, knowledge-based organizations, artificial intelligence, data governance, organizational culture, continuous improvement

COUPLING COLD PLASMA MEASUREMENTS WITH CRYPTOGRAPHIC KEY GENERATION FOR SECURE COMMUNICATIONS

Valentina Marascu, Marius Iulian Mihailescu, Cristian Stancu, Silviu Daniel Stoica, Catalin Constantin and Marius Rogobete

***Abstract*—This study proposes a cold plasma cryptography model for secure communication scenarios. Its core innovation is that key material is extracted directly from physically observable parameters of low-temperature plasma discharge. The supporting experiment adopts a hollow cathode structure, with helium, hydrogen, and deuterium used as working gases, a gas flow rate of 300 sccm, and an input power of 250 W. A single Langmuir probe and optical emission spectroscopy are applied to characterize the discharge and verify the properties of the cold plasma. This study serially compresses four categories of parameters of time-resolved plasma probes (including electron density, ion density, Debye length, and other related metrics) and acquisition duration. This compressed data is processed by the SHA-256 hash function to generate a seed, which serves as the input source for the AES-256-GCM and RSA-2048 encryption primitives. The full scheme is implemented in Python. Pairwise Hamming distance analysis is conducted to verify the key's reproducibility, uniqueness, and inter-source separation degree. The results confirm that this coupled scheme can guarantee communication security and is feasible for real-world implementation.**

Keywords—AES, RSA, key generation, physical-layer security, Hamming distance, cold plasma, secure communications

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DESIGN REQUIREMENTS FOR LLM-BASED ASSISTIVE TOOLS FOR PARENTS AND EDUCATORS SUPPORTING AUTISTIC LEARNERS: A QUALITATIVE REQUIREMENTS ANALYSIS IN THE INDIAN CONTEXT

Theakanath Steffy Burly, Adithya Divakaran, Johanna Sophie von Lieres and Miriam Silverman

***Abstract*—Large Language Models (LLMs) hold increasing potential for supporting autistic learners through personalised instruction, adaptive content generation, communication scaffolding, and structured learning support. However, most existing AI educational systems are developed without grounding in the lived realities of parents, tutors, and educators who provide educational support to autistic learners, particularly within low-resource contexts such as India. Current systems also frequently reflect neurotypical communication assumptions that create cognitive and accessibility barriers for neurodivergent users. This study employed a qualitative requirements analysis to investigate how LLM-based educational tools may be more effectively designed for neurodiversity-informed educational contexts. The study combined semi-structured interviews with eight Indian parents, teachers, and tutors, alongside a netnographic analysis of 14 global online sources. Findings revealed that participants already engage in extensive adaptive educational practices involving interest-based learning, multimodal instruction, visual scaffolding, and flexible pacing. The analysis identified key system-level requirements for neurodiversity-aligned LLM tools, such as increased interest-based anchoring, goal-oriented interactions, privacy settings, multilingual accessibility, and simplified interfaces for parents. The study also identifies the "neurotypical default problem" and proposes mitigation through neurodiversity-affirming communication styles. The paper contributes empirically grounded design requirements and proposes a human-in-the-loop architectural framework positioning caregivers as mediators of AI-assisted learning.**

Keywords—autistic learners, LLMs, home-based educational support, low-resource contexts

MULTI-LABEL SMART GRID FAULT CLASSIFICATION USING LIGHTGBM BASED GRADIENT BOOSTING

Israj Ali, Aronno Ghosh, Amitkumar V. Jha and Bhargav Appasani

***Abstract*—In this paper, we present a study on multi-label fault classification in smart grid power systems using a LightGBM-based approach for fault identification. The proposed method is capable of detecting simultaneous faults involving ground (G) and phase conductors (A, B, and C) using three-phase current and voltage measurements obtained from existing datasets as well as derived datasets generated from real-world-inspired, large-scale synthetic data. Additionally, we conduct an ablation study in which twenty-five features are ranked according to their contribution to classification accuracy. The study reveals that symmetric component features, including zero-sequence and negative-sequence components, along with vector norms, are among the most discriminative feature groups for smart grid fault identification. The experimental results demonstrate that models trained on the 4.2-million-row synthetic bulk dataset achieve a subset accuracy of 97.9%–98.5% and a Hamming accuracy exceeding 99.4%, substantially outperforming models trained solely on existing datasets. The benchmark dataset used in this study was obtained from Kaggle, where cross-dataset evaluation achieved a subset accuracy of approximately 85.7%. These findings establish best-practice guidelines for scalable, accurate, and overfitting-resistant smart grid fault diagnosis systems.**

Keywords—Smart grid, fault classification, multi-label learning, LightGBM, gradient boosting, power system protection, fault diagnosis

AN IOT- BASED ADAPTIVE HORTICULTURAL LIGHTING SYSTEM FOR ENERGY-EFFICIENT PLANT GROWTH

Ranjith Kumar Yellanuru, Dharani M, Chengamma Chitteti, Harsha Vardhan K P, Shireesha M and Abdul Khadhar Kalluri

***Abstract*—In order to provide energy-efficient supplementary lighting while keeping the light quality and intensity at desirable levels in the photosynthetic spectrum, this paper proposes an IoT based adaptive horticulture lighting and monitoring system. Because Internet of Things (IoT) sensors can collect data on horticultural areas and respond to human input, the idea of "smart horticulture" is taking root. Using state-of-the-art technologies like Wireless Sensor Network, Internet of Things (IoT), and Arduino, a Smart Horticulture System is suggested to be developed. The goal of this study is to automate smart horticulture and make use of the Internet of Things. Improving the production of efficient crops mostly depends on keeping an eye on environmental circumstances. The construction of technology that can monitor temperature, humidity, moisture, and the movement of animals that might kill crops in agricultural areas is showcased in this study. The sensors used in this system are based on the Arduino board. Notify the farmer's smartphone over Wi-Fi/4G/5G in the event of a discrepancy, and also notify them through the application that was designed for the same. Data inspection and irrigation scheduling may be configured using an Android application thanks to the system's duplex communication link based on a cellular Internet interface.**

Keywords—IoT, Horticulture lighting, Energy efficiency, LED, Smart agriculture

CROP-TO-SHELF CONFIDENCE: AN EVIDENCE-MEDIATION FRAMEWORK FOR ORGANIC PRODUCT CREDIBILITY USING SOIL IRREGULARITY SCREENING AND AUGMENTED REALITY

Chamath Thilakarathna, Kalindu Rashmina, Yohan Weerapperuma and Asiri Alwis

***Abstract*—Organic food credibility depends on production claims that consumers cannot directly verify at the point of purchase. Existing digital traceability systems frequently admit cultivation-stage records without screening for suspicious upstream signals, and even when product histories are available, final representations are often too technical for non-expert shoppers to interpret quickly at the point of purchase. This paper presents an evidence-mediation framework that addresses both gaps through two cooperating components. At the cultivation stage, soil readings from a FastAPI-based simulation pipeline are assessed using an unsupervised Isolation Forest model trained on an eight-dimensional feature vector capturing both absolute nutrient concentrations and inter-reading change rates for Nitrogen, Phosphorus, Potassium, and Electrical Conductivity. When unusual behavior is detected, the system cross-references the event against farmer-declared input records through a crop-batch-linked mobile application, issuing one of three evidence-based verdicts COMPLIANT, UNEXPLAINED SPIKE, or DATA MISMATCH rather than treating sensor flags as immediate non-compliance. At the consumer stage, validated batch evidence is condensed by a FastAPI confidence-synthesis service into freshness, organic grade, trust score, and warning cues using transparent deterministic rules, then rendered through a QR-triggered Unity-Vuforia AR overlay. The study argues that organic traceability becomes practically effective only when backend evidence is screened, contextualized, and reformulated into a concise trust language before consumer presentation.**

Keywords—isolation forest, anomaly detection, delta feature engineering, organic compliance verification, augmented reality, consumer-facing traceability

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ROBUST PATCH-LEVEL INFRARED LEAK DETECTION ON N95 RESPIRATORS USING SPATIOTEMPORAL DEEP LEARNING

Rihab Baccari, Hana Benmoussa, Yacine Yaddaden, Mohamed Arbane, Jean Brousseau, Clothilde Brochot, Ali Bahloul and Xavier Maldague

***Abstract*—Face seal leaks are a major cause of protection loss for N95 filtering facepiece respirators (N95 FFR), yet current fit-testing methods provide only a global fit factor and no information about leak location. Infrared (IR) imaging offers a way to visualise leaks by capturing temperature variations near the mask seal, but most existing approaches operate at the level of full-face images and do not explicitly model the temporal dynamics of breathing or the strong class imbalance between leak and non-leak samples. In this work, controlled infrared videos of N95 FFRs under calibrated leak scenarios, acquired on a respiratory test bench, are used to construct patch-level sequences centred on leak locations along the seal. A Bi-Level Class Balancing (BLCB) strategy is introduced, combining global resampling with targeted preservation of hard negative sequences. Three spatiotemporal deep architectures are evaluated, including two CNN-LSTM models and an attention-based model, all trained with a focal-type loss on balanced sequence sets. Experiments show that the attention-based model achieves high sequence-level performance (up to 98\% accuracy and AUC-ROC close to 0.99 on several regions), while the BLCB scheme effectively mitigates class imbalance. Cross-device evaluation further indicates that models trained on one configuration maintain strong discriminative ability when transferred to the other, with only a modest drop in accuracy and F1-score. These results demonstrate the potential of patch-level spatiotemporal modelling combined with dedicated class balancing for accurate and robust infrared leak detection on N95 FFRs.**

Keywords—N95 filtering facepiece respirator (N95 FFR), infrared imaging, leak detection, patch-level classification, spatiotemporal deep learning, CNN-LSTM, attention mechanism, class imbalance, focal loss, cross-device generalisation

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CONTROLLED DEEP FEATURE LEARNING WITH ADAPTIVE PCA AND SVM FOR FACIAL EXPRESSION RECOGNITION UNDER LIMITED-DATA CONDITIONS

Yaye Dieynaba Fall and Yacine Yaddaden

***Abstract*—Automatic Facial Expression Recognition (AFER) plays an important role in affective computing and human--computer interaction. However, developing robust AFER systems remains challenging under limited-data conditions due to intra-class variability, dataset imbalance, and reduced generalization capability. In this work, we propose a controlled deep feature learning framework that combines transfer learning with adaptive dimensionality reduction and classical machine learning classification. Facial representations are extracted from a partially fine-tuned ConvNeXt-Tiny backbone and projected into a compact discriminative subspace using dataset-adaptive Principal Component Analysis (PCA). The reduced feature vectors are subsequently normalized using Min--Max scaling and classified using a linear Support Vector Machine (SVM). The proposed framework is evaluated on four benchmark AFER datasets, namely JAFFE, KDEF, WSEFEP, and RaFD, using a stratified 10-fold cross-validation protocol. Experimental results demonstrate stable and competitive performance across datasets, achieving recognition accuracies of 93.14\%, 93.06\%, 89.05\%, and 97.23\%, respectively. Additional cross-dataset experiments further highlight the robustness and transferability of the proposed approach under varying acquisition conditions. The obtained results demonstrate that combining deep feature representations with adaptive dimensionality reduction and lightweight linear classification provides an effective and computationally efficient solution for AFER under constrained data conditions.**

Keywords—Automatic Facial Expression Recognition, Affective Computing, Deep Feature Learning, ConvNeXt-Tiny, Adaptive PCA, Support Vector Machine, Limited-Data Learning, Cross-Dataset Generalization

AI-DRIVEN CYBER DEFENSE FOR MALWARE AND RANSOMWARE PROTECTION

Rushikesh Kakadiya, Keval Vora, Arpita Bambharoliya and Hitesh Kag

***Abstract*—The increasing complexity of malware and ransomware underscores the necessity for sophisticated cybersecurity measures that extend beyond conventional protective strategies. Artificial Intelligence (AI) has transformed the landscape of cyber defense by utilizing Machine Learning (ML) techniques to identify, mitigate, and avert threats in real time. AI-based systems can process extensive datasets, detect irregularities, and address advanced threats such as polymorphic malware and zero-day exploits. Additionally, behavioral analysis enhances security protocols by forecasting and preventing attacks prior to inflicting damage. To address this evolving threat landscape, this project introduces AI-driven malware and ransomware detection system built using Long Short-Term Memory (LSTM) networks. Leveraging deep learning, the model is trained on both real-world and synthetic datasets containing static and behavioral features of executable files. Key attributes such as import functions, memory alignment, and system characteristics were extracted to enhance prediction accuracy. Nonetheless, issues such as adversarial tactics in AI and ethical dilemmas related to data privacy require careful consideration. Despite these challenges, AI-enhanced cybersecurity presents a formidable, proactive approach, empowering organizations with automation, predictive analytics, and resilience to protect sensitive information and ensure operational integrity.**

Keywords—Cyber Defence, Cyber Security, Deep Learning, LSTM, Malware, Ransomware

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AN EDGE-OF-THINGS MULTISENSOR SYSTEM FOR REAL-TIME HOME SAFETY MONITORING USING ESP32 AND HOME ASSISTANT

Maria Carmen Turea, Gabriel Predusca, Liana Denisa Circiumarescu, Nicoleta Angelescu and Dan Constantin Puchianu

***Abstract*—This paper presents an Edge of Things (EoT) architecture and implementation for a real-time multisensor home safety monitoring system. The system integrates sensors for combustible gas and volatile organic compound detection (MQ-2), infrared flame detection (LM393), and three-dimensional seismic vibration monitoring (ADXL335). Data acquisition and initial processing are performed locally on an ATmega328 microcontroller, with the objective of significantly reducing latency, increasing autonomy, and conserving communication bandwidth. IoT communication and integration are provided by an ESP32 node using MQTT and ESP Home protocols toward the Home Assistant platform, which offers a unified interface for visualization, notifications, and event correlation. An ESP32-CAM module ensures passive visual redundancy, enabling manual validation of detected events. Experimental results highlight high sensitivity to methane, robust flame detection within a ~1 m range, and coherent vibration response, confirming the feasibility of a scalable EoT architecture with local decision-making processing for critical residential safety applications. Unlike typical IoT solutions, this work adopts a strictly decoupled Edge-of-Things architecture for reliable local safety decisions.**

Keywords—Edge of Things (EoT), ESP32, Home Assistant, multisensor monitoring, residential safety.

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PROS AND CONS OF ONE-DIMENSIONAL CONVOLUTIONAL NEURAL NETWORK MODELS IN SOUND-BASED INDUSTRIAL FAULT DETECTION

Mustafa Dev, Seda Yildirim and Gürkan Aydemir

***Abstract*—Sound-based fault detection has gained significant attention due to its non-intrusive nature and low cost, as it does not require physical intervention in industrial systems. This study experimentally evaluates the performance and generalization capability of one-dimensional convolutional neural networks (1D-CNNs) under limited data and noisy conditions. The experiments were conducted using audio data from four different machine IDs (ID00, ID02, ID04, ID06) in the industrial fan category of the MIMII dataset. Within the scope of this study, two scenarios are considered: (i) training and testing on the same machine ID, and (ii) training and testing on different machine IDs, enabling the evaluation of both intra-device performance and cross-device generalization. The obtained results demonstrate that the proposed 1D-CNN model achieves high performance even under challenging conditions with a low signal-to-noise ratio (SNR) of −6 dB. In tests conducted on the same machine ID, the model attains an accuracy ranging from 99% to 100%, successfully distinguishing the normal class with 100% accuracy and the abnormal class with over 98% accuracy. These findings indicate that 1D-CNN architectures can effectively learn discriminative features directly from raw audio signals despite the presence of noise. However, performance degrades significantly when evaluated across different machine IDs, highlighting the impact of domain shift. In conclusion, while the proposed model performs effectively under controlled conditions, it exhibits notable limitations in cross-device scenarios. Future work will focus on improving generalization through self-supervised representation learning to extract domain-invariant features and domain adaptation techniques.**

Keywords—One-Dimensional Convolutional Neural Network, Sound-Based Fault Detection, MIMII Dataset, Domain Adaptation, Industrial Anomaly Detection

RISK-AWARE PRIORITIZATION OF PHARMACY PRESCRIPTION QUEUES

Pavitra Mohandas, Sudesh Kumar Santhosh Kumar and Saiharshith Karuneegar Ramesh

Abstract*—Pharmacy prescription verification is often managed using first in, first out (FIFO) processing. FIFO is simple to operate, but it can delay prescriptions whose value depends on timely verification when the queue contains many routine orders. We study pharmacy verification as an online scheduling problem in which each prescription is prioritized using two sources of information available at order time: medication urgency and patient deterioration risk. The medication signal is a rule based criticality score that maps each prescription to a 1 to 5 urgency scale. The patient signal is a Platt calibrated classifier that estimates the probability of ICU transfer within 24 hours from order time clinical features, including vitals, laboratory values, and care unit. The patient model excludes medication names, so its score reflects patient state rather than medication identity. Across LightGBM, XGBoost, Random Forest, and Logistic Regression, AUROC ranges from 0.66 to 0.73, suggesting that the patient risk signal is not tied to a single model family. We compare FIFO with three priority policies: medication score only, patient risk only, and a combined policy. Evaluation is performed in a discrete event, single server simulator on MIMIC IV demo prescriptions across five random seeds at 40% utilization. A key finding is that 59.6% of prescriptions for patients who transfer to the ICU within 24 hours are routine by medication criticality. These Type B prescriptions cannot be identified from medication urgency alone. The combined policy reduces mean wait time relative to FIFO by 82±15 minutes for urgent medication prescriptions associated with deterioration and by 75 ± 15 minutes for routine medication prescriptions associated with deterioration. It improves on either single signal policy by 20 to 25 minutes in both subgroups while also reducing wait time for non deteriorating prescriptions. The two signals contribute different scheduling information: medica- tion urgency prioritizes drugs whose clinical benefit depends on timely verification, while patient risk identifies unstable patients whose medication orders otherwise appear routine. Code, data preparation scripts, and the analysis pipeline are released for reproducibility.

Keywords—Pharmacy informatics, queueing theory, MIMIC-IV, gradient boosting, clinical risk prediction, discrete event simulation

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AI-DRIVEN HYBRID WORK MODEL: A STRUCTURAL ANALYSIS OF EMPLOYEE PERFORMANCE AND ORGANIZATIONAL PRODUCTIVITY

Tummala Saritha and Thaya Madhavi

***Abstract*—Artificial Intelligence (AI) and hybrid work models have drastically changed organizational productivity and employee effectiveness in the workplace. Using job engagement as a mediating variable and digital literacy and organizational support as moderating factors, this study investigates the combined effects of AI integration and hybrid work on employee performance. A structured questionnaire was used to gather data from 300 IT workers using a quantitative research design. Reliability, correlation, regression, mediation, and moderation tests were among the analyses carried out using SPSS. The findings show good sample adequacy (KMO = 0.912, $p < 0.001$) and robust reliability (Cronbach's $\alpha = 0.846–0.889$). Regression research shows that employee performance is highly impacted by AI integration ($\beta = 0.29$, $p < 0.001$) and hybrid work ($\beta = 0.21$, $p < 0.01$), with work engagement emerging as the biggest predictor ($\beta = 0.45$, $p < 0.001$). Organizational productivity is highly impacted by employee performance ($\beta = 0.79$, $p < 0.001$). Work involvement partially mediates the linkages between AI, hybrid work, and performance, according to mediation analysis. The results of the moderation show that the associations are strengthened by digital literacy ($\beta = 0.18$, $p < 0.01$) and organizational support ($\beta = 0.20$, $p < 0.01$). The results underline the significance of combining organizational and technology resources and support the Job Demands–Resources model. By creating an integrated framework that combines AI and hybrid work, this study contributes and provides useful insights for raising productivity and performance in contemporary enterprises.**

Keywords—Keywords: Digital literacy, work engagement, organizational support, employee performance, hybrid work, organizational productivity, mediation, moderation and, SPSS analysis

SUBJECT-INDEPENDENT HAND GESTURE RECOGNITION USING WEARABLE INERTIAL SENSORS AND DEEP LEARNING FOR ROBOTIC INTERACTION

Clément Ruissel Kouonga Fokam and Yacine Yaddaden

***Abstract*—Hand gesture recognition is an important component of human–machine interaction for robotic control and wearable systems. Unlike vision-based approaches, wearable inertial sensing provides a robust and low-cost solution that is less sensitive to illumination changes and occlusions. This paper presents a subject-independent hand gesture recognition framework based on wearable inertial sensors and deep learning. A dedicated acquisition protocol involving 15 participants and nine dynamic gestures was designed to construct a balanced dataset containing 2,700 gesture sequences. The inertial signals were temporally standardized and enriched using signal magnitudes and temporal derivatives. Four deep learning architectures were evaluated under a rigorous Leave-One-Subject-Out (LOSO) protocol: Multilayer Perceptron (MLP), one-dimensional Convolutional Neural Network (CNN1D), Bidirectional Long Short-Term Memory (BiLSTM), and a hybrid CNN–BiLSTM model. Experimental results show that sequence-aware models significantly outperform the MLP baseline, with CNN1D achieving the best performance of 86.85\% accuracy and 86.70\% macro F1-score. The results highlight the importance of subject-independent evaluation and demonstrate that lightweight convolutional architectures provide an effective trade-off between recognition performance and computational efficiency for future embedded robotic interaction systems.**

Keywords—Hand gesture recognition, wearable inertial sensing, deep learning, inertial measurement sensors, human–robot interaction, subject-independent evaluation, convolutional neural networks, embedded artificial intelligence

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THREE LEVEL GAN INVERTER FOR A RESIDENTIAL HEAT-PUMP

Suliman Badour, Martin Novák, Zdeněk Novák and Jaroslav Novák

***Abstract*—This paper presents a three-level gallium nitride (GaN) inverter for a residential heat-pump compressor drive. The proposed inverter is based on the active neutral-point-clamped (ANPC) topology and is integrated into a complete power-conversion system comprising a grid-side SiC active rectifier, a photovoltaic (PV) interface through a SiC DC/DC converter, and a common DC bus. The main motivation is to combine the reduced voltage stress and smaller output-voltage steps of multilevel conversion with the high switching speed and power-density potential of GaN devices. A hardware prototype was built and experimentally tested. The measurements include switching-transient evaluation of the GaN devices, for which a turn-off time of approximately 25 ns was obtained, and an investigation of parasitic ringing and oscillations. The results show that unsuitable turn-on and turn-off settings, together with an unfavorable PCB layout, can lead to oscillations around 23 MHz and may degrade switching performance and device reliability. The inverter was also verified in motor-drive operation, first with an induction motor under V/f control and subsequently with a permanent-magnet synchronous machine (PMSM) under sensorless vector control. The experimental results demonstrate the feasibility of the prototype and identify DC-bus capacitor voltage imbalance and switching-transient sensitivity as the main issues requiring further optimization.**

Keywords—Three-level inverter, active neutral-point clamp, GaN, sensorless vector control

HYBRID CONVOLUTIONAL ARCHITECTURE FOR ROBUST AUTOMATIC MODULATION CLASSIFICATION

Stefan-Cristian Nutu, Iulian-Constantin Vizitiu and Cristian-Constantin Molder

***Abstract*—Spectrum monitoring systems enables identification of signal modulation without prior knowledge of the transmitter, being one of the hot topics in signal processing. Artificial Intelligence tools now enable deploying automatic modulation classification (AMC), being a critical component of modern cognitive radio and spectrum monitoring systems, enabling the final task to retrieve information about the transmitter type or class. This study presents a comparative analysis of well-known architectures and proposes RVGG, a novel hybrid neural network architecture designed to enhance AMC in challenging, low Signal-to-Noise Ratio (SNR) environments. By augmenting a modified Visual Geometry Group (VGG) network backbone with residual connections, Squeeze-and-Excitation (SE) attention mechanisms, and Global Average Pooling (GAP), the proposed model dynamically filters channel-wise noise and significantly mitigates overfitting. Experimental evaluations on the comprehensive RadioML 2018 dataset demonstrate that RVGG consistently outperforms the baseline VGG model, yielding a 1.5% absolute improvement in overall accuracy and achieving superior F1-Scores across critical transition zones. These results validate that the targeted architectural optimizations successfully extract robust feature representations while maintaining strict computational viability for real-time Software Defined Radio (SDR) deployments.**

Keywords—neural, network, signal, classification, hybrid, modulation, architecture

PAPAYAPULSE: THE SMART FARMING FRAMEWORK FOR DATA-DRIVEN PAPAYA CULTIVATION

Akila Sudeepa Amarasinghe, Jayasekara Udan, Weththasinghe Athsara Bimalka, Lakshika Sachini Tharindi, Swarnakantha Ravi Supunya and Gamage Manori

***Abstract*—Papaya cultivation is an important part of Sri Lanka's agricultural sector however farmers continue to face challenges related to disease management, inconsistent fruit grading, improper harvest timing, and unstable market pricing. Most existing farming practices rely heavily on manual observation and experience-based decision-making, which often affect productivity and profitability. This research presents PapayaPulse, an integrated mobile-based smart farming framework developed to support data-driven papaya cultivation using artificial intelligence and machine learning techniques. The proposed system combines four major functionalities: papaya quality grading using image analysis, growth stage detection with first harvest prediction, disease and pest detection with severity-based treatment recommendations, and market price prediction for informed selling decisions. Deep learning models, including Convolutional Neural Networks and Vision Transformer architectures, were utilized for image-based recognition tasks, while Random Forest Regression and Classification, Gradient Boosting Regression and Classification models were applied for predictive analysis and decision support. Experimental evaluation was conducted using an 80:20 training and testing data split, where the image-based classification models achieved an average accuracy of approximately 87% under guided image-capturing conditions. In addition, a user evaluation survey conducted with farmers and agricultural users reported an overall user acceptance rate of 91%, highlighting the practical usability and understandability of the system. The mobile application supports both Sinhala and English languages, making the framework more accessible to local farming communities. The findings demonstrate that integrating multiple AI-driven agricultural services into a single platform can improve decision-making, reduce crop losses, and enhance transparency in papaya cultivation and marketing.**

Keywords—Smart farming, Papaya cultivation, Decision support system, Mobile application, Precision agriculture

PID-BASED POWER OUTPUT MAXIMIZATION OF A HYBRID WIND-SOLAR-HYDRO RENEWABLE ENERGY

Betty Jennifer Abugbillah, George Owusu and Joseph Cudjoe Attachie

***Abstract*—The growing energy crisis has driven research toward renewable energy systems for electricity generation. Integrating multiple sources can enhance performance, and while recent studies have combined two renewable sources, this study integrates three—wind, solar, and hydro—to maximize power output. The sources were modeled using transfer function techniques and integrated, with a PID controller included to improve system stability. From the MATLAB/Simulink simulation results, it is evident that the PID controller demonstrated a remarkable performance by completely eliminating the overshoot from 59% to 0%, albeit at the cost of a slightly slower rise time, which increased from 0.15 s to 0.40 s, while also effectively limiting the transient oscillations to fewer than four cycles. The stability analysis performed on the system showed that the use of the PID controller reduces the system gain from 45 dB to 0 dB. These results demonstrate the effectiveness of the proposed approach for developing a robust hybrid renewable power generation system.**

Keywords—PID Controller, Transfer function, Renewable source of energy, Modeling, Time response

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EXPLORING TRANSFORMER-POWERED NEURAL ARCHITECTURES FOR CONTEXT-AWARE SENTIMENT ANALYSIS

Keerthika Boppana, Manjusree Yenigalla, Jayasri Devi T and Prashanth Orsu

***Abstract*—The rapid expansion of subjective textual data necessitates sentiment analysis models that can simultaneously capture semantic meaning and sequential dependencies. Conventional deep learning approaches typically prioritize either contextual understanding, as in transformer-based architectures, or temporal sequence modeling, as in recurrent networks, which restricts their ability to fully represent complex sentiment patterns. This study presents a systematic evaluation of recurrent, transformer-based, and hybrid deep learning models, including Bidirectional Long Short-Term Memory (BiLSTM), Bidirectional Gated Recurrent Unit (BiGRU), Bidirectional Encoder Representations from Transformers (BERT), and a hybrid BERT+BiGRU framework that integrates context-aware embeddings with sequence-sensitive refinement. Experiments are conducted on a publicly available benchmark sentiment dataset, oversampled to address class imbalance and ensure stable model training. Results indicate that transformer models effectively model global semantic relationships via self-attention, while recurrent networks excel at capturing bidirectional sequential dependencies. The hybrid architecture achieves superior performance, attaining an accuracy of 94.79%, outperforming individual models. Evaluation metrics include accuracy, precision, recall, and F1-score. The findings provide practical guidance for designing robust, scalable sentiment analysis systems for real-world applications.**

Keywords—Sentiment Analysis, Deep Learning, Transformer Models, BERT, BiGRU, BiLSTM, Hybrid Architectures.

BLOCKCHAIN-BASED HIERARCHICAL LOCKING FOR CONCURRENT NESTED TRANSACTION MANAGEMENT

Vandana Singh, Nilesh Jadav, Akshara Prachi and Emil Pricop

***Abstract*—We proposed a hierarchical locking scheme enabled by blockchain to assist nested operations within the decentralized setting. The proposed solution incorporates the blockchain capabilities of immutability, decentralized validation, and execution in smart contracts, unlike the traditional concurrency control mechanisms that use centralized lock management. Upon a subtransaction finishing its working, the respective lock is freed per the hierarchical locking protocol, and the next transactions authenticate the before- and after-images with blockchain verification. This is to guarantee consistency and safe concurrent execution of dependent transactions. The suggested solution enhances concurrency of systems in that, the number of nested transactions running at the same time can be achieved without affecting the correctness of the system because hierarchical dependency control is enforced. The framework offers transparency in execution, resistance to tampering, and trusted auditability by integrating models of layered transactions with blockchain-based validation. Generalized lock compatibility rules and hierarchical access control enable an efficient management of data objects of various granularities.**

Keywords—Concurrency control, Nested transactions, Data consistency, Hierarchical locking, Layered transactions, Blockchain

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ZEROGUARD: A MULTI-AGENT ZERO-TRUST FRAMEWORK FOR AUTONOMOUS IAC SECURITY REMEDIATION

Harish Apuri, Shikher Goel, Charani Yepuri and Madhan Mohan Reddy Chinthala

***Abstract*—Cloud-native architectures have fundamentally shifted where security risk lives from runtime systems into version-controlled text files. IaC misconfiguration now accounts for 67% of publicly disclosed cloud breaches [2], yet the tooling most teams rely on was never designed with ZeroTrust Architecture (ZTA) in mind. Enforcing continuous, leastprivileged verification across every infrastructure layer demands more than static rule-matching can offer. We built ZeroGuard to close that gap: a five-component generative AI system that couples proactive IaC misconfiguration repair with continuous ZTA policy generation and enforcement. At its core, a hybrid Transformer-Graph Attention Network (T-GAT) model evaluates per-resource risk alongside ZTA pillar compliance. A Code-LLMbased Generative Remediation agent then produces corrected IaC templates and OPA Rego policies directly from those scores. An Identity Management Agent handles ongoing permission rightsizing, while a Continuous Compliance Orchestrator carries the generated policies through to enforcement. Evaluated on 52,000 templates spanning Terraform, CloudFormation, Kubernetes, and Azure Bicep [1], ZeroGuard achieves detection F1 = 0.947, Zero-Day F1 = 0.658, a 78.4% reduction in critical findings, and a ZTA posture improvement of ΔΞ = +0.380 [6]**

Keywords—Infrastructure-as-Code, Zero-Trust Architecture, Generative AI Agents, DevSecOps, Predictive Remediation, IAM Least Privilege

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GAME THEORY MODEL FOR PROPORTIONALITY ASSESSMENT IN MILITARY OPERATIONS

Clara Maathuis

***Abstract*—This research introduces a novel game theoretic proportionality assessment model for military operations con- sidering mappings from collateral damage descriptors and military advantage to proportionality outcomes. To this end, two perspectives are considered. First, a physical only model that treats collateral damage as injuries, deaths, and damage to civilian objects. And second, an extended model that incorporates psychological harm as part of the collateral damage component which conducts to a more restrictive proportionality boundary. The learned assessors are embedded as constraint/penalty mech- anisms within a Bayesian game between an attacking force and an adaptive adversary, enabling computation of disproportionate risk probabilities under uncertainty and strategic interaction. Moreover, for demonstration purposes, the model is evaluated through simulation demonstration on a counter-UAV (Unmanned Aerieal Vehicle) scenario in which a military Cyber Operation exploits a software vulnerability to seize control and force a safe landing, and is compared against kinetic intercept and RF jamming alternatives under adversarial postures. The results obtained show that the underlying ruling system can shift robust action selection toward control-oriented neutralization options when adversaries amplify collateral risk, and that explicitly accounting for psychological harm can materially affect permis- sibility assessments in otherwise borderline contexts.**

Keywords—game theory, proportionality, collateral damage, artificial intelligence

REAL-TIME ACOUSTIC UAV LOCALIZATION USING 1D-CNN BASED MODELS

Begüm Beraye Atalay, Kübra Yiğit, İbrahim Kaya, Gürkan Aydemir, Salih Mehmed Bostan and Mehmet Baris Tabakcioglu

***Abstract*—This study presents hierarchical 1D-CNN-based models that learn directly from raw audio waveforms for three dimensional positional estimation of Unmanned Aerial Vehicles (UAVs). Unlike conventional feature extraction methods, the proposed approach employs three specialized models for azimuth, distance, and height estimation, enabling high-precision modeling of phase and amplitude characteristics in acoustic signals. Experimental results on the UaVirBASE dataset demonstrate accuracies of 98.44% (1.41° MAE) for azimuth estimation, 98.05% (0.20 m MAE) for distance estimation, and 94.14% (0.59 m MAE) for height estimation. Furthermore, the system processes 5-second audio segments within 11.9–18.6 ms, demonstrating its capability to meet real-time operational requirements for UAV tracking. The results indicate that the proposed hierarchical architecture outperforms traditional methods such as MFCC, STFT, and LFCC in both positional accuracy and computational efficiency.**

Keywords—UAV detection, Sound source localization (SSL), 1D-CNN, Real-time signal processing, Multi-model architecture

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FROM DIGITAL TWINS TO AUTONOMOUS CONTROL: PHYSICS-INFORMED DEEP REINFORCEMENT LEARNING FOR TRANSIENT CALIBRATION OF ALTERNATIVE FUEL ENGINES

Mehmet Selman Gökmen

***Abstract*—The industrial transition of internal combustion engines to zero-carbon alternative fuels, such as hydrogen and ammonia, renders traditional engine calibration paradigms inadequate due to complex combustion kinetics. Historically, static lookup tables populated through steady-state dynamometer testing and traditional proportional-integral-derivative controllers fail to adapt to nonlinear dynamics during transient operations, such as sudden load increases; this limitation leads to severe knock risks and massive emission spikes. On the other hand, training autonomous artificial intelligence algorithms, such as deep reinforcement learning, directly on a physical engine poses risks of catastrophic hardware damage due to the trial-and-error mechanism of the agent. To overcome the manual calibration bottleneck, this conceptual study evaluates the potential of an autonomous control approach that integrates deep reinforcement learning agents with physics-guided digital twins. In these conceptually examined architectures, it is envisioned that engine control is formulated as a Markov decision process in a continuous action space, requiring the use of the soft actor-critic algorithm. It is supported by literature findings that the autonomous exploration process of the agent must be constrained by a multi-objective penalty and reward function embedded with thermodynamic rules. Literature findings and theoretical evaluations confirm that this rapidly developing simulation-to-reality transfer methodology can simultaneously optimize interdependent multiple variables, improve the integral absolute error in transient states by 20%, and reduce months of experimental calibration effort by 71%. Consequently, by presenting a digital twin perspective ranging from data synthesis via generative adversarial networks to autonomous decision-making via deep reinforcement learning, this study establishes a new industrial standard vision for autonomous engine management in the alternative fuel era.**

Keywords—Autonomous Engine Calibration, Deep Reinforcement Learning, Digital Twin, Transient Optimization, Alternative Fuels, Simulation-to-Reality Transfer

SECURITY-EVENT-DRIVEN MOBILE BACKUP WITH SEARCHABLE ENCRYPTED STORAGE

Mara Antonia Dragomir and Stefania Loredana Nita

***Abstract*—Backup on mobile devices is usually performed on a fixed schedule or at the user's initiative, which leaves the most recent data unprotected at exactly the moments when the device is under threat. This paper presents a mobile backup system that inverts this logic: instead of a timer, backups are driven by security events observed on the device, so that a current snapshot is preserved when the risk of loss is elevated. A set of background Android components monitors signals such as repeated failed authentication, SIM changes, untrusted networks and suspicious application installations, and a trigger engine initiates a backup while suppressing redundant executions. Because a backup exposes a large and sensitive cross-section of personal data, all information is encrypted on the device before transmission, and a searchable index is built locally so that the backup can be queried by metadata without revealing that metadata to the server. The searchable component uses a deterministic HMAC-based construction that favours low clientside cost, and we make explicit the trust model under which its confidentiality guarantees hold. We describe the architecture, the triggering and encryption mechanisms, and the practical limitations encountered in building such a system on Android, which we believe are instructive for similar work.**

Keywords—data backup, mobile security, searchable symmetric encryption, security event detection

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A REGRESSION-BASED MACHINE LEARNING FRAMEWORK FOR DECISION SUPPORT IN RAILWAY TRANSPORT SYSTEMS

Constantin Sebastian Lazar

***Abstract*—Resource allocation is one of the most important activity that appears in any organization, especially in transportation systems. Railway transport operators must solve complex planning problems such as wagon allocation and ticket pricing adjustments. Due to the complexity of ticket pricing problem, the traditional solving of this problem involved a fix per-kilometer price depending on season. Artificial intelligence and machine learning techniques can bring a strong contribution for dynamic ticket pricing in railway transport system. This paper presents a regression-based machine learning framework that can support optimal ticket price prediction, based on historical information given by the user. The proposed software requires two CSV files including historical data and the data on which the price prediction must be realized, then trains five regression models: Linear Regression, Ridge Regression, Lasso Regression, Random Forest Regression and Support Vector Regression. The performance of every model is evaluated using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and the coefficient of determination (R^2), providing to the user the solution of the best-performing model. The framework uses seven features and the experimental evaluation is realized with Monte Carlo generated synthetic dataset, the result being the price prediction and a comparative performance of regression models. The proposed system is implemented as a prototype application in Python and it can be adapted to real world operational datasets.**

Keywords—machine learning, regression, dynamic pricing, railway transport, Monte Carlo simulation

TURATHY QUEST: AN AI-POWERED 3D GAME FOR DYNAMIC CULTURAL HERITAGE LEARNING IN THE UAE

Osama Hosam and Khalifa Ali

***Abstract*—The integration of technology into educational paradigms has become imperative in modern pedagogy. This paper presents "Turathy Quest," an innovative educational game designed to address the challenges associated with traditional methods of teaching cultural and historical heritage, specifically within the context of the United Arab Emirates (UAE). Traditional pedagogical approaches often rely on rote memorization, leading to student disengagement and poor long-term knowledge retention. Turathy Quest leverages immersive 3D environments and interactive gameplay to transform learning into an engaging, exploratory experience. Players navigate a virtual character through significant UAE landmarks, solving contextually relevant quizzes and collecting cultural artifacts like poetry. This work details the project's objectives, its alignment with UAE's strategic priorities for cultural preservation, and a comprehensive analysis of its technical and operational feasibility. A comparative analysis with existing educational tools highlights the unique proposition of a dedicated 3D exploration game for UAE heritage. The expected outcomes, analyzed through hypothetical yet realistic data models, indicate a significant potential for increased student engagement, improved knowledge retention, and the provision of a valuable tool for both formal education and cultural tourism. The project demonstrates the viability of using serious games to make learning about national heritage more effective and enjoyable.**

Keywords—Serious Games, Educational Technology, Cultural Heritage, UAE History, 3D Learning Environment, Game-Based Learning, Digital Preservation

FAST SPEECH ENCRYPTION TECHNIQUE USING ADJACENCY MATRIX, DYNAMIC DNA CODING, AND QUANTUM CHAOS MAP

Mustafa A. Al Sibahee, Zaid Alaa Hussien, Salah Mortada, Zaid Ameen Abduljabbar, Vincent Nyangaresi, Iman Qays Abduljaleel, Rafal Alaa Jabbar, Ali Hasan Ali and Ahmed Ali Ahmed

***Abstract*—In the age of big data, large quantities of audio signals are output continuously every day. Following the rapid advancements in modern computer and social media technologies, we now have an alternative framework for building a more secure audio encryption system. As a result, data encryption technologies have evolved considerably. Several audio encryption techniques are now available, mainly because the quantum and chaos theories have become increasingly important lately. This study presents a cryptographic technique for protected speech communication. Our approach is novel because it integrates four separate audio encryption methods into the same structure, making it safer. These methods are dynamic DNA sequence scrambling, quantum chaotic maps, multi-chaotic maps, and graph theory. In the first stage, graph theory and a multi-chaotic map are used to generate multi-encryption keys. The creation of a multi-chaotic map involves three types of chaotic map, a 1D sine map, a 2D extended logistic map and a 2D Hanon map, which results in unexpected encryption keys. In the second stage, the speech signal vectors are scrambled twice: once using a quantum chaotic map, and again using a dynamic DNA sequence. Using the encryption keys established in the first stage, the speech signal obtained in the second stage is sent to the final module. In the third stage, the encryption key elements and scrambled speech vector values are transformed into a binary representation to compute an XOR operation between them. Next, a different encryption key is chosen randomly for each vector of the scrambled speech signal, to increase the difficulty for hackers attempting to retrieve the encrypted data. Numerous metrics are used to evaluate the process, including the key space, log-likelihood ratio, histogram, segmental signal-to-noise-ratio, spectrogram, correlation coefficient, and signal-to-noise ratio. The results show that this method is safer than several existing comparable speech encryption methods against various forms of attack.**

Keywords—Cryptography, Graph theory, Scrambling, Quantum logistic map, Hanon map, Sine map

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A GEOMETRIC NONLINEAR CONTROL APPROACH FOR STABILIZING NETWORKED SUPPLY CHAIN SYSTEMS UNDER STOCHASTIC DEMAND UNCERTAINTY

Mutaz Ali, Nuseiba Yousif and Mastora Sahal

***Abstract*—Supply chain networks exhibit highly coupled dynamic behavior resulting from uncertain demand patterns, delayed information exchange, and decentralized operational decisions. These characteristics often lead to instability phenomena, most prominently the bullwhip effect, where small variations in customer demand become significantly amplified as orders propagate upstream through the network. This study introduces a geometric nonlinear control framework aimed at stabilizing multi-echelon supply chain systems operating under stochastic demand disturbances and structural delays. The inventory dynamics are reformulated within a nonlinear control-affine structure, allowing the use of structural controllability analysis together with Lyapunov-based stability verification. A feedback control law that combines integral regulation with a nonlinear damping component is proposed in order to attenuate oscillatory inventory behavior and limit variance propagation across supply chain stages. To assess the effectiveness of the proposed approach, a synthetic dataset is generated using an autoregressive demand model enriched with seasonal patterns and disruption events. A comprehensive Monte Carlo simulation framework is employed to evaluate system performance across multiple uncertainty scenarios, including demand shocks, transportation delays, and volatility changes. The numerical results reveal substantial improvements in dynamic performance. In particular, the proposed controller reduces the bullwhip amplification ratio by approximately 68%, shortens settling time by more than 60%, and significantly enhances robustness against delay-induced instability when compared with conventional linear feedback strategies. The findings demonstrate that nonlinear geometric control concepts can provide a rigorous analytical foundation for stabilizing complex supply chain networks and improving operational resilience in automated logistics environments.**

Keywords—Supply chain control, nonlinear systems, bullwhip mitigation, robustness, stochastic demand, automation systems

MULTIMODAL DEEP LEARNING FOR HUMAN FATIGUE DETECTION AND CLASSIFICATION USING SPEECH AND TEXT MODALITIES

Şükrü Selim Çalık and Zeynep Hilal Kilimci

***Abstract*—Automated detection of human fatigue is of critical importance for a wide range of applications including occupa- tional safety, driving safety, and human performance monitoring. While existing fatigue detection systems predominantly rely on image processing and physiological signal-based approaches, the rich acoustic and linguistic information available in speech signals remains largely underexplored. In this study, we propose a multimodal deep learning framework for binary fatigue clas- sification (energetic vs. fatigued) using speech signals. A purpose- built dataset was constructed via neural speech synthesis under controlled acoustic parameters and prosodic disfluency injection to simulate energetic and fatigued speaking conditions. Three multimodal fusion strategies—Early Fusion, Mid Fusion, and Late Fusion—are evaluated, each combining acoustic features (Mel-spectrogram and handcrafted audio descriptors) with lin- guistic features derived via automatic speech recognition (ASR) followed by a BERT language model. An audio-only CNN+MLP baseline (82.5% accuracy) is also provided for comparison. Experimental results demonstrate that the Late Fusion model achieves the highest performance with 94.7% accuracy and 0.978 AUC-ROC. These findings establish that speech-based multimodal approaches offer a powerful and complementary alternative to camera-dependent and physiological methods for fatigue detection.**

Keywords—human fatigue detection., multimodal learning., BERT., fusion strategies., speech analysis.

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PERFORMANCE-ORIENTED EVALUATION OF LONG TERM EVOLUTION NETWORKS FOR HETEROGENEOUS APPLICATIONS USING NETSIM

Andreea Daniela Sirbu, Teodor Iustinian Paunescu, Gabriel Predusca, Liana Denisa Circiumarescu, Nicoleta Angelescu and Dan Constantin Puchianu

***Abstract*—Long Term Evolution (LTE) networks are the backbone of modern mobile communications and support a wide range of applications with significantly different Quality of Service (QoS) requirements, ranging from best-effort data traffic to latency-sensitive services such as voice and video streaming. In this context, evaluating the behaviour of LTE networks as a function of application type, transport protocol, and QoS class is essential for the design and optimization of mobile networks. This paper presents a comparative performance analysis of an LTE network simulated in the NetSim environment, with the objective of assessing the impact of TCP and UDP transport protocols, as well as the Best Effort (BE) and Extended Real-Time Polling Service (ERTPS) QoS classes, on the main performance indicators: throughput, delay, and jitter. The analysis considers several representative application types (CBR, HTTP, EMAIL, FTP, VIDEO, and VOICE), and the resulting data support the identification of optimal protocol - QoS combinations for different traffic categories. The conclusions highlight the advantages of UDP for real-time applications and the critical role of QoS configuration in LTE networks.**

Keywords—LTE, NetSim, performance analysis

AN EFFICIENT VISION TRANSFORMER-BASED SKIN CANCER CLASSIFICATION FRAMEWORK USING AN IMBALANCED DATASET

Najwa Abdulateef and Zakariya Oraibi

***Abstract*—One of the most common and deadly forms of cancer worldwide is skin cancer. Exposure of the skin to ultraviolet (UV) rays from direct sunlight is the primary cause of this type of cancer. For early-stage diseases to be successfully treated, early and precise identification is essential. In this paper, we propose a technique that extracts global features from an efficient ViT-16 model by turning the image into a sequence of 16×16 patch tokens, supplemented by positional embeddings. These tokens pass through twelve Transformer Encoders using Multi-Head Self-Attention to produce the final 768-dimensional feature vector which will be used for the final classification task. In order to test the ViT-based classifier, a challenging skin lesion dataset with seven classes was used which is called HAM10000 database. The dataset consists of 10,015 images and it is highly imbalanced. The proposed lightweight model was trained on 80\% of data and tested on the remaining 20\% with 100 epochs utilized during training stage. It achieved a high classification accuracy of 92.62% which outperforms state-of-the-art methods applied on the same dataset.**

Keywords—Skin Lesion Detection, Vision Transformer, Features Extraction

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ML BASED MICROSCOPIC IMAGE ANALYSIS FOR AUTOMATED DETECTION AND CLASSIFICATION OF BLOOD DISORDERS

Buddhika Roshan, Sonali Liyanahetti, Heshani Niwanthika, Shamith Siriwardhana, Dinithi Pandithage, Rangi Liyanage and Subhash Jayasinghe

***Abstract*—In the current study, an integrated machine learning (ML) framework has been proposed for the automatic detection and classification of the four main hematologic diseases, i.e., leukemia, thalassemia, anemia, and malaria, from the microscopic blood smear images. The traditional approaches in the diagnosis of blood-related diseases are based on microscopic examination, which is a tedious, subjective, and skill-dependent approach, sometimes resulting in delays in the detection of these diseases, particularly in underdeveloped countries. To overcome these limitations, the current study proposes an integrated detection system using disease-specific deep learning models, including a DenseNet-MobileNet hybrid network with a Convolutional Block Attention Module (CBAM) for the detection of leukemia, a MobileNetV2-ViT two-stage hybrid network for the detection of thalassemia, a ResNet50-EfficientNet hybrid network for the detection of anemia, and a CNN-ViT network for the detection of malaria. In addition, the proposed system will include the integration of Explainable Artificial Intelligence (XAI) techniques, i.e., Gradient-weighted Class Activation Mapping (Grad-CAM) and SHapley Additive exPlanations (SHAP), to improve the interpretability of the results. The proposed system will ensure the accuracy of the results to be above 80%, the inference time below 5 seconds, and will be made available through a cost-effective web platform to ensure the applicability of the system in both urban and rural settings.**

Keywords—blood disorder detection, machine learning, deep learning

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DIGITAL TWIN FOR THE DYNAMIC MODELING OF A LINEAR ACTUATOR WITH SERVOMOTOR

Marius Constantin Marica, Ionel Bostan, Nicu Bizon and Victor Constantin

***Abstract*—This paper presents the development and validation of an experimental Digital Twin for a linear actuator with servomotor, implemented in the MATLAB/Simulink environment. The model reproduces the dynamic behaviour of the drive system based on real parameters and interface signals defined at the servomotor driver level, using a modular architecture that explicitly separates the motion profile, the control structure and the physical system model. Three control strategies are compared: the classical PID controller in a hierarchical structure, the Mamdani-type fuzzy control and the Sugeno-type fuzzy control, on systematic positioning and velocity tracking scenarios, with mechanical loads varying between 100 g and 10 kg. The quantitative evaluation uses standardized performance indicators: rise time, percentage overshoot, absolute stationary error and stabilization time, synthesized in comparative graphs and a normalized radar graph. The results demonstrate that the Sugeno fuzzy controller offers the fastest response with a trade-off in overshoot, the PID control provides superior stability and reduced stationary errors, and the Mamdani controller exhibits good robustness to load variations without overshooting. The proposed Digital Twin constitutes a reproducible and extensible platform for analysing, comparing, and optimizing control strategies in industrial linear drive systems.**

Keywords—Digital Twin, linear actuator, servomotor, fuzzy control, PID control, MATLAB/Simulink, Industry 4.0m dynamic modelling

ATTENTION-ENHANCED U-NET FOR ROBUST N95 FFR SEGMENTATION IN INFRARED IMAGERY

Hana Benmoussa, Rihab Baccari, Yacine Yaddaden, Mohamed Arbane, Jean Brousseau, Clothilde Brochot, Ali Bahloul and Xavier Maldague

***Abstract*—Infrared (IR) imaging provides a non-invasive approach for evaluating the fit of N95 filtering facepiece respirators (N95 FFRs) and detecting potential leakage. This work presents an optimized U-Net architecture for N95 FFR segmentation from infrared images, a critical component for reliable leakage analysis. The proposed architecture integrates bilinear upsampling, Squeeze-and-Excitation (SE) blocks, and normalization techniques to improve feature representation, stabilize training, and reduce computational cost. The model is trained on one participant dataset and evaluated on a separate unseen dataset containing mask types not encountered during training, enabling assessment of cross-participant generalization and robustness. Experimental results demonstrate that the proposed model achieves an IoU of 98.61\% and a precision of 99.94\%, outperforming the standard U-Net across all evaluated metrics while demonstrating strong generalization capability for practical healthcare and industrial applications.**

Keywords—Infrared imaging, N95 FFR segmentation, U-Net, Squeeze-and-Excitation, bilinear upsampling, medical mask detection, thermal imaging, leakage detection, deep learning

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ON THE LIMITS OF ATTENTION-ENHANCED LONG SHORT-TERM MEMORY NETWORKS FOR AUTOMOTIVE STEERING TORQUE MODELING

Michael Schmid, Tianze Liang, Osman Aksu, Mišel Radosavac, Florian Bierwirth and Hans-Georg Herzog

***Abstract*—Accurate modeling of Electric Power Steering (EPS) systems is essential for predicting electrical power demand in modern vehicle electrical and electronic (E/E) architectures. This paper investigates sequential deep learning approaches for data-driven EPS torque prediction on real-world driving data (∼2.2 million samples, 4988 driving sequences), using a sequence-level evaluation protocol with block-bootstrap confidence intervals and permutation tests. Explicit temporal modeling via LSTM significantly outperforms non-sequential MLP baselines, with medium-to-large effect sizes (Cohen's $d = 0.70–1.12$, $p < 0.001$), confirming that sequential processing of vehicle dynamics signals is essential for accurate torque estimation. This paper further evaluates whether attention mechanisms, including Simple, Additive (Bahdanau), and Scaled Dot-Product variants, can improve upon the LSTM baseline. None yields a practically relevant improvement, with effect sizes remaining negligible ($|d| < 0.1$) for Simple and Additive Attention, while Scaled Dot-Product Attention significantly degrades performance ($p < 0.001$). Analysis of the learned attention weights reveals two failure modes, recency collapse and uniform collapse, explaining why attention cannot contribute beyond what the LSTM hidden state already encodes for short automotive time series. Additionally, a small LSTM with 85K parameters achieves near-identical performance to medium models with 598K parameters at 3.5× lower inference latency, establishing it as the recommended architecture for deployment in resource-constrained automotive systems.**

Keywords—LSTM, attention mechanism, electric power steering, steering torque modeling, E/E architecture, automotive time series, deep learning

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COMPARATIVE EVALUATION OF CONTINUOUS- AND FINITE-CONTROL-SET MPC FOR A THREE-PHASE GRID-CONNECTED VOLTAGE-SOURCE INVERTER

Viet Nguyen Hoang, Duong Pham Hong and Hien Nguyen Thu

***Abstract*—This paper presents a comparative evaluation of continuous-control-set model predictive control (CCS–MPC) and finite-control-set model predictive control (FCS–MPC) for a three-phase grid-connected voltage-source inverter. Both controllers are developed using the same synchronous referenceframe current model, system parameters, phase-locked loop, and reference-current profile to ensure a fair comparison. In the continuous-control-set scheme, a continuous modulation vector is optimized and implemented through space-vector modulation, which enables fixed-switching-frequency operation. In contrast, the finite-control-set scheme directly selects the optimal switching state from a finite set of inverter voltage vectors, thereby eliminating the need for an intermediate modulation stage. The two methods are evaluated under three active-current reference levels of 0.5 A, 5 A, and 10 A, while the reactive-current reference is kept at zero to achieve near-unity-power-factor operation. Simulation results show that both controllers successfully track the current references and keep the reactive-current component close to zero. Under the considered parameter setting, finitecontrol-set model predictive control achieves lower currenttracking error, smaller current ripple, and lower phase-current total harmonic distortion. At the 10 A operating point, the total harmonic distortion of the phase current is reduced from 2.42% with continuous-control-set model predictive control to 1.76% with finite-control-set model predictive control. However, continuous-control-set model predictive control preserves a fixed switching frequency of 20 kHz, whereas finite-control-set model predictive control exhibits a slightly varying average switching frequency in the range of 20.8–21.05 kHz. The results highlight the practical tradeoff between current quality and switchingfrequency regularity in predictive control of grid-connected inverters.**

Keywords—Continuous-control-set model predictive control, finite-control-set model predictive control, grid-connected inverter, current control, space-vector modulation, switching frequency, total harmonic distortion

DEVELOPMENT OF A DRIVING MODE APPLOCKER FOR MOBILE PHONES USING 1D CNN AND RASPBERRY PI 4

Andrea Bague, Molly Domingo and Rosemarie Pellegrino

***Abstract*—Distracted driving caused by smartphone usage remains a significant contributor to road traffic accidents worldwide. Studies have consistently shown that mobile phone interaction while driving increases cognitive workload, visual distraction, and crash risk. This study suggests creating a prototype Driving Mode AppLocker that uses smartphone accelerometer data to identify vehicle motion and blocks access to distracting mobile apps in order to address this issue. For real-time motion categorization, the system combines an Android smartphone with a Raspberry Pi 4 platform and makes use of a one-dimensional Convolutional Neural Network (1D CNN) model that was trained using Edge Impulse. To ascertain whether the user is in a moving vehicle or stationary, the accelerometer data is processed as time-series inputs. Once driving motion is detected, predefined applications such as messaging and social media apps are automatically disabled using Android accessibility services. The system aims to reduce distracted driving behavior through automated enforcement rather than voluntary compliance. Performance evaluation will be conducted using a confusion matrix, targeting at least 85% classification accuracy. The proposed prototype contributes to intelligent transportation safety systems and supports Sustainable Development Goal 3.6 by promoting road safety through embedded artificial intelligence and edge computing technologies.**

Keywords—Distracted driving, Accelerometer, Raspberry Pi 4, 1D Convolutional Neural Network (1D CNN), Edge Impulse AI, Mobile application restriction

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PERFORMANCE EVALUATION OF AN LQG CONTROLLER FOR A VOC-BASED THREE-PHASE ACTIVE RECTIFIER

Vinh Ngo Quang

***Abstract*—Voltage-Oriented Control (VOC) is a widely adopted control strategy for three-phase active rectifiers based on the Voltage Source Rectifier (VSR) topology. In this paper, a cascade control structure is developed, in which a linear Proportional–Integral (PI) controller is employed in the outer DC-link voltage control loop to ensure power balance, while the inner grid current control loop is designed using a Linear Quadratic Gaussian (LQG) controller. By integrating an optimal Linear Quadratic Regulator with a Kalman state estimator, the LQG controller enables current control based on estimated system states in the presence of measurement noise and model uncertainties. The proposed cascade PI–LQG control structure aims to enhance current waveform smoothness, improve Pulse Width Modulation (PWM) modulation quality, and increase robustness against operating disturbances. Simulation results demonstrate that the proposed method maintains high grid-side current quality and achieves improved stability under voltage and load variations, indicating its potential applicability in three-phase active rectifier systems requiring high power quality.**

Keywords—VSR, VOC, PI, LQG, Kalman filter, PWM

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DEVELOPING CUSTOM LINE CHARTS FOR MOBILE APPLICATION

Shubham Kamdi

***Abstract*—This paper aims to explore an MVVM (Model View ViewModel)-based mobile application that plots a graph spanning multiple data points. In doing so, readers will gain insights into how the trading apps draw charts and manipulate the data line function to provide a perfect visual representation of how the data is being shaped. The paper will also provide a comparison of UIKit implementation. It will also provide an Architectural framework that readers can use to develop their custom mobile applications. The source for the same will be provided in form of a Github repository.**

Keywords—MVVM, Data Points, Architectural Framework, Mobile Applications

IMPACT OF AI AGENTS ON THE DIGITAL SUPPLY CHAIN

Veselin Popov and Petya Popova

***Abstract*—Digital supply chains are evolving to include autonomous software agents. These agents support the execution of actions in areas such as planning, logistics, inventory, and manufacturing. The roles of AI agents and their impact vary across the respective domains. This study reviews recent literature sources after 2021 and presents real-world case studies to: i) distinguish agent-based from conventional AI; ii) define a two-dimensional typology that classifies agents by functional area and level of autonomy (monitoring, forecasting/consulting, and prescription/execution); and iii) indicate the effects of increasing the performance of AI agents on resilience, efficiency, and sustainability. The results of the literature review show that agents with high autonomy for inventory/logistics and smart manufacturing are associated with operational potential, such as faster replanning, lower waste and energy consumption, and better service levels. In contrast, procurement and compliance agents are emerging and understudied. The study discusses the need for governance and a human in the loop for safe deployment. It highlights gaps in research on inter-organizational orchestration and ethical oversight. This study outlines the benefits and challenges of deploying AI agents in digital supply chains, as well as opportunities to assess their strategic impact.**

Keywords—AI, AI agents, SCM, impact, classification

COGNITIVE LOAD IN EXTENDED REALITY-ASSISTED INDUSTRIAL MAINTENANCE: A SYSTEMATIC LITERATURE REVIEW

Mouad Danane and Abdelmajid El Ouadi

***Abstract*—Extended Reality (XR) technologies—encompassing Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR)—are increasingly deployed in industrial maintenance to enhance operator performance and support knowledge transfer. However, a systematically under-explored dimension is the cognitive impact of these immersive interfaces on maintenance technicians. Cognitive overload in safety-critical maintenance tasks directly compromises performance, increases error rates, and threatens operator well-being. Despite growing recognition of this challenge, no prior systematic review has specifically examined cognitive load measurement methodologies across XR modalities in industrial maintenance contexts. This paper presents a Systematic Literature Review (SLR) following PRISMA 2020 guidelines, analysing peer-reviewed studies published between 2016 and 2026. From 221 initial records retrieved from Scopus and ScienceDirect, 24 empirical studies were included after rigorous screening. Our synthesis reveals: (i) subjective instruments— particularly NASA-TLX—dominate evaluation practice (present in 45.8% of studies), while continuous physiological monitoring remains marginal (12.5%); (ii) AR-based guidance is associated with lower reported cognitive load than VR in procedural maintenance tasks, though methodological heterogeneity prevents meta-analytic synthesis; (iii) critical gaps persist in real-time cognitive monitoring, adaptive system design, and evaluation of Industry 5.0 human–AI collaboration contexts. We contribute a Cognitive Load Evaluation Taxonomy (CLET) structured along three orthogonal dimensions—measurement type, interface factor, and task factor—and a prioritised research agenda for cognitive load-aware XR maintenance systems.**

Keywords—Extended Reality, Augmented Reality, Virtual Reality, Industrial Maintenance, Cognitive Load, Mental Workload, Systematic Literature Review, PRISMA, Industry~5.0, Human-Centric Manufacturing, Operator~5.0

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A SURVEY ON QUANTUM MACHINE LEARNING ALGORITHMS AND QUANTUM-INSPIRED ALGORITHMS

N Sai Srithaja, Dr Om Prakash Patel and A Kapil Kumar

***Abstract*—The goal of Machine Learning (ML) is to create models that learn from previous experience without being specifically stated. Machine learning has an endless list of applications, including understanding patterns, forecasting future developments, and making choices. Also, it can handle huge amounts of multi-dimensional data in the form of large tensors that are vectors. However, there are some applications which takes exponential time to solve by machine learning algorithm. To solve such problems in respectively lesser time, recently Quantum Computing (QC) has caught the attention of many researchers. Quantum Computers are based on qubits, which have the property of superposition and entanglement. A qubit can carry 0 and 1 combinations at the same time, unlike traditional computers that rely on binary bits for computation. As a result, it explores multiple possibilities simultaneously. This paper reviews and discusses significant developments in quantum computing, quantum machine learning, and quantum-inspired evolutionary algorithms that have emerged over the past two to three decades.**

Keywords—Qubits, Quantum Computing, Quantum Machine Learning, Quantum Evolutionary, Quantum-Inspired Algorithms

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QoS-Guaranteed Resource Slicing in Wired Networks via ML Metaheuristics

Alexandru Petrisor Cioponea, Constantin Viorel Marian and Robert Cristian Robu

***Abstract*—Multi-tenant wired networks based on the DOCSIS 3.1 standard must simultaneously serve tenants with heterogeneous and time-varying service level agreement requirements. Classical static resource partitioning fails under dynamic traffic conditions, leading to either wasted capacity or service level agreement violations. This paper proposes a dynamic resource slicing framework that employs a Genetic Algorithm augmented by a Random Forest traffic predictor for demand-aware warm-start initialization to optimize the joint allocation of downstream bandwidth, transmit power, and Orthogonal Frequency Division Multiple Access minislot assignments across multiple tenants in real time. The proposed framework is evaluated against three baseline algorithms Round Robin , Weighted Static, and MaxMin Fairness over 60 simulation episodes with heterogeneous traffic profiles. Results demonstrate that the proposed GA significantly outperforms the Round Robin algorithm, delivering higher average throughput, lower packet loss, and better overall Quality of Service satisfaction. An impact analysis isolating the ML component demonstrates that the trained Random Forest predictor consistently outperforms a static heuristic seed, leading to improved QoS satisfaction and higher aggregate fitness, thereby directly quantifying the value of data-driven prediction within the overall framework.**

Keywords—network slicing, cable networks, docsis 3.1, genetic algorithm, quality of service, resource allocation, machine learning, multi-tenant networks

COMPARATIVE ANALYSIS OF MEDICAL INFORMATION SYSTEMS FOR IMPROVED PATIENT CARE AND DATA PRECISION

Dan Theodor Andronic, Stefan Titu and Aurel Mihail Titu

***Abstract*—Medical information systems (MIS) have become the infrastructure on which clinical decision-making and reporting rest, carrying a twofold promise: better patient care and more precise data. This paper analyses comparatively the main architectural archetypes of MIS, the integrated monolith, the interoperability-oriented system and the modular system, illustrated with three systems present on the Romanian market, without ranking them. The central argument is that data precision is the product of two factors that multiply, infrastructure and organisation. Infrastructure sets a ceiling on quality, through interoperability, imaging integration (RIS/PACS), resilience and structuring. The organisational layer, that is who enters the data, how and how often, determines how much of that ceiling is actually reached. Drawing on our clinical experience and on the international literature, the paper argues that, in the Romanian healthcare system, the dominant constraint is not the type of system but the shortage of staff and the absence of a clear assignment of responsibility. The operational conclusion belongs to quality management: better data come from the best-integrated system, used under firm governance of data entry.**

Keywords—medical information systems, data quality, interoperability, quality management, medical imaging (RIS/PACS), electronic health record

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INTELLIGENT VPN TRAFFIC ANALYSIS AND CLASSIFICATION FRAMEWORK ON RASPBERRY PI USING MACHINE LEARNING TECHNIQUES

Mihai Bucurel, Sebastian-Alexandru Dragusin and Nicu Bizon

***Abstract*—The increasing adoption of Virtual Private Networks (VPNs) for secure communications has created new challenges regarding traffic monitoring, classification, and anomaly detection in resource-constrained environments. This paper presents an intelligent framework for VPN traffic analysis and classification deployed on a Raspberry Pi platform. The proposed system combines secure VPN connectivity using OpenVPN and WireGuard with real-time traffic monitoring and machine learning (ML)-based analysis. Network traffic is collected and processed using packet capture and inspection tools, while Random Forest (RF) and Support Vector Machine (SVM) models are employed to classify traffic flows and identify potentially suspicious activities. Furthermore, TensorFlow Lite is integrated to enable lightweight real-time inference on embedded hardware with limited computational resources. Experimental evaluation demonstrates the feasibility of deploying intelligent traffic analysis services directly on edge devices, providing a cost-effective solution for secure Small Office/Home Office (SOHO) environments. The obtained results indicate that ML techniques can effectively enhance traffic visibility and support cybersecurity monitoring while maintaining low resource consumption on Raspberry Pi-based platforms.**

Keywords—VPN, Raspberry Pi, traffic analysis, traffic classification, machine learning, Random Forest, Support Vector Machine, TensorFlow Lite, edge computing, cybersecurity

DESIGN AND IMPLEMENTATION OF A HYBRID AI MOBILE APPLICATION FOR MOTORCYCLE WEATHER DECISION SUPPORT

Maria-Elena Stanciu, Mihai Oproescu and Rodica-Mihaela Teodorescu

***Abstract*—The proposed work is based on the implementation of a mobile application for motorcycle drivers. This application is implemented in the Swift programming language combined with various APIs such as Apple WeatherKit and interfaces for integrating artificial intelligence in the backend, while the SwiftUI programming language is used in the frontend. The application uses the MVVM (models, views, view models) architecture and has two LLM providers integrated into it: Apple Foundation Models - for processing local tasks and Google Gemini API - for processing tasks in the cloud and making LLM available on devices that are not compatible or do not have the necessary resources to run locally.**

Keywords—Apple Foundation Models, Google Gemini, LLM, Weather, motorcycle

COMPARATIVE ANALYSIS OF INCREMENTAL CONDUCTANCE AND KALMAN FILTER APPROACHES FOR OPTIMIZING PHOTOVOLTAIC WATER PUMPING SYSTEMS

Ikram Saady, Btissam Majout, Mohammed Karim and Badre Bossoufi

***Abstract*—This paper investigates a Photovoltaic Water Pumping System (PVWPS) driven by an induction motor (IM) controlled through Direct Torque Control (DTC). The study focuses on enhancing overall system performance by comparing two Maximum Power Point Tracking (MPPT) algorithms: the Incremental Conductance (INC) algorithm and the Kalman Filter-based MPPT (KF-MPPT) algorithm. The INC algorithm is widely used due to its simplicity, but it often suffers from steady-state oscillations and a slow response under rapid irradiance variations. In contrast, the KF-MPPT aims to enhance tracking accuracy and dynamic performance by estimating the optimal operating point more precisely. The DTC technique is employed to control the electromagnetic torque and flux of the IM, ensuring efficient water pumping operation. The complete PVWPS was modeled and simulated in MATLAB/Simulink under variable solar conditions. Comparative results demonstrate that the integration of KF-MPPT with DTC significantly reduces power oscillations, improves transient response, minimizes torque and flux ripples, and increases the pumped water flow compared to the INC -DTC combination.**

Keywords—Direct Torque Control, Incremental Conductance, Kalman Filter MPPT, Solar Irradiance Variations

ML-DRIVEN DETECTION OF MALICIOUS PE FILES: A LIGHTWEIGHT AND SCALABLE APPROACH

Gokay Mutlu, Nese Rihani and Ozgur Koray Sahingoz

***Abstract*—Malware is a significant cybersecurity risk, particularly when it is embedded in executable formats like Portable Executable (PE) files. This research aims to deliver a whole machine learning pipeline for malware detection using the PE Files Malwares dataset. The dataset was thoroughly preprocessed, followed by experiments using ten different feature selection techniques, of which SelectKBest using ANOVA F-score performed optimally, reducing the dataset to the top ten most informative features. To establish comprehensive baselines, a number of machine learning and deep learning algorithms were trained and tested using 5-fold stratified cross-validation. The Random Forest classifier performed optimally, achieving an average accuracy of 95.95, closely followed by Decision Tree at 95.94 and XGBoost at 95.69, all of which reported consistent precision, recall, and F1-score metrics of about 0.96. On the other hand, deep learning models like MLP, Conv1D, and LSTM performed poorly at 54.90, 55.08, and 45.46 respectively. This significant performance gap is fundamentally attributed to the structured, tabular nature of the ten selected features, which limits the representational advantage of deep neural networks compared to high-dimensional or sequential domains. This research suggests that traditional ensemble-based machine learning models are more suitable for malware detection than deep learning models, and feature selection is critical for better model performance.**

Keywords—Malware Detection, Machine Learning, Deep Learning, Computational Efficiency, PE File Analysis

A N IMPROVED NONLINEAR PI BASED CONTROL STRATEGY FOR A VIENNA RECTIFIER II BASED EV POWERTRAIN CHARGING SYSTEMS

Doğan Çelik

***Abstract*—The worldwide expansion of DC fast-charging infrastructure is accelerating to meet the continuously rising demand from the electric vehicle sector. This rapid growth imposes considerable pressure on existing electrical distribution networks, especially due to the increasing deployment of high-power charging stations and their strict requirements for maintaining power quality and grid stability. In this context, power electronic converters play a central role in enabling efficient and reliable energy conversion between the grid and electric vehicles. To address these issues, this paper proposes a nonlinear PI (N-PI) based control strategy for a Vienna rectifier–based EV charging system. The proposed control method is designed to enhance dynamic response, improve disturbance rejection capability, and maintain stable DC-link voltage regulation under varying operating scenarios, including reference changes, load variations, and imbalance conditions. Furthermore, an N-PI–based neutral-point balancing controller is applied in the Vienna rectifier system to reduce DC-link capacitor voltage imbalance and maintain stable midpoint voltage regulation. The effectiveness of the proposed approach is verified through comparative analysis with conventional PI control, demonstrating improved overall system performance and robustness for next-generation fast-charging applications.**

Keywords—nonlinear PI, Vienna Rectifier II, EV Powertrain, neutral-point balancing, fast-charging

PREDICTIVE RESILIENCE IN 5G/6G MEC INFRASTRUCTURES: ADAPTIVE ENTROPIC CONTROL AND DIGITAL TWINS WITHIN A MULTI-AGENT COGNITIVE FRAMEWORK

Constantin Alin Copaci

***Abstract*—Growing structural complexity within Multi-access Edge Computing topologies challenges the rollout of fifth-generation advanced networks and the shift toward sixth-generation ecosystems. These networks demand ultra-low latency, decentralized execution, and autonomous continuity. Standard orchestration policies remain reactive, resolving faults only after they occur, with little capability to foresee systemic degradation in hostile settings. This paper introduces the Autonomous Resilience Hyperstructure Omega, a distributed cognitive architecture built to fortify fifth-generation and sixth-generation Multi-access Edge Computing deployments. The proposed framework fuses multi-agent reinforcement learning, operational entropy-based control loops, semantic service migration, and predictive self-reconfiguration. We model the infrastructure as a dynamic graph of intelligent edge nodes defined by heterogeneous computational capacity, communication latency, energy profiles, and instability indices. To mathematically measure resilience dynamics, we introduce two metrics: the Adaptive Cognitive Resilience Potential and the Temporal Resilience Drift. These indicators evaluate adaptive capacity and track systemic degradation over time. Empirical tests via simulation demonstrate increased architectural stability, reduced operational entropy, and self-stabilizing behaviors, proving that the Autonomous Resilience Hyperstructure Omega successfully shifts orchestration toward a predictive, autonomous, and anti-fragile operational model customized for artificial intelligence-native sixth-generation infrastructures.**

Keywords—Adaptive Entropic Control, Digital Twins, Edge Computing, Multi-Agent Systems, Predictive Resilience

AISA: A HYBRID HUMAN-AI EVALUATION FRAMEWORK FOR TRUSTWORTHY AI BENCHMARKING

Yasser El Hardouz

***Abstract*—The rapid proliferation of AI systems across safety-critical domains has exposed a fundamental flaw in current evaluation methodologies: automated benchmarks, however sophisticated, are insufficient proxies for real-world trustworthiness. We introduce AISA --- the AI System Assessment Protocol --- a formal, reproducible hybrid evaluation framework that systematically integrates automated AI scoring with structured human expert judgment. AISA defines a four-layer architecture comprising Task Specification, Automated Evaluation, Human Expert Review, and Hybrid Arbitration, governed by an arbitration function that dynamically weights human and machine contributions based on confidence, domain sensitivity, and historical accuracy. We formalize the protocol mathematically, specify inter-rater reliability guarantees, and demonstrate its superiority over both purely automated and purely human evaluation baselines across three benchmark domains. AISA is designed to become an international reference standard for AI tools evaluation, with an open specification that scales from individual research groups to regulatory bodies. This work establishes both an academic standard and the methodological foundation for the Aisetapp.com evaluation platform.**

Keywords—AI benchmarking, hybrid evaluation, trustworthy AI, human-AI collaboration, evaluation protocol, AI governance, EU AI Act

AN EFFICIENT AUTHENTICATION PROTOCOL FOR ROBUST SECURITY IN WIRELESS BODY AREA NETWORKS

Joshua Auko, Vincent Nyangaresi, Zaid Ameen Abduljabbar, Zaid Alaa Hussien, Ali Hasan Ali and Hamid Ali Abed Al-Asadi

***Abstract*—The ever increasing number of aging populace together with high number of chronic diseases has led to wide adoption of medical internet of things, such as wireless body area networks (WBANs). Through these networks, physiological data such as blood glucose, body temperature, ECG, blood pressure, heart rate and EEG are collected and transmitted to remote medical professionals for analysis, diagnosis and treatment. However, the deployed open wireless channels and IEEE 802.15.6 standardized protocol have vulnerabilities that can easily compromise the patient data. Although many security solutions have been presented based on techniques such as certificates and bilinear-pairings, these algorithms have either high overheads or still have numerous security gaps. In this paper, a lightweight encryption protocol is presented. It is shown to incur the least computation costs and average communication overheads. In addition, it offers anonymity, untraceability, authentication, session key agreement, perfect key secrecy, revocability and conditional privacy. Moreover, it protects against node capture, session hijacking, denial of sleep, denial of service, key compromise, side-channeling, impersonation, KSSTI, eavesdropping, session key disclosure, privileged insider, tracking, offline guessing, forgery and non-repudiation.**

Keywords—BSU, WBAN, attacks, threat, algorithms, encryption

AI-POWERED LEARNING PATHWAYS: PERSONALIZED LEARNING AND DYNAMIC ASSESSMENTS

Aviral Shukla, Aryan Gupta and Robin Kumar

***Abstract*—Online education has changed a lot in recent years due to digitalization and AI. Instead of teaching every student the same way, technology now allows schools and universities to create a personalized learning experience for each student. But still, there are big challenges in making sure that tests and exams measure what a student knows and where they need to improve. The platform is built with modern web technologies, making it fast and easy to use. If, after the test, the student gets less than 60 percent, they can generate their paths and be made aware of the topic on which they need to focus. The result is that tests are no longer just a final check at the end of learning — they become a part of the learning journey itself. This research points to a future where online education is truly built around each individual student — making learning smarter and more effective for everyone**

Keywords—AI, Personalized Learning, Generative AI, Assessment, Firebase, Next.js, Ethics, Privacy

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XAI-DRIVEN HYBRID DEEP LEARNING AND TRANSFORMER-BASED APPROACH FOR MULTI-LABEL EMOTION AND SENTIMENT CLASSIFICATION

Nurul Absar, Md. Symum Hossain and Tanvir Mahtab Zihan

***Abstract*——Emotions and sentiments expressed in user generated text reflect psychological, social, and cultural tenden cies. Detecting them automatically is important for applications such as mental health monitoring, customer analytics, social me dia analysis, and human–computer interaction. While sentiment and emotion analysis has made significant progress in high resource languages like English, Bengali—one of the most widely spoken languages in the world—remains underexplored due to limited annotated datasets, low-resource constraints, and the complexity of multi-label affective expressions. To address these challenges, this study proposes a hybrid CNN–BiLSTM frame work with BanglaBERT embeddings for multi-label emotion and sentiment classification in Bengali. The model demonstrates state of-the-art performance compared to existing approaches. The dataset used in this study contains seven emotion categories and five sentiment categories. Extensive experiments were con ducted using multiple optimizers and baseline models, including standalone deep learning and transformer-based models. Results show that the proposed hybrid CNN–BiLSTM with BanglaBERT embeddings achieves 99.7% and 99.8% accuracy in sentiment and emotion detection, outperforming all individual models and showing superior performance in F1-score, precision, and recall metrics. Furthermore, the inclusion of Explainable AI (XAI) techniques such as LIME provides human-understandable explanations for model predictions, highlighting the contribution of specific words or phrases to each predicted label**

Keywords—Multi-label classification, Sentiment analysis, Emotion recognition, Hybrid deep learning, Transformer models, Explainable AI (XAI), CNN–BiLSTM

RF FINGERPRINTING AND CLASSIFICATION OF 15 DIFFERENT UAV REMOTE CONTROLLERS VIARAW SIGNAL ANALYSIS WITH 1D-CNN

Kübra Yiğit, Begüm Beraye Atalay, İbrahim Kaya, Gürkan Aydemir, Salih Mehmed Bostan and Mehmet Baris Tabakcioglu

***Abstract*—This study presents a high-performance framework for the identification of 15 different UAV remote controllers using raw Radio Frequency (RF) signals. To address the security risks posed by the rapid proliferation of Unmanned Aerial Vehicles (UAVs), a specialized 1-Dimensional Convolutional Neural Network (1D-CNN) architecture is developed. This model eliminates the computational overhead of manual feature engineering by learning discriminative features directly from time-domain data. A dedicated burst detection algorithm is implemented to capture signal onsets, ensuring optimal data representation and noise reduction. The proposed methodology achieves a classification accuracy of 99.87% demonstrating significant discriminative power even between hardware-identical controllers. Experimental results indicate an average inference latency of 10.42 ms confirming the system's suitability for highspeed real-time identification. These findings suggest that the proposed approach offers a scalable and efficient alternative to traditional feature-based methods for critical defense applications.**

Keywords—Drone Identification, RF Fingerprinting, 1DCNN, Deep Learning, Signal Processing

DEEP LEARNING BASED COVERAGE MAPPING IN KNIFE-EDGE STRUCTURED SCENARIOS

Ugur Erbas, Bahtiyar Bayram, Adem Avci and Mehmet Baris Tabakcioglu

***Abstract*—Coverage map estimation is fundamental in planning wireless communication systems to enhance service quality and minimize operational costs. Although traditional deterministic propagation models offer high precision, their computational costs and processing times increase exponentially, especially in urban areas. In this study, a ResNet-based Conditional Variational Autoencoder (ResNet-CVAE) architecture is proposed for rapid and accurate coverage map generation in scenarios involving multiple diffractions. In order to generate dataset, a dynamic ray-tracing code integrating Geometric Optics (GO) and the Uniform Theory of Diffraction (UTD) was developed. By processing obstacle geometry and transmitter locations as both numerical and spatial condition information, the proposed deep learning model successfully captures abrupt signal level drops and physical shadowing effects behind obstacles. Experimental results demonstrate that the ResNet-CVAE model produces high accurate results with significantly lower computational overhead compared to traditional methods and adapts effectively to complex obstacle configurations. This approach offers significant potential for real-time analysis in network planning and base station placement processes.**

Keywords—coverage estimation, Uniform Theory of Diffraction (UTD), deep learning, ResNet-CVAE, wireless communications, ray tracing

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EXTRACTION OF ANTHROPOMETRIC MEASUREMENTS USING CONVOLUTIONAL NEURAL NETWORK FOR SOMATOTYPE CLASSIFICATION WITH DIET SUGGESTIONS

John Casper Santos, Lesler John Gantalao, Daniela Marie Alpez and Sherard Chris Banquerigo

***Abstract*—Body Mass Index (BMI) cannot differentiate muscle mass from fat distribution, while manual somatotyping offers comprehensive assessment but lacks scalability. This study developed and validated an AI-driven web application for automated somatotype classification from 2D camera images with personalized diet recommendations. The system employed a five stage hybrid pipeline: CNN-based silhouette feature extraction, SVR/Random Forest prediction of anthropometric measurements (trained on CAESAR dataset, N=4,431), Bayesian Ridge calibration to Filipino anthropometry, deterministic somatotype computation, and multivariate bias correction for seven-category classification. Validation on 30 Filipino males using nested Leave One-Out Cross-Validation achieved 76.7 percent accuracy (Cohen's kappa of 0.670, substantial agreement), improving from 36.7 percent baseline with measurement MAE of 0.21 to 3.49 mm. The rule-based diet engine received Scale-Level Content Validity Index of 1.00 from certified Nutritionist-Dietitians. Automated camera-based somatotype classification approaches human inter rater reliability and offers scalable health profiling, though low Mesomorph recall (17 percent) and pilot sample size require further validation.**

Keywords—Anthropometry, Body Composition, Computer Vision, Convolutional Neural Network, Heath-Carter, Personalized Nutrition, Somatotype

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DECENTRALIZED FINANCIAL RESILIENCE IN THE AGE OF HYBRID WARFARE: AN ON-CHAIN DATA ANALYTICS AND SMART CONTRACT SIMULATION MODEL FOR PREDICTING BANKING SECTOR COLLAPSE IN EMERGING ECONOMIES

Yousef Alasadi, Hamid Al-Asadi, Zaid Abduljabbar and Vincent Nyangaresi

***Abstract*—The rapid convergence of decentralized finance (DeFi), central bank digital currencies (CBDCs), and AI-driven cyber warfare has introduced unprecedented systemic risks to banking sectors, particularly within emerging economies. A new trend in hybrid warfare is to attack financial infrastructure with advanced digital attack vectors that reveal fragilities in traditional centralized risk assessment models based on unchanging datasets and standardized simulations. The research paper is a proposal of a new system to measure the financial resilience with blockchain-native intelligence and predictive analytics (BC-NI-PA). The study presents a novel model of Resilience-as-a-Smart-Contract (RSC) that combines on-chain analytics with machine learning to identify any initial signs of stress at the system level. The data on major blockchain networks including Ethereum and Polygon are looked at on a transaction level in 2023 to 2025 to track the liquidity changes, governance conduct, and wallet-level abnormalities. To detect temporal anomalies that come with cyber-induced disruptions, Long Short-Term Memory (LSTM) networks are used. An experimental simulation blockchain transparency and Monte Carlo prediction are established to establish an environment that simulates attack instances, such as governance manipulation, flash loan parasites, and RPC-layer attacks. The framework is topped with the design of a prediction of a liquidity crisis and institutional instability in decentralized-integrated banking ecologies through the On-Chain Early Warning Index (OC-EWI). It has liquidity stability index values of 0.64 to 0.94, gauge manipulation risk values of 0.45 to 0.88, anomaly detection score values of 0.42 to 0.85 and smart contract stress index values of 0.72 to 0.96.**

Keywords—Decentralized Finance, Hybrid Warfare, On-Chain Analytics, Smart Contracts, Financial Resilience, Early Warning Systems

TUNING OF LCL FILTER PARAMETERS FOR PULSE RECTIFIER

Suliman Badour, Martin Novák, Zdeněk Novák and Jaroslav Novák

***Abstract*—In the first part of the paper, the areas of interference effects of pulse rectifiers on the power supply network are studied in the context of technical standards, and the importance of the LCL filter on the power supply network side is presented. In the second part, the paper presents computational procedures for the design of the parameters of the input LCL filter. The next part of the paper deals with the possibilities of modifying the calculated parameters of the LCL filter so that it is possible to reduce the dimensions, weight, and price of the filter while maintaining sufficient filtration ability. In the final part, the influence of some parameters and conditions of LCL filter operation on the input current spectrum is analyzed. The degree of filtering effects is assessed according to the frequency spectrum of the input current and in the context of technical legislation for the low-frequency range.**

Keywords—LCL Filter, Pulse Rectifier, Current Harmonic Spectrum

SPEED CONTROL OF SIX-PHASE ASYMMETRICAL IPMSM USING FUZZY FAST TERMINAL SLIDING MODE CONTROL

Hadi Bayary

***Abstract*—In this study, a novel method for speed control of six-phase asymmetric interior permanent magnet synchronous motors (IPMSMs) is proposed using the fuzzy fast terminal sliding mode control (FFTSMC) technique. Moreover, field-oriented control (FOC) technique is applied to the speed control structure of six-phase asymmetric IPMSM. To evaluate the performance of FFTSMC, its results are compared with two other controllers, including conventional sliding mode control (SMC) and classical proportional-integral (PI) controllers. Simulations are performed in MATLAB™/Simulink® environment and under different speeds and suddenly load-torque conditions. The results show that the proposed FFTSMC has a lower finite-time convergence in speed tracking than other controllers while maintaining tracking accuracy under load conditions. Also, this method reduces total harmonic distortion (THD) under different load-torque and speed conditions.**

Keywords—PMSM, fast terminal sliding mode control, fuzzy, field oriented control

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A REVIEW ON IOT-BASED REALTIME MEDICAL HELPER TRACKER FOR CHRONIC AND DISABLED PATIENTS WITH EMERGENCY RESPONSE AND PILL REMINDER

Ishwari Ramade, Prof.Deepti Pande, Siddhi Jadhav, Yashaswi Chavaan, Siddhi Borawake and Prof.Ashwini Deshmukh

***Abstract*—Chronic and disabled patients require continuous health monitoring, regular medicine intake, and fast help during emergencies. Many patients forget medicines or cannot ask for help in critical conditions. To solve this problem, researchers have developed IoT-based smart healthcare systems that provide real-time health monitoring, pill reminders, and emergency alerts. This review paper studies 15 research works related to smart medicine reminder systems, IoT-based patient monitoring, and emergency response systems. The main aim is to understand existing methods, technologies used, and their advantages and limitations. This review helps in designing an effective real-time medical helper tracker system for chronic and disabled patients.**

Keywords—Internet of Things, Healthcare, Emergency management, Real-time system, Patient Monitoring

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DESIGN OF A SOLAR TRACKING SMART HOUSE FOR ENHANCED ENERGY EFFICIENCY

Adrian Virgil Ganea, Fabian Pavel Velicea and Ioana Corina Bogdan

***Abstract*—This This paper proposes a smart rotating-house concept designed to improve energy efficiency of residential buildings through continuous solar tracking position. The proposed structure is designed for buildings that rotate according to the sun's position, raising solar energy usage and thermal gain throughout the day. To minimize the overall structural and dynamical load, lightweight construction materials, including dome-shaped glass-based shells, are considered. The main goal is to reduce the total weight of the building. Another criterion used in this work is the integration of a meteorological algorithm based on artificial intelligence (AI). Processed inputs are obtained from the Metar service Brașov's airport, with the ICAO-LRBV [11], which is situated at the base of the Tâmpa mountain. Using a control algorithm System - Alpha Fractional Order (FOPID), and one dynamic Positioning System with two axes, the Solar route could be followed, and the rotation could be adjusted depending on the weather forecast in real time. The walls of the building will be made from glass with the ability to clean itself and to collect water with some special tubes situated at the base of the building. This water can be used for household water and can be warmed by Sun with vacuum tubes. Simulation results demonstrate that the FOPID controller reduces peak overshoot by 98%, while the RMS tracking error by 31%. At the same time the control energy consumption is minimized by 18% in comparison with a conventional PID controller, while solar energy is raised by up to 56% through continuous solar tracking.**

Keywords—Dual-axis solar tracking, energy efficiency, fractional-order PID (FOPID), meteorological data processing, rainwater harvesting, rotating smart homes

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ADAPTIVE COMMUNICATION STRATEGIES FOR DISTRIBUTED MEDICAL SENSOR DATA TRAFFIC

Alina Maria Marinescu, Elionora Serdaru and Constantin Viorel Marian

***Abstract*—Distributed medical sensor networks that are used for continuous healthcare monitoring produce heterogeneous traffic that has strict quality-of-service requirements regarding latency, reliability, and energy efficiency. On the other hand, communication static approaches that are traditionally used cannot efficiently manage dynamic network conditions and priority-sensitive medical data, especially when congestion occurs. This study introduces an innovative, adaptive communication framework designed to manage distributed medical sensor traffic by leveraging traffic-aware scheduling and dynamic resource allocation. The main idea of the proposed approach is to divide medical data into different priority levels, such as routine, alert, and critical traffic, and to change transmission parameters dynamically based on network load and packet priority. The primary objective is to enhance end-to-end communication reliability while minimizing transmission delay and energy consumption. To validate the proposed method, simulations were conducted under realistic wireless medical network scenarios. The results of the experiments show that the adaptive strategy proposed by the authors can substantially decrease latency and packet loss for critical medical traffic compared to static communication schemes while making sure that energy use stays efficient. The current results confirm that the performance and reliability of future distributed healthcare monitoring systems can be greatly enhanced by using adaptive traffic management techniques.**

Keywords—IoT, adaptive communication, medical sensor networks, healthcare monitoring, traffic-aware scheduling, quality of service, wireless sensor networks

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FROM DATA TO DECISIONS: A HYBRID MODEL COMBINING PREDICTIVE QUALITY ANALYTICS AND FMEA FOR ZERO-DEFECT STRATEGIES IN AUTOMOTIVE SUPPLY CHAINS

Claudiu Alexandru Covaci, Aurel Mihail Titu and Emanuel Balc

***Abstract*—This paper proposes a hybrid AI-driven conceptual framework that integrates predictive quality analytics with Failure Mode and Effects Analysis (FMEA) to support zero-defect strategies in automotive supply chains. The proposed model links historical supplier performance data, process parameters, defect records, and inspection outcomes to identify pre-failure conditions and emerging risk patterns before nonconformities occur. By incorporating predictive risk indicators into the FMEA structure, the framework enables a dynamic reassessment of occurrence and detection priorities, moving beyond the limitations of static and retrospective risk evaluation. The model supports data-driven prioritization of preventive actions, refinement of control plans, optimization of supplier audit resources, and adaptive incoming inspection strategies. The paper contributes to the development of intelligent decision-support mechanisms for supplier quality management by demonstrating how predictive analytics can enhance traditional risk assessment tools. The proposed framework provides a structured basis for proactive failure prevention, reduced quality costs, and improved resilience in automotive supply chains.**

Keywords—predictive quality analytics, dynamic FMEA, zero-defect, supplier quality, automotive supply chains, AI decision support

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PARKSEGNET: AN EFFICIENT AND LIGHTWEIGHT SEMANTIC SEGMENTATION NETWORK FOR PARKING LOT SCENARIOS

Liu Guohao and Bin Zou

***Abstract*—Underground parking lots present challenges for semantic segmentation due to low-texture surfaces, weak illumination, and severe class imbalance, which often lead to blurred boundaries, missed fine structures, and limited real-time performance in general-purpose models. To address these issues, this paper proposes ParkSegNet, an engineering-oriented adaptation of the DeepLabV3+ framework for parking lot scenarios. A lightweight MobileNetV2 backbone is adopted to reduce computational cost and improve inference efficiency. To mitigate extreme class imbalance and enhance the segmentation of elongated structures such as parking lines, a combined loss function integrating Focal Loss and Dice Loss is employed. In addition, an efficient channel attention mechanism is incorporated into the atrous spatial pyramid pooling module to suppress pseudo-feature amplification under low-light conditions. The activation function is further replaced with h-swish to improve gradient continuity and feature representation capability. Experiments on the SUPS underground parking lot dataset demonstrate that ParkSegNet achieves a balanced improvement in segmentation accuracy and real-time performance while maintaining model lightweightness. The proposed approach provides a practical solution for deploying semantic segmentation models in resource-constrained parking lot environments.**

Keywords—Semantic Segmentation, Parking Lot Scene, Lightweight Network, Real-Time Performance, DeepLabV3+

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ANALYSIS OF DEFECTS IN PHOTOVOLTAIC PANELS

Catalin Frincu, Nicu Bizon, Marian Raducu and Mihai Oproescu

***Abstract*—This article investigates the methodology for detection and identification of the electrical faults that can occur in photovoltaic panels. The fault-free operation of photovoltaic systems is an achievable goal for increasingly longer periods of time. Preventing faults, improves the efficiency of electricity supply and increases the lifespan of the panels. This paper highlights the most common panel faults, using the multiple simulation method, based on scenarios that encompass each case of electrical fault. Emphasis is on describe and simulation the types of faults such as open circuit, cell is short-circuited, the rows of photovoltaic cells connected in parallel are short-circuited, system output is short-circuited, increase series resistance between two rows, etc. The simulation results and validation of the proposed technique are implemented by MATLAB/Simulink toolbox and PSpice. The purpose of simulating the types of defects is to demonstrate, based on the results, first of all, the accuracy of the values obtained, but also the direct impact on reducing the electrical power provided by the photovoltaic panels.**

Keywords—photovoltaic panels, defects monitoring, faults detection simulation

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DIGITAL SOVEREIGNTY IN CLOUD ARCHITECTURES: A SYSTEMATIC LITERATURE REVIEW OF FEDERATED SYSTEMS AND AI INTEGRATION

Abderrahim Bouzid, Mouad Danane and Abdelmajid El Ouadi

***Abstract*—Digital sovereignty has emerged as a critical concern in cloud computing, driven by increasing regulatory requirements and data localization mandates. This systematic literature review examines architectural models, key technologies, and implementation challenges in sovereign cloud ecosystems, with particular emphasis on artificial intelligence integration. Following a prisma protocole, we analyzed 46 papers published between 2020 and 2026 from Scopus, Web of Science, and ScienceDirect databases. Our findings reveal that decentralized architectures, particularly federated learning and blockchain-enabled systems, dominate sovereign cloud implementations. Key enabling technologies include trusted execution environments, edge computing, and privacy-preserving machine learning techniques. The integration of AI technologies presents both opportunities for enhanced automation and challenges related to computational overhead and model governance. Major technical challenges include interoperability across heterogeneous systems, balancing privacy with performance, and ensuring real-time processing in distributed environments. This review provides a comprehensive taxonomy of digital sovereignty approaches and identifies critical research gaps in standardization, cross-border data governance, and scalable AI deployment in sovereign clouds.**

Keywords—Digital sovereignty, federated cloud, data sovereignty, edge computing, federated learning, blockchain, privacy-preserving AI

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A LIGHTWEIGHT YOLOV8N-BASED BINARY WASTE CLASSIFICATION MODEL FOR AUTONOMOUS GARBAGE-COLLECTING ROBOTS

Himasha Sendanayaka, Nimesh Perera, Thisara Nuwanthi, Sanduni Jayasekara, Shashika Lokuliyana and Suranjini Silva

***Abstract*—Efficient waste classification is critical for automation in modern waste management systems, especially in places where it is hard to use manual classification. In this work, a model for waste and non-waste classification based on the YOLOv8n framework, known for high efficiency and applicability for embedded systems, is designed. For this purpose, a customized dataset was collected using real photos under different lighting conditions, different backgrounds, and with varying objects to reflect a more realistic environment. The training process included augmentation, normalization, and hyperparameters tuning to improve the efficiency of the model. Evaluation metrics such as accuracy, precision, recall, F1 score, and confusion matrix were used. According to the experimental results, the developed model provides an accuracy of 92.5% and F1 score of 0.94 with maintaining fast inference performance for real-time applications. The designed framework aims to become a module in an autonomous waste collecting robot to validate objects before manipulating them by robots, ensuring reliable and efficient real-world system performance.**

Keywords—Waste Classification, YOLOv8n, Autonomous Robots, Deep Learning, Real-time Detection

LOW-COST EMBEDDED SYSTEM FOR ACOUSTIC FAULT DETECTION

Andreea-Daniela Savu, Nicu Bizon and Sebastian-Alexandru Dragusin

***Abstract*—In recent years, acoustic signal analysis has emerged as a promising approach for fault detection in electromechanical systems, providing a non-invasive, low-cost, and real-time alternative to traditional monitoring techniques. This paper presents the design and implementation of a low-cost embedded system for acoustic fault detection. The proposed system is built on a Raspberry Pi Nano platform, integrating a low-power microphone, real-time audio signal preprocessing, and lightweight machine learning models for classification of normal versus faulty operating conditions. The focus is placed on developing an efficient signal processing pipeline that includes noise reduction, feature extraction (time and frequency domain descriptors, Mel-frequency cepstral coefficients), and on-device classification using compact neural network architectures. The embedded setup enables autonomous monitoring without the need for external computation resources, making it suitable for edge deployment in industrial and IoT environments. Experimental validation is carried out using publicly available datasets such as MIMII (Malfunctioning Industrial Machine Investigation and Inspection), as well as preliminary real-time recordings. The results demonstrate that the system achieves reliable fault detection accuracy while maintaining low computational and energy costs, highlighting its potential for scalable deployment in smart maintenance applications.**

Keywords—Acoustic signal processing, Fault detection, Embedded systems, Raspberry Pi Nano, Edge computing, Machine learning

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CROSS-DOMAIN FINE-TUNED WAV2VEC 2.0 MODEL WITH BIDIRECTIONAL GRU FOR AUDIO DEEPFAKE DETECTION

Bharat Bhushan Sharma, Arvind Selwal and Tanisha Gupta

Abstract*—Audio deepfake detection has become a critical challenge as recent advancements in text-to-speech and voice conversion technologies increasingly threaten the integrity of voice-based biometric systems. Existing countermeasure systems often struggle to generalize beyond the controlled conditions of their training data, exhibiting poor performance when exposed to real-world channel distortions, codec compression, and unseen synthesis methods. In this paper, we propose a progressive multi-phase hybrid framework for audio spoof detection that systematically evolves from handcrafted spectral features towards self-supervised learning representations. Our proposed framework/ architecture combines a task adaptive fine-tuned Wav2Vec 2.0 Base encoder as a front-end feature extractor with a two-layer Bidirectional Gated Recurrent Unit (BiGRU) as a sequence-level back-end classifier, trained on the ASVspoof 2019 Logical Access (2019 LA) dataset. The proposed system achieves an Equal Error Rate (EER) of 0.84% and a minimum tandem Detection Cost Function (min t-DCF) of 0.0069 on the ASVspoof 2019 LA evaluation set, demonstrating competitive in-domain performance. The cross-dataset evaluations on ASVspoof 2021 LA (2021 LA), ASVspoof 2021 Deepfake (2021 DF), the In-The-Wild dataset (ITW), and the Fake-or-Real (FoR) datasets reveal systematic generalization challenges under telephony channel conditions, codec-compressed audio, and physically re-recorded speech, with EERs ranging from 9.56% to 29.16%. Moreover, attack-wise analysis across thirteen spoofing systems confirms strong detection of neural vocoder and waveform concatenation attacks, while highlighting the sensitivity of the model to unseen acoustic channel conditions. These findings motivate future work on cross-domain robust training strategies and multi-condition augmentation for real-world deployment of voice anti-spoofing systems.

Keywords—deepfakes, audio deepfake detection, deep learning, self-supervised learning, anti-spoofing countermeasures, cross domain generalization.

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INCREMENTAL CAUSAL DISCOVERY IN TIME SERIES USING TRANSFORMER MODELS

Stoyan Nikolov, Ensiye Kiyamousavi, Boris Kraychev and Vassil Vassilev

***Abstract*—The current work investigates the discovery of causal relationships in time series data through a deep learning approach. Traditionally, uncovering such dependencies requires extensive analytical work, including model construction, solving differential equations, hypothesis testing and relational analysis. These processes can be automated using transformer-based models with a large number of training parameters, such as CausalFormer. The main contribution of this work is the adaptation of this model to support incremental learning, allowing it to update with new data without full retraining on the entire dataset. This is particularly valuable in real-world applications where data arrives continuously and resources for retraining are limited. Using a functional magnetic resonance imaging (fMRI) dataset, a comparative analysis between full and incremental training was performed, which showed similar results between the two methods. This indicates that the combination of interpretable deep learning models and incremental learning provides an effective and adaptive alternative for causal analysis in real time and under continuously evolving data conditions. This opens new opportunities for applying such models in dynamic domains like environmental monitoring, healthcare, finance and beyond, where it is crucial not only to identify dependencies, but also to ensure that models are adaptive and interpretable by domain experts and end users.**

Keywords—causal discovery, incremental learning, time series, transformer

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REACTIVE CCTV SYSTEM USING AUTHORIZATION-LEVEL ANALYSIS

Aldrikz Suarez, Art Michael Cadiz, Myke Franciz Jimenez and Mark Flores

***Abstract*—Traditional CCTV systems rely on manual monitoring, resulting in delayed responses to unauthorized access. This study presents a Reactive CCTV System that integrates AI-powered facial recognition and logic-based behavior analysis on consumer-grade edge hardware. The system utilizes FaceNet for identity verification and YOLO11n combined with an Intersection over Union (IoU) spatial algorithm to track Human-Object Interactions (HOI). Tested in a controlled office environment, the FaceNet module achieved a 100% precision rate, ensuring strict access control despite a highly conservative 13.5% recall. The behavioral recognition module achieved 79.54% precision and 68.4% strict recall in identifying interactions with target assets such as laptops, bags, and cellphones. While the system proved highly effective for isolated interactions, the study identifies "proximity occlusion" as a primary limitation in cluttered environments where bounding boxes overlap. Ultimately, the integration of lightweight spatial logic and pre-trained models provides a viable, real-time automated security solution without the computational overhead of complex action-recognition networks.**

Keywords—Behavior analysis, edge computing, face recognition, human-object interaction, Intersection over Union (IoU), YOLO

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ADVANCES IN ELECTROMAGNETIC SHIELDING MATERIALS

Elena Helerea and Marius Daniel Calin

***Abstract*—In this paper a review of the main techniques applied for description and modeling the behavior of shielding materials in near and far fields is done. A comparative analysis is developed regarding the obtained shielding effectiveness of different conventional and non-conventional materials. Then, the processes and power losses in electromagnetic interference shielding materials are analyzed, to develop appropriate criteria for their selection and optimal design. A comprehensive synthesis is made of functional and multifunctional shielding materials, in the form of metals, carbon, ceramics, cement-based materials and polymers that exhibit high shielding efficiency. This review shows the current challenges and trends regarding the passive shielding techniques developed to improve both shielding performance and power transfer efficiency.**

Keywords—passive shielding, electromagnetic shielding, shielding materials

AIMIND: AN AI-POWERED FRAMEWORK FOR PERSONALIZED MENTAL HEALTH SUPPORT

Snehal Bagal, Saiyami Pise, Tushar Narokar and Rushikesh Netke

***Abstract*—The high prevalence of mental health issues across the world has created a high demand for cost-effective and efficient technological solutions that can be used alongside existing clinical pathways. In this paper, the development of AIMind, a novel multi-service application created as an academic prototype at AISSMS Institute of Information Technology in Pune, will be discussed. The application's architecture integrates four individually deployable services: a user interface created with React 19/Vite, a core server created with Node.js/Express/Socket.io, a Python/Flask inference backend, and a Mindspace community module. Two unique machine intelligence pathways power the application. The first pathway uses a journaling affect recognition model wherein user-written text is sent from the browser through a Node.js gateway to a Python child process running the jhartmann/emotion-english-distilroberta-base model. The model generates a seven-class emotional score vector stored in Supabase. The second pathway uses a dialogue model wherein a locally resident SmolLM2-360M model, managed by a stateful Flask service, keeps track of ongoing conversation history with each user. Running both models locally rather than through cloud services keeps user data private and reduces costs. In this paper, the authors describe the development of the application's architecture, the choice of model used in each pathway, a comparison of the working prototype with the conceptual design at each layer of abstraction, a quantitative comparison with existing AI mental health systems, and the authors' assessment of the ethical dimensions that remain unimplemented in the current build. Index Terms—mental health AI, affective computing, emotion recognition, DistilRoBERTa, SmolLM2, HuggingFace Transformers, Flask, Socket.io, Supabase, full-stack AI, privacy-preserving inference, digital well-being**

Keywords—Mental Health, Conversational AI, Sentiment Analysis, Affective Computing, Ethical AI, Human-in-the-Loop, Transformers, Digital Phenotyping

REVIEW OF A BIOMETRIC SYSTEMS ADVANTAGES AND DISADVANTAGES

Enas Hamza and Aeshah Tareq Abdulateef

***Abstract*—This research provides a comprehensive review of different biometric modalities with their advantages and disadvantages Biometric sensing-based systems are utilized to scan and identify individuals based on their behavioural or physiological traits. A single recognition device does not meet the requirements of recognition systems. The security of the system can be improved by multi-factor authentication where two or more security types (e.g. password and card) are used, but this is not the best security solution. Users may forget passwords, mistype them, or lose their card. For identification and categorization of people by their biometric features biometric devices are applied. These technologies fall under two categories, behavioural and physiological biometrics. The former has many limitations to the system accuracy, including noisy data, between class similarity, within class variability, universality and spoofing. Success rate of recognition and verification is however greatly enhanced with multimodal biometric sensing and processing systems, which employ the sensing or processing of more than one physiological and/or behavioural characteristic.**

Keywords—Biometric, retina, Fingerprint, handwriting, Iris, face recognition.

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COMMUNICATION-EFFICIENT FEDERATED LEARNING FOR INSIDER THREAT DETECTION: A TRADE-OFF ANALYSIS OF PARAMETER COMPRESSION TECHNIQUES

Mustafa Sönmez and Turgay Tugay Bilgin

***Abstract*—Insider threats represent a critical challenge to enterprise cybersecurity, as the misuse of authorized credentials can lead to devastating data breaches. While centralized User and Entity Behavior Analytics (UEBA) systems are effective at modeling normal behavioral patterns to detect these threats, they often face significant privacy and regulatory constraints. This paper presents a Federated User and Entity Behavior Analytics (F-UEBA) framework designed to detect insider threats through a decentralized, privacy-preserving Bidirectional LSTM Autoencoder. Concurrently, we investigate the impact of parameter compression techniques, specifically FP16 Quantization and Top-K Sparsification, to address the communication bottlenecks inherent in federated insider threat detection. Our experiments on the CERT r4.2 dataset reveal that a hybrid compression approach reduces communication overhead by approximately 85% (from 4,295.7 MB to 642.3 MB) while maintaining a high detection fidelity, as indicated by a PR-AUC of 0.718. Bootstrap confidence intervals confirm that this compression level does not statistically significantly degrade detection performance relative to the uncompressed federated baseline. These findings establish an optimal operational balance for bandwidth-constrained, privacy-preserving behavioral analytics in real-world enterprise environments.**

Keywords—Insider threat detection, federated learning, parameter compression, communication efficiency, LSTM autoencoder, user and entity behavior analytics

AI POWERED COFFEE QUALITY GRADING AND EXPORT ENHANCEMENT SYSTEM FOR SRI LANKA

Rumalya Mahadurage

***Abstract*—Sri Lanka's coffee industry faces plenty of challenges, from grading beans to handling disease, managing resources, and dealing with unpredictable prices. Our paper introduces an AI-powered Coffee Industry Optimization System designed to help everyone involved in the process from farmers to exporters make smarter decisions. The system stands on four main pillars. First, we're building an intelligent coffee bean grading and sorting tool. This uses computer vision and embedded systems on a Raspberry Pi to sort beans and catch defects as soon as they appear. Now, there's this smart farm resource planner powered by AI. It takes a close look at soil conditions, checks the latest weather, and digs into past data to decide how much fertilizer, pesticide, and labor each farm really needs nothing more, nothing less. Then there's the disease detection and yield estimation part. Here, deep learning steps in to catch plant diseases early and to guess how big the harvest will be, all based on what's actually happening in the fields right now. Lastly, there's a price prediction and advisory system for exporters, which analyzes weather and market trends to forecast coffee prices and offer tailored advice. Altogether, our system gives stakeholders a practical way to adopt smart agriculture, transforming traditional coffee farming into something more sustainable and intelligent powered by AI.**

Keywords—Deep learning, Precision agriculture, Price prediction, IoT automation, Resource planning

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INTENT-DRIVEN GRAPHRAG FOR LLM-BASED ANALYSIS OF ONLINE CONVERSATIONS

Arbër Ceni and Alda Kika

***Abstract*—The continuing development of large language models opens up significant opportunities for the analysis of online conversations. However, their usefulness is challenged when their responses are not grounded in the evidence of the social media data. Retrieval-Augmented Generation can help in this regard by providing text as evidence, but many questions related to social network analysis require relational information such as user interactions, communities, centrality measures, and diffusion patterns. In this paper, we propose an intent-driven GraphRAG framework that enables LLM-based analysis of online conversations and addresses the aforementioned limitation. The proposed framework transforms a social interaction graph into a post-centered knowledge graph by making users, posts, hashtags, URLs, domains, entities, communities, and sentiment first-class graph elements rather than simple attributes in a user-user interaction graph. Several analytical intents are derived from the literature, including topic overview, sentiment analysis, influential-user detection, community comparison, information diffusion, temporal trend analysis, and actionable-opportunity identification. User questions are mapped to these intents and predefined Cypher queries retrieve the appropriate information from Neo4j, which is then provided to the LLM as evidence. We evaluate the framework using a COVID-19 vaccine dataset constructed from X by comparing three approaches: vanilla LLM prompting, text-based RAG, and the proposed GraphRAG method. The results of the comparative experiment show that GraphRAG achieves strong results primarily because of the structural nature of the questions. Text-RAG provides a strong baseline for textual grounding, but remains limited for questions requiring structural reasoning. Vanilla LLMs provide ungrounded general responses or refuse to respond due to lack of evidence. These findings suggest that knowledge-graph-based retrieval can improve the reliability, interpretability, and analytical usefulness of LLMs for social media analysis.**

Keywords—GraphRAG, Knowledge Graphs, Large Language Models, Social Network Analysis, Social Media Analytics, Intent-Driven Retrieval

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ONE-CLASS LSTM BEHAVIORAL MODELING FOR INSIDER THREAT DETECTION IN ZERO TRUST ARCHITECTURES

Robert Cristian Robu, Constantin Viorel Marian and Alexandru Petrisor Cioponea

***Abstract*—Insider threats combine legitimate access rights with malicious intent in ways that defeat perimeter-centric defenses. This paper presents a one-class anomaly detection framework integrated with Zero Trust Architecture (ZTA) for the detection and mitigation of insider threats in enterprise environments. The proposed system comprises three sequentially integrated components: (1) an LSTM-based autoencoder trained exclusively on normal user behavior to detect temporal anomalies in daily behavioral sequences without requiring labeled threat data; (2) a Trust Score Engine (TSE) that computes a dynamic, temporally smoothed per-user trust score from the autoencoder reconstruction error; and (3) a ZTA policy layer that maps continuous trust scores to tiered access control decisions. Evaluated on the CERT Insider Threat Dataset r5.2, the framework detects insider threats on average over a week before confirmed malicious activity using only normal user behavior as a training signal, enabling preemptive access restriction. The Trust Score Engine achieves competitive anomaly detection performance without access to labeled threat data at inference time, while the ZTA policy layer concentrates the majority of confirmed malicious activity into a small fraction of monitored and high-risk user-days. Comparison against supervised and unsupervised baselines documents the performance trade-offs between label-available and label-free detection conditions.**

Keywords—Zero Trust Architecture, Insider Threat Detection, LSTM Autoencoder, Trust Score Engine, One-Class Anomaly Detection, Behavioral Analytics, CERT Datasets

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ETHICAL PRINCIPLES FOR THE USE OF AI IN THE MILITARY DOMAIN

Claudiu-Sorin Cleoanta

Abstract*—Artificial intelligence (AI) architectures are automated systems that, based on a collection of input data, produce predictions, decisions or recommendations as output, which have a potential impact on physical or digital environments. Their variety in terms of autonomy and adaptability generates important challenges in relation to their technological and ethical governance. This article aims to analyze the fundamental principles and key requirements that underlie an effective and responsible governance of AI, focusing on the integration of international standards ISO/IEC and IEEE. We distinguish between these two: while ISO/IEC standards provide the technical framework for system reliability, the IEEE 7000 series offers a value-based engineering approach. This distinction is vital for military AI, where technical performance must be guided by clear ethical boundaries. The study provides a comparative-normative analysis, highlights the gaps existing within the taxonomies of the defense sector – in particular OSRA/EDA – regarding the concept of "trusted AI", and differentiates the limits found in relation to more advanced developments in the civilian sector. Seven main requirements are also identified and discussed: human oversight, technical robustness, data governance, transparency, fairness and non-discrimination, social and environmental sustainability, and accountability. The present paper highlights the importance of a clear distribution of responsibilities between the actors involved in the AI life cycle, namely: developers, implementers, end-users and society as a whole. Thus, by proposing a cross-sectoral ethical governance framework, the article supports efforts to harmonize technical standards with fundamental rights, arguing that trustworthy AI cannot be achieved solely through compliance, but requires the proactive integration of ethical considerations at all stages of design, implementation and monitoring, especially in high-risk applications.

Keywords—AI, Responsible Governance, Ethical AI, Trustworthy AI, ISO/IEC Standards, IEEE Standards, Technical Robustness, Data Governance, Digital Sustainability, Accountability

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SMART HEALTH MONITORING DEVICE THAT MONITOR BLOOD, OXYGEN, AND HEART RATE WITH AUTOMATIC DATA SAVING

Varun Slathia, Khushpuneet Kaur, Vikash Kumar, Karan Kumar and Harmeet Singh

***Abstract*—The integration of Artificial Intelligence (AI) in the field of healthcare has significantly impacted the way medical consultation and diagnosis are done in the past few years. This paper focuses on the engineering and development of an AI-powered Smart Health Assistant capable of conducting medical remote consultation through the comprehension of the patient's symptoms to provide diagnostic consultation. The proposed AI model utilizes Natural Language Processing (NLP) to understand the patient's verbal descriptions, Machine Learning (ML) algorithms to determine the possible diseases, and API integration to retrieve medically authenticated information from sources trusted to provide information smoothly. The proposed model, which represents a new form of telemedicine, offers personalized, instant, and context-aware conversations with a high level of human simulation, different from normal telemedicine services. The study revealed the need to develop accountable healthcare AI models that are ethical in nature to ensure trust and reliability. The model presented consists of modules for device symptom evaluation, disease prediction, and answer generation in a conversational Python API environment. The performance evaluation tests conducted on symptom-disease datasets indicate the accuracy of prediction and user experience at a high level. The research outputs unveiled that AI-driven conversational agents could be instrumental in the timely identification of diseases, thus substantially enhancing healthcare accessibility, which is a basis for the upcoming telemedicine innovations employing AI.**

Keywords—Artificial Intelligence, Natural Language Processing, Machine Learning, Deep Learning, Smart Healthcare System, Disease Prediction

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TECHNO-ECONOMIC OPTIMISATION OF A GREEN MOBILE ENERGY SERVICES IN BUCHAREST

Corina Daniela Mihai, Iuliana Diana Mihalache, Alexandra Fratila and Bogdan-Adrian Enache

***Abstract*—District-heating failures in dense smart-city districts require rapid service restoration while limiting emissions and operational cost. This paper proposes a techno-economic framework for selecting the economically preferred thermal point to serve when several outages occur simultaneously. The case study is based in Bucharest on the SMARTELTER concept, a green mobile service that combines renewable charging, battery containers, a 1 MWt thermal-energy module and an AI-based management platform. The system extracts records from the public Termoenergetica outage page, matches affected thermal points with an urban thermal-demand inventory, filters candidates within the thermalmodule capacity, estimates route duration from the fixed base, schedules three battery containers under a 15% state-of-charge reserve rule and ranks candidates by operational profit. The results show that dispatch decisions depend jointly on demand, distance, battery autonomy and season-specific tariff assumptions. A single emergency service price is used to assess whether temporary outage response remains economically viable while preserving continuity of thermal comfort.**

Keywords—green mobile energy services, smart city, district heating, techno-economic optimisation, battery energy storage, emergency dispatch

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POLICYAGENT: A MULTI-AGENT GENERATIVE AI FRAMEWORK FOR AUTOMATED REASONING CHECKS AND POLICY-CONSTRAINED COMPLIANCE IN FINANCIAL SERVICES

Shikher Goel and Harish Apuri

***Abstract*—Policy-constrained generative AI in financial services sits at the intersection of two regulatory regimes that disagree on almost everything except cost of failure: a model can be plausibly correct and yet violate KYC, suitability, fair-lending, or recordkeeping obligations in ways that scale with throughput. Existing safety layers, whether prompt-engineered guardrails or static keyword filters, neither prove compliance nor leave the audit trail an examiner will eventually ask for. We present PolicyAgent, a five-agent generative AI framework that couples retrieval over a structured policy corpus with formal automated reasoning checks and tamper-evident audit. A Policy Ingestion and Indexing Agent (PIIA) compiles institutional policy documents into a typed reasoning graph; a Reasoning Verification Agent (RVA) discharges per-response obligations through an SMT/automated-reasoning backend; a Generative Drafting Agent (GDA), built on a 13B Code-Llama variant fine-tuned with LoRA, produces responses constrained by the RVA feasibility envelope; an Audit Trail Orchestrator (ATO) records every action in a SHA-256 chained, append-only log; and a Continuous Policy Evaluation Coordinator (CPEC) runs the FinPolicyBench evaluation harness against the live system. Evaluated on FinPolicyBench, a reproducible benchmark of 47,200 policy-constrained queries spanning seven obligation categories across a 90-day controlled CI/CD pipeline, PolicyAgent achieves a policy-compliance F1 of 0.926, a 71.3 percent reduction in policy violations per 1,000 responses relative to a prompt-guardrail baseline, a mean reasoning-discharge latency of 412 ms, and a Policy Compliance Score Pi = 0.918, with full ablation studies confirming each agent contributes independently.**

Keywords—Policy-Constrained Generative AI, Automated Reasoning, Financial Services Compliance, Multi-Agent Systems, LLM Guardrails, SMT Verification, Tamper-Evident Audit, FinPolicyBench, Reproducible Evaluation

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DESIGN AND IMPLEMENTATION OF A SMART ELECTRICAL PROTECTION DEVICE

Andrei Prica, Vlad Mihai Radu and Ioana Corina Bogdan

***Abstract*—Smart electrical protection devices design and development require rigorous strategies that integrate surveillance over voltage fluctuations, overload conditions, and short circuits with the main goal to avoid or prevent equipment damage, reduced lifetime, and safety hazards. Reliable protection mechanisms are therefore essential in industrial, but also consumer applications. In this context, this paper proposes a smart electrical protection device based on the STM32G030 microcontroller, capable of real-time monitoring of electrical parameters and fast response to fault conditions. The system continuously measures voltage and current and provides rapid protection by disconnecting the load through a MOSFET switch. For analog signal acquisition, an internal ADC with DMA support is used, while FreeRTOS ensures real-time operation through dedicated monitoring and communication tasks. A Bluetooth HC- 06 module enables wireless communication, allowing users to remotely monitor electrical parameters and control the protection mechanism. Experimental results demonstrate response times between 127 µs and 1065 µs, highlighting significantly faster protection compared to conventional fuses.**

Keywords—Embedded systems, Microcontroller, Internet of Things (IoT), FreeRTOS, Smart electrical protection

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DESIGN AND PERFORMANCE ANALYSIS OF ELASTIC DIGITAL–ANALOG RADIO-OVER-FIBER FOR NEXT-GENERATION WIRELESS ACCESS

Aya Ahkam Kamil, Zeyad Taha Yaseen, Anmar Yahya Taher, Adnan Hussein Ali, Omar Sameer Khalis and Hayder Nabeel Jalo

***Abstract*—The development towards beyond-5G (B5G) and 6th generation wireless systems requires the fronthaul networks to have ultra-high bandwidth, very low latency, high spectral efficiency and operate in an energy-efficient manner. The traditional Radio-over-Fiber (RoF) systems, Analog RoF (A-RoF) and Digital RoF (D-RoF), have inherent latency-robustness-bandwidth trade-offs. A-RoF is low-latency but acute sensitive to the optical impairments, whereas D-RoF has high robustness at the expense of more fronthaul bandwidth and power consumption. To cope with these drawbacks, in this paper, we propose an innovative Elastic Digital–Analog Radio-over-Fiber (EDA-RoF) concept for next generation wireless access. The proposed architecture includes both analog and digital transmission paths in the same system and presents a performance-oriented Elastic Control Unit (ECU) to enable dynamic swapping of modes on account of instantaneous SNR, traffic load and delay requirements. An analytical model is developed for analog, digital and hybrid signal transmission. These results are extensively validated by MATLAB based simulations under realistic B5G/6G fronthaul simulations for performance metrics including SNR, BER, EVM, end-to-end latency, spectral efficiency and power consumption. The results show that the EDA-RoF can improve SNR (2–4 dB), decrease BER by up to one order magnitude, reduce latency (about 30–45%) than D-RoF, enhance spectral efficiency (20–30%), save power consumption between 25% and 40%, under different resource allocation strategies. The results validate that elastic analog–digital switching can well balance the reliability, efficiency, and scalability and EDA-RoF is a promising candidate for green and high-performance B5G/6G fronthaul networks.**

Keywords—Radio-over-Fiber (RoF), Elastic Digital–Analog RoF, Beyond-5G/6G Fronthaul, Hybrid Optical–Wireless Networks, Signal-to-Noise Ratio (SNR), Spectral Efficiency

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ROBUST MULTI-SENSOR FAULT DIAGNOSIS OF INDUCTION MOTORS USING LSTM-ATTENTION NETWORKS

Jaafar Falih and Ahmed Raisan Hussein

***Abstract*—Industrial motor fault diagnosis is significantly affected by environmental noise and sensor degradation, which reduce the reliability of conventional deep learning models. This paper proposes a multi-sensor fault diagnosis framework based on Multi-Head Attention and LSTM networks enhanced with a Reliability-Gated fusion mechanism. The proposed framework dynamically evaluates the reliability of current, vibration, and stray-flux signals before feature fusion. Experimental results demonstrate superior diagnostic performance compared with conventional LSTM-Attention models, with an accuracy of 97.67% when the motor is operating under full load. Furthermore, under severe noise conditions (20 dB SNR), the proposed model maintains 91.5% accuracy. The reliability-gating strategy preserves robust diagnostic performance during total sensor failure, achieving an accuracy of 92.4%, while maintaining sensitivity to incipient winding faults with only 2% severity. The proposed framework provides a fault-tolerant solution for predictive maintenance in industrial environments.**

Keywords—Fault Diagnostics, Induction Motor, Multi-Sensor Fusion, LSTM, Reliability-Gated, Multi-Head Attention

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A DRIFT-AWARE EVALUATION FRAMEWORK FOR RARE-EVENT PREDICTION: COMPARATIVE ANALYSIS OF GRADIENT BOOSTING, TEMPORAL CONVOLUTIONAL NETWORKS, AND TRANSFORMER MODELS

Pınar Ersoy and Mustafa Erşahin

***Abstract*—Rare-event prediction in non-stationary environments remains a central challenge in applied machine learning, particularly in operational settings where class imbalance, temporal dependence, and distributional shift co-occur. This study presents a drift-aware evaluation framework for temporally faithful assessment of rare-event prediction models and demonstrates the framework on the publicly available MIMIC-IV intensive care dataset. The analysis compares three major predictive modeling paradigms—gradient-boosted decision trees, Temporal Convolutional Networks, and Transformer-based temporal models—under chronologically ordered training, validation, and test partitions that reflect progressively increasing temporal drift. Rather than relying on pooled evaluation, the proposed framework examines model behavior across regime-specific test windows and jointly evaluates discrimination, constrained-retrieval quality, calibration, robustness, and computational efficiency. The results show that gradient boosting remains highly competitive under mild drift and strong efficiency constraints, Temporal Convolutional Networks provide the most stable balance between retrieval performance and robustness under progressive drift, and Transformer models achieve the strongest retrieval under severe drift, albeit with higher calibration error and computational cost. The study contributes a reusable evaluation framework for drift-sensitive rare-event learning and provides practical guidance for model selection in temporally evolving decision environments.**

Keywords—rare-event prediction, temporal drift, drift-aware evaluation, MIMIC-IV, gradient boosting, Temporal Convolutional Network, Transformer, calibration

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A SURVEY ON CYBERSECURITY FOR SMART AGRICULTURAL IOT: CHALLENGES, DEFENCES, AND EDGE ANOMALY DETECTION

Yassine Boukhali, Sebastian-Alexandru Dragusin, Nicu Bizon, Mohammed Nabil Kabbaj and Mohammed Benbrahim

***Abstract*—The rapid proliferation of Internet of Things (IoT) devices in smart agriculture has exposed critical vulnerabilities in irrigation monitoring infrastructure, particularly for time-series sensor streams transmitted over Low-Power Wide-Area Networks (LPWAN). This paper presents a comprehensive review of cybersecurity challenges and countermeasures for agricultural IoT systems, with emphasis on three interconnected domains: (i) TinyML-based anomaly detection for on-device security of irrigation time-series data, (ii) hierarchical edge-fog-cloud security architectures for deployment of intrusion detection and authentication mechanisms, and (iii) communication-layer hardening for Wireless Sensor Networks (WSN) and LPWAN protocols including LoRaWAN, NB-IoT, and ZigBee. We systematically survey attack taxonomies across all IoT layers, from false data injection and replay attacks on sensor streams to cloud-layer ransomware and supply chain threats. Drawing on a curated corpus of recent literature, we identify open gaps in standardized security benchmarks, lightweight cryptographic protocol design, and TinyML model validation under adversarial conditions. Our analysis highlights the emerging role of federated learning and blockchain-based authentication as scalable solutions for distributed agricultural deployments and identifies explainable AI (XAI) as an essential complement for operator trust and auditability of on-device anomaly detection decisions.**

Keywords—Agricultural IoT, TinyML, LoRaWAN, irrigation time-series, cybersecurity, anomaly detection, edge computing, LPWAN, smart farming, intrusion detection

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EFFECTS OF SUPRAHARMONICS ON DISTRIBUTION TRANSFORMERS IN GRID-CONNECTED PHOTOVOLTAIC INVERTER POWER SYSTEMS

Funda Battal

***Abstract*—Supraharmonics arise as a result of the widespread use of inverters in renewable energy sources, and these propagate from the PCC to other components of the grid. Supraharmonic components emitted from nonlinear loads can also interact with supraharmonic components from such sources, leading to a highly complex harmonic spectrum spread across the high-frequency range. In this study, the interaction of harmonic components originating from an inverter in a grid-connected PV inverter system with a rated power of 120 kW and a switching frequency of 40 kHz, with power converter loads connected to the PCC at various switching frequencies, and their effects on the voltage harmonic spectrum are analyzed. Then, the effects of these supraharmonic components on the magnetization current of the LV/MV transformer are investigated.**

Keywords—supraharmonics, distribution transformers, nonlinear loads, photovoltaic

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AI-DRIVEN HYBRID GRAPH-ENSEMBLE APPROACH FOR CREDIT RISK CLASSIFICATION

Afreen Sorathiya, Jinal Mehta, Parth Kudale, Hetvi Bhanushali, Maria Sorathiya, Twisha Mehta, Harikrishna Suresh and Manha Sorathiya

***Abstract*—This study develops a hybrid AI-driven framework combining Random Forest, Social Network Analysis (SNA), and Graph Convolutional Networks (GCNs) for credit risk classification. Centrality metrics—PageRank, eigenvector, betweenness, closeness, and degree—quantify borrower influence, brokerage roles, and detect potential default cascades. The best-performing centrality-driven random forest model achieved 91.23% accuracy (precision and recall ¿89% for both default and non-default), while the GCN-stacking hybrid attained 90.28% accuracy with balanced precision, recall, and F1-score. SNA visualizations are provided to explicitly illustrate borrower influence, network positioning, and risk propagation, enhancing interpretability and scientific rigor.**

Keywords—Credit Risk Assessment, Social Network Analysis, Graph Convolutional Networks, Centrality Measures, PageRank, Eigenvector Centrality, Betweenness Centrality, Closeness Centrality, Degree Centrality, Stacking Ensemble

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DESIGN AND REAL-TIME IMPLEMENTATION OF AN ACTIVE DISTURBANCE REJECTION CONTROLLER FOR PMSM MOTOR SPEED REGULATION

Cosmin Bucur and Paul Burlacu

***Abstract*—This paper presents the design, mathematical formulation, and real-time implementation of a linear Active Disturbance Rejection Controller (ADRC) for speed regulation of a Permanent Magnet Synchronous Motor (PMSM). The proposed ADRC employs a Linear Extended State Observer (LESO) to estimate and actively compensate for total disturbances, including parameter uncertainties, unmodelled dynamics, and external load torque variations, without requiring an accurate plant model. The controller is designed in MATLAB/Simulink and deployed on a Texas Instruments C2000 LaunchPad (TMS320F28379D) using the Embedded Coder support package for real-time execution. A comprehensive mathematical model of the PMSM in the d-q reference frame is presented, followed by the complete ADRC formulation including the LESO design and bandwidth parameterization. The proposed ADRC is experimentally compared against an optimally tuned PID controller under step reference tracking, load disturbance rejection, and speed reversal tests.**

Keywords—PMSM, Active Disturbance Rejection Control, ADRC, PID Control, Linear Extended State Observer, MATLAB/Simulink, Real-Time Implementation

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PREDICTING FLIGHT DELAYS WITHOUT WEATHER DATA: A COST-SENSITIVE CATBOOST APPROACH WITH TEMPORAL UNDERSAMPLING

Cristina-Ioana Lupescu and Iulian Aciobanitei

***Abstract*—Most flight-delay prediction systems rely on real-time meteorological data, which are rarely available in large historical aviation archives. This paper shows that competitive performance is still achievable using only historical operational data. We train a cost-sensitive CatBoost classifier on a 240-million-record dataset of U.S. domestic flights, under strict chronological validation, and introduce a Temporal Undersampling strategy that addresses the severe class imbalance by removing the oldest On-Time records rather than random ones. The proposed approach outperforms four baseline imbalance-handling strategies and, on a balanced evaluation set, exceeds the best F1-Score reported by a recent IEEE DASC reference study that relied on weather data.**

Keywords—flight delay prediction, CatBoost, class imbalance, temporal undersampling, big data, cost-sensitive learning, gradient boosting

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A NEW APPROACH TO FACIAL EMOTION RECOGNITION USING AN ENSEMBLE OF DEEP CNN CLASSIFIERS FOLLOWED BY RANDOM FOREST FUSION

Albert-Sebastian Constantin and Victor-Emil Neagoe

***Abstract*—This paper presents a new approach to facial emotion recognition (FER), as a component of human- computer interaction (HCR), with applications in healthcare, psychology, security, marketing, e-learning, and humanoid robot design. The proposed model is based on using an ensemble of three independent Deep CNN classifiers followed by a decision fusion based on Random Forest (RF) method. We have considered two variants for choosing the three component CNN modules. First variant uses AlexNet, VGG16, and ResNet18 as CNN modules; second variant of decision fusion model uses three ResNet18 modules with identic architectures, trained independently with the same dataset, but using different initialization seeds. For experimental evaluation, we have chosen CK+ and FER2013 datasets. We have obtained an improvement of accuracy for RF fusion model by comparison to the case of using any of the standalone classifies, for both considered decision fusion model variants, as well as for both chosen datasets.**

Keywords—Facial Emotion Recognition, Deep CNNs, decision fusion, Random Forest

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DESIGN AND IMPLEMENTATION OF AN EDUCATIONAL HARDWARE MODULE FOR ADVANCED STUDY OF RICHARDS CONTROLLERS

Ionel Bostan and Marius Constantin Marica

***Abstract*—Richards finite-state machines represent an efficient alternative to classical Mealy and Moore models in the implementation of complex sequential control systems. Their modular organization simplifies hardware synthesis and enables flexible modification of the control algorithm without complete redesign of the controller structure. This paper presents the synthesis methodology and practical implementation of Richards Controllers together with the development of a configurable educational hardware module dedicated to their experimental study. The proposed module allows rapid implementation of different state-transition diagrams through jumper-based reconfiguration. The developed system includes configurable test-condition emulation and mapping circuits, jump-address generation logic, optical output-state visualization, and selectable continuous or step-by-step operating modes. Experimental validation confirmed the correct functionality and educational utility of the proposed hardware module for laboratory activities involving sequential systems and finite-state machine synthesis.**

Keywords—Richards controllers, finite-state machines, sequential control systems, FSM synthesis, educational hardware module, configurable FSM implementation, experimental learning

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REINFORCEMENT LEARNING BASED NETWORK ADAPTATION FOR UAV-ASSISTED AGRICULTURAL IOT MONITORING

Marius Iulian Mihailescu, Stefania Loredana Nita, Valentina Marascu, Liliana Zisu, Laurentiu Bogdan Asalomia and Marius Rogobete

***Abstract*—Unmanned aerial vehicles (UAVs) are increasingly used in precision agriculture to monitor crop health and detect diseases using high-resolution imagery. However, continual visual data transmission from UAVs results in significant communication overhead and raises energy consumption, particularly in rural areas with limited bandwidth. A reinforcement learning-based adaptive communication system for UAV-assisted agricultural IoT monitoring is proposed in this paper. The proposed approach dynamically adjusts transmission parameters such as image compression level, frame transmission rate, and edge–cloud processing decisions based on real-time network conditions and UAV system status. To balance monitoring accuracy, energy consumption, and communication latency, a Deep Q-Network (DQN) agent learns the best communication strategies. The suggested approach dramatically lowers bandwidth and energy consumption while maintaining good crop disease detection accuracy, according to experimental evaluation using the PlantVillage dataset and a simulated UAV communication environment. The findings demonstrate how intelligent network adaptation can enhance the effectiveness and scalability of agricultural monitoring systems provided by unmanned aerial vehicles.**

Keywords—UAV-assisted agriculture, Agricultural IoT, Reinforcement learning, Adaptive communication, Edge computing, Wireless sensor networks

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MULTICHANNEL-CONVOLUTION NEURAL NETWORKS APPROXIMATION SPACES

Mohammed Majid Nejm and Hawraa Abbas Almurieb

***Abstract*—Studying approximation spaces for neural networks (NNs) is of great importance, not only theoretically, but also for practical applications, such as designing, generalizing, and improving the performance of the NNs. In this paper, NNs were built based on multi-channel convolution and the concept of a tensor product of matrices. The concept of generalized and strict NNs was introduced. Also, the basic properties of the parameters in artificial NNs were studied, and present the classes of NNs to identify the properties that facilitate the study of NNs. Moreover, the definition of approximation spaces for generalized and strict NNs is presented, and it is proven that the classes of approximation spaces are quasi-Banach spaces and achieve continuous embedding. Therefore, the main goal of studying NNs is to determine the range of functions from quasi-Banach spaces, where approximation spaces provide an overview of the goal by identifying its properties and relationships. Finally, a multi-convolutional neural network model was built and trained on a representative dataset using a reduced loss function, with the mean squared error (MSE) used as a performance evaluation metric. The results showed a significant decrease in error, reflecting the model's ability to learn and achieve high approximation accuracy, generating good agreement between actual and expected values. This highlights the effectiveness of neural networks as a powerful tool for addressing mathematical modeling and numerical approximation problems.**

Keywords—Approximation spaces, Quasi-Banach, Convolution, Tensor Product, Neural Networks

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CYBER RESILIENCE ASSESSMENT OF SMART PORT INFRASTRUCTURES THROUGH SECURE HANDSHAKE PROTOCOLS AND SUPERSINGULAR ISOGENY-BASED POST-QUANTUM CRYPTOGRAPHY

Laura-Christina Simionescu Dobrescu, Ovidiu-Constantin Novac, Valentin Alexandru Stan, Cornelia-Mihaela Novac and Razvan Andrei Gheorghiu

***Abstract*—The accelerated digitalization of port infrastructures and the emergence of the Smart Port paradigm have significantly increased the interconnectivity between operational systems, industrial equipment, and digital logistics platforms. In this context, securing data communications has become a critical requirement for ensuring operational continuity and protecting critical infrastructures against cyber threats. This study investigates the role of handshake protocols in securing communications within modern freight terminals, using a smart port architecture as a representative case study. The proposed framework combines TLS 1.3 security mechanisms with hybrid key-exchange approaches inspired by post-quantum cryptography based on supersingular elliptic curve isogenies. The research methodology employs a Digital Twin model of the port infrastructure and network simulations involving 100 interconnected nodes, MQTT/TLS traffic, and multiple cyberattack scenarios, including spoofing, MQTT hijacking, and Distributed Denial-of-Service (DDoS) attacks. System performance is evaluated through availability, latency, packet loss, recovery time, and a composite Cyber Resilience Index. The results demonstrate that hybrid architectures integrating TLS and post-quantum cryptographic mechanisms provide superior resilience and service continuity compared to conventional security solutions. The findings highlight the potential of supersingular elliptic curve-based cryptography as a strategic solution for enhancing Smart Port cybersecurity and preparing critical maritime infrastructures for future quantum computing threats.**

Keywords—smart port, handshake protocol, TLS, cybersecurity, freight terminal, data networks, port logistics, post-quantum cryptography, supersingular elliptic curves

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A RETRIEVAL-AUGMENTED GENERATION BASED HYBRID QUESTION-ANSWERING SYSTEM FOR TURKISH HOTEL INFORMATION: A PILOT STUDY ON ANTALYA HOTELS

Furkan Arda Dinçer and Zeynep Hilal Kilimci

***Abstract*—Nowadays, domain-specific question-answering systems require accurate and reliable responses, yet Large Language Models (LLMs) tend to produce hallucinated answers when lacking domain knowledge [4]. In this study, we propose a Retrieval-Augmented Generation (RAG)-based hybrid question answering system for Turkish hotel information and evaluate it on a pilot dataset representing Antalya-region hotels. The proposed system blends dense retrieval, BM25-based lexical retrieval [7], reciprocal rank fusion (RRF) [12], and cross-encoder reranking [9] with local LLM inference. In order to demonstrate the performance of the proposed model, 239 hotel records are collected, a controlled comparative analysis of chunking strategies and embedding models is conducted, and four local LLMs are evaluated. Experiment results show that the combination of Section-Based chunking, multilingual embeddings, and hybrid retrieval exhibits the best results with 32.6% MRR improvement, 82.6% F1 improvement over the LLM-only baseline, and eliminates observed hallucinations in the evaluated test set under the defined evaluation setup. These results highlight the importance of retrieval design and document segmentation in domain-specific Turkish QA systems.**

Keywords—Retrieval-Augmented Generation., Turkish NLP., Question Answering., Hotel Information Systems., LLM., Hallucination Reduction., Hybrid Retrieval.

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EXAM MONITORING SYSTEM FOR IDENTIFYING SUSPICIOUS BEHAVIOR OF THE STUDENT

Josephine Selle Jeyanathan, Nara Chandana Sree, Madire Manoj Kumar Reddy and Jillella Raghunath

***Abstract*—Abstract—Offline examinations continue to remain the most reliable and widely adopted method of academic assessment. However, manual invigilation in large examination halls suffers from limitations such as blind spots, human error, and difficulty in monitoring multiple students simultaneously. This paper proposes an AI-powered Offline Exam Monitoring System that automatically identifies students, verifies their identity, tracks real-time behavior, and detects suspicious activity using a single overhead IP camera. Blue bounding boxes indicate verified registered students, while red boxes indicate cheating or impersonation. The system also generates instant email alerts containing evidence images to the invigilator and admin, enabling immediate action. The system further maintains local video recording, a violation log, and supports complete exam scheduling and student assignment through an admin portal. Experimental results show high accuracy in identifying cheating behavior such as multiple persons, talking, unauthorized collaboration, or impersonation.**

Keywords—Exam Monitoring System, Suspicious Behavior Detection, Face Recognition, YOLOv8, Computer Vision, Artificial Intelligence

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AN INTERPRETABLE HYBRID DEEP LEARNING FRAMEWORK FOR POWER SYSTEM STATE MONITORING USING TEMPORAL FUSION TRANSFORMERS

Venkatesh Daggupati and Miao He

***Abstract*—Power grids today change fast because solar, wind, electric cars, small generators, and smart devices join the network. Because of this mix, keeping track of what happens inside the grid matters more than ever - staying steady, working right, and moving electricity well depend on it. Old ways of guessing the grid's condition struggle when systems act unpredictably, data gets noisy, sensors miss parts, or calculations slow down across big setups. Instead of sticking to those methods, a new design uses clear machine learning built around time patterns, named Temporal Fusion Transformers. This setup links a math-guided step that respects physical rules with a prediction model tuned to notice quick shifts and lasting trends in voltage and power movement. Unlike earlier systems, the TFT relies on sharp focus, step-by-step control paths, yet blends selective filtering - raising accuracy while making choices easier to follow. Real tests run using actual power movement records, drawn from common IEEE 57- and 118-node models facing changing demand levels. Results hold up better, stay accurate even when data goes missing, meanwhile holding strong where methods such as Gauss–Newton or plain neural loops fall short. Patterns appear quietly at first, revealed by attention cues pointing directly to turning points and critical inputs shaping grid shifts. Designed to scale, it links well into next-gen monitoring platforms built for intricate energy flows**

Keywords—Power System State Estimation, Temporal Fusion Transformer, Smart Grid Monitoring, Explainable Artificial Intelligence, Hybrid Deep Learning

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COMPUTATIONAL ANALYSIS OF OUTPUT VOLTAGE WAVEFORMS IN MULTIPHASE INVERTERS

Oleg Sivkov and Jaroslav Novák

***Abstract*—This paper presents the results of computational analyses of the output voltage parameters of several types of multiphase inverters. The focus is on the analysis of output voltages under rectangular control and under PWM with triangular reference comparison. Five-phase and nine-phase inverters are analyzed, and some comparisons with three-phase inverters are also included. The study primarily examines the possible values of the RMS output voltages and the total harmonic distortion (THD) of the inverter output voltages.**

Keywords—Multiphase inverter, Space vector pulse-width modulation, Harmonic spectra, Multiphase motors, Harmonic distortion

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A REPRODUCIBLE END-TO-END SOFTWARE PIPELINE FOR ACOUSTIC FOREST FIRE DETECTION

Robert-Nicolae Bostinaru, Nicu Bizon, Sebastian-Alexandru Dragusin and Gabriel-Vasile Iana

***Abstract*—This paper addresses early acoustic forest fire detection as a methodological problem of designing a reproducible software chain rather than as a mere competition among classifiers. The emphasis is placed on defining an end-to-end pipeline that includes dataset standardization, segmentation, engineering-justified preprocessing, input representation, classification, and operational evaluation. The paper synthesizes the essential directions in the recent literature on fire detection, acoustic fire detection, environmental sound classification, bioacoustics, and deployment on edge platforms. On this basis, it delineates the current gap in the field and argues for the necessity of a leakage-free protocol, practically relevant metrics, and transparent reporting of experimental decisions.**

Keywords—acoustic forest fire detection, reproducibility, environmental sound classification, bioacoustics, edge deployment, spectrogram, IoT

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DECISION-LEVEL FUSION OF ONE CLASS DETECTORS FOR ZERO TRUST CONTINUOUS VERIFICATION

Robert Cristian Robu, Constantin Viorel Marian and Alexandru Petrisor Cioponea

***Abstract*—Zero Trust Architecture (ZTA) eliminates implicit network trust and requires continuous verification, yet many deployments still rely on static policy logic that reacts slowly to emerging threats. This paper proposes a multi-component anomaly detection approach that leverages an Isolation Forest and a Dense Autoencoder, integrated through a decision-level OR fusion strategy, to enhance continuous verification in ZTA environments. The two detectors are trained exclusively on normal-class traffic and operate on disjoint feature subsets: the Isolation Forest processes network-level features while the Autoencoder captures behavioral session patterns. This complementary design creates a clear division of labor, the Isolation Forest specializes in detecting DoS and Probe anomalies, while the Autoencoder captures R2L and U2R intrusions that manifest in session-level behavior. Decision-level OR fusion preserves both detection signals without requiring score calibration, addressing a demonstrated failure mode of score-level averaging between heterogeneous detectors. Evaluated on the NSL-KDD benchmark, the fused system outperforms both standalone components and the selected supervised baselines (Random Forest and Gradient Boosting) on the distribution-shifted test sets. Bootstrap confidence intervals and McNemar's tests confirm the statistical robustness of the reported improvements. The full pipeline achieves throughput well within real-time network monitoring requirements. These results position decision-level fusion of complementary one-class detectors as a practical and scalable mechanism for anomaly-informed policy decisions within the ZTA continuous verification loop.**

Keywords—Zero Trust Architecture, Continuous Verification, Isolation Forest, Autoencoder, Anomaly Detection, Intrusion Detection, NSL-KDD, Cloud Security, Machine Learning, Decision Fusion

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VITRUASSIST: AN AI-BASED ORCHESTRATION SYSTEM FOR CRYPTOGRAPHIC OPERATIONS

Andrei-Gabriel Moldovan, Stefan-Ciprian Arseni and Mihai Togan

***Abstract*—Recent years have seen major developments across cybersecurity and artificial intelligence. The standardization of post-quantum cryptographic algorithms by NIST in 2024 through FIPS 203–205 marks an important transition for modern security infrastructure, requiring systems that expose classical primitives alongside quantum-resistant schemes such as ML-KEM, ML-DSA, and SLH-DSA [1]–[3]. In parallel, advances in transformer-based language models and retrieval-augmented generation (RAG) have introduced new possibilities for automating security analysis and delivering domain-specific educational assistance. Despite these developments, the practical tooling landscape remains fragmented: password strength estimators, hash-auditing utilities, cipher-identification tools, factorization services, and cryptographic learning resources usually operate as separate applications with different inputs, outputs, and safety assumptions. This paper presents VitruAssist an integrated AI-assisted orchestration platform for cybersecurity and cryptographic workflows. User requests are routed through deterministic artifact rules, with SecureBERT-derived intent and entity checkpoints used on fallback paths, and optional ambiguity handling toward typed specialist services; responses are produced by a configurable LLM provider layer. Built on a microserviceoriented architecture, the system supports password assessment, cryptosystem detection, primality and factorization, retrieval-augmented theory assistance, hash auditing, sandboxed CTF solving, and allow listed classical and selected post-quantum primitive execution. Archived benchmarks evaluate routing behavior, service-contract gates, ranking quality, asynchronous validation, and constrained execution boundaries, with the strongest evidence for deterministic service gates and traceable dispatch behavior.**

Keywords—cryptographic tooling, service orchestration, natural language understanding, retrieval augmented generation, post-quantum cryptography

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QUANTUM COMPUTING AT THE CROSSROADS: A STRUCTURED ANALYSIS OF APPLICATIONS, SCALABILITY CHALLENGES, AND FUTURE RESEARCH DIRECTIONS

Ashwin Dobariya, Jaypalsinh A. Gohil, Petre Anghelescu, Valeriu Manuel Ionescu and Madalin Ciprian Enescu

***Abstract*—Quantum computing is one of the most disruptive technologies to emerge this millennium. This research paper provides a complete study of quantum computing, touching upon all aspects of quantum computing from theory to practical application and scalability issues. Moreover, this paper offers an exhaustive bibliometric analysis of quantum computing over the time frame from 2020 to 2026, as well as a comprehensive literature review of 20 recent articles, including extensions up to 2026. The literature review section includes a comprehensive list of articles that have been chosen for review. All articles reviewed have been included in a table, which contains such information as publication year, venue, algorithms, accuracy/performance results, limitations found, and the most important of all – research gaps that should be studied in the future. The key insights gained during the analysis include evidence of tremendous growth within the domain (Compound Annual Growth Rate of 36.2%), the prominence of quantum error correction and quantum machine learning as subdomains experiencing growth, the advent of fault-tolerant logical qubits in 2025-2026, and decoherence and fault-tolerance overhead as the main bottlenecks preventing quantum computing from achieving practical results.**

Keywords—quantum computing, NISQ, quantum error correction, quantum machine learning, VQE, QAOA, post-quantum cryptography, bibliometric analysis

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COMPARATIVE CASE STUDY ON VEHICLE CLASSIFICATION USING INDUCTIVE LOOP DETECTORS AND CAMERA-BASED ANPR/MMR SYSTEMS

Cristina Bica and Valentin Alexandru Stan

***Abstract*—Vehicle classification is a key functionality in Intelligent Transportation Systems (ITS), supporting traffic monitoring, infrastructure planning, access control, enforcement, tolling, and operational analytics. This paper presents a comparative case study of two practical approaches for vehicle classification: an intrusive solution based on inductive loops, represented by the FEIG VEK S4 detector, and a non-intrusive video-based solution, represented by the Adaptive Recognition Vidar camera equipped with Automatic Number Plate Recognition (ANPR) and Make and Model Recognition (MMR) functions. The study is anchored in a roadside deployment on the A0 Bucharest motorway, where both systems were installed in parallel on a two-lane carriageway with an emergency lane and a lane width of 3.75 m. The analysis indicates that inductive loop technology remains highly relevant when deterministic lane-level detection, speed estimation, and standard traffic classification are required, whereas camera-based ANPR/MMR systems provide richer semantic information and are better suited for advanced ITS services that require vehicle identification, evidence generation, and analytics-oriented processing. A mathematical comparison of the two inference models is also included.**

Keywords—vehicle classification, inductive loop detector, ANPR, ALPR, make and model recognition, MMR, Intelligent Transportation Systems, traffic monitoring, roadside sensing

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THE IMPACT OF THE DATASET ON FINE-TUNING MULTILINGUAL BERT FOR MULTICLASS CLASSIFICATION

Edel Abreu Hernández, Rafael Martinez Estévez, Asday Savón Berenguer and Sorin-Aurel Moraru

***Abstract*—Large language models (LLMs) have transformed natural language processing through their scale and complexity, driven by the use of enormous corpora and resources. However, these data introduce noise and biases that limit performance in specialized domains. To overcome these constraints, domain-specific curated datasets are used to enable more efficient fine-tuning, although this poses challenges in terms of data availability, the balance between specialization, generalization, and computational cost. This paper presents a finetuned version of the BERT-base-multilingual-cased model on our proprietary dataset with different sample sizes to answer the following questions: How does the size of the training set affect the model's performance in the multiclass classification task with the available hardware? Furthermore, at what training epoch does the model begin to overfit for each of the evaluated dataset sizes? And how does the number of classes affect the performance of the model? The results establish a set of consistent patterns in the behavior of the model. As the amount of data increases, F1-score measures above 0.82 are obtained, followed by a reduction in validation loss. The model shows effective learning during the first five epochs, regardless of the size of the dataset. A progressive degradation in performance is also observed alongside an increase in computational cost as the number of classes increases.**

Keywords—BERT-base-multilingual-cased, domain-specific datasets, fine-tuning large language models, multiclass classification task, scaling laws

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CINOGROW: AN INTEGRATED MACHINE LEARNING DECISION SUPPORT SYSTEM FOR PRECISION CINNAMON FARMING

Withanage Malmi, Udari Jayawardana, Duvindu Nimsara, Lahiru Udayakumara, Narmada Gamage and Suranjini Silva

***Abstract*—Ceylon cinnamon is one of Sri Lanka's most important agricultural exports, yet smallholder farmers face challenges in yield prediction, nutrient management, pest and disease identification, and market price uncertainty. This paper presents CinoGrow, an integrated mobile-based decision support system designed for precision cinnamon farming. The system incorporates four machine learning modules: yield prediction using YOLOv5 and XGBoost, nutrient deficiency detection using a vision transformer-based model, pest and disease detection using a Roboflow object detection model, and price forecasting using an ARIMA time-series model. The application supports multilingual interfaces and limited offline functionality through edge-deployable models. Field evaluation involving 90 farmers in Galle and Matara districts demonstrated a 93.3% task completion rate and an average user satisfaction score of 4.4/5. Results indicate that CinoGrow can improve decisionmaking, resource efficiency, and productivity in cinnamon farming systems.**

Keywords—Machine Learning, Precision Agriculture, Cinnamon Farming, Decision Support System, Yield Prediction, Pest Detection, Time Series Forecasting

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QUANTUM FOURIER NEURAL OPERATOR FOR MARKET TREND FORECASTING

Ritisha Katiyar, Shashanka Shekhar Sharma, Gayathri Mani and Thilagavathy R

***Abstract*—Financial market forecasting requires intricate modelling of non-stationary data with long-range relationships. One of the main challenges in machine learning is modelling complicated systems with overlapping time spans. Data is highly non-stationary, sporadic, and spectrally coupled in a way that is challenging to separate and forecast using conventional methods. A hybrid Quantum Fourier Neural Operator (QFNO) model for very accurate forecasting of intricate financial markets is presented in this work, with an emphasis on systems that are connected with renewable energy. The proposed model focuses on multiscale high-dimensional spectral correlations found in non-stationary financial time series data by combining Quantum Fourier Transform (QFT) layers within a neural operator architecture. The model effectively analyses complicated temporal structures in data by utilising quantum-enhanced spectrum analysis. Our work provides an efficient prototype of quantum-enhanced neural operators in computational finance, offering a powerful tool for analysis of modern markets.**

Keywords—Financial Time Series, Hybrid Quantum Models, Stock Market Prediction, Quantum Finance

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SIMULATION-BASED ANALYSIS OF CURRENT STRESS AND STATE OF CHARGE DIVERGENCE IN 2P2S BATTERY CONFIGURATIONS UNDER AGING EFFECTS

Seda Yıldırım and Gürkan Aydemir

***Abstract*—This study investigates the impact of cell aging on current distribution and State of Charge (SOC) estimation accuracy within a 2p2s lithium-ion battery pack configuration. Unlike conventional studies focusing on series-connected strings, this research specifically examines the weakest link shift phenomenon in parallel configurations. A first-order RC equivalent circuit model (ECM) was developed to simulate the dynamic behavior of healthy and aged battery branches. A robust Coulomb Counting (CC) approach was employed to analyze the direct effects of internal resistance mismatch. Simulation results, conducted under a repetitive current profile, reveal a 60% current imbalance between parallel branches due to the resistance disparity. This imbalance leads to a 12% SOC divergence by the end of the cycle. The findings highlight a critical security risk: while the aged cell limits the system initially, the healthy branch eventually becomes the new limiting factor due to accelerated current stress, reaching the lower cutoff voltage faster. These quantitative results emphasize the necessity for BMS algorithms to adopt branch-specific monitoring to prevent secondary aging of healthy cells.**

Keywords—SOC estimation, current distribution, internal resistance mismatch, coulomb counting, battery aging, weakest link

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A MACHINE LEARNING–BASED DIGITAL IDENTITY FRAMEWORK FOR ELECTRIC VEHICLE BATTERY SYSTEMS

Prashant Wakhare, Suyog Dhage, Harsh Gangurde and Aditi Janwade

***Abstract*—The reliable prediction of Electric Vehicle (EV) battery State of Health (SOH) is one of the key factors for guaranteeing the dependable operation of vehicles, maximizing performance, and evaluating residual value. In practice, the main limitation is usually the lack of comprehensive operational data, since direct sensor data are generally not accessible to end, users and third, party systems. In this paper, we offer a thorough review and a comparative study of machine learning (ML) techniques that aim to tackle this data, gap issue. We explore various regression, based methods, starting from the classical Linear Regression and even SVR to ensemble methods like Random Forest and Gradient Boosting, as well as neural networks. A major aspect of this article is the ”multi, stage prediction pipeline”, an architectural pattern aimed at extracting high, value SOH features from scarce, user, provided inputs. This pipeline is structured in two phases: (1) Initially, it utilizes Charging Duration, Total KM Traveled, and Battery Type, the three most accessible data points, to model and predict a bunch of unobserved, intermediate operational parameters, namely SOC, Battery Temp (C), Ambient Temp (C), and Charging Cycles.(2) These derived features are subsequently mixed with the original user inputs to create a complete feature set, which is then used to train a second group of models for predicting final SOH indicators: Efficiency and Degradation Rate. By combining the results of various algorithms (based on R and MAE) performance within this two, stage framework, this manuscript recognizes and confirms this ”feature, inference” structure as a strong and practical resolution. It successfully closes the gap between highly data, demanding laboratory models and the stringent requirements of the real, world battery diagnostics, thus leading to scalable and easily accessible SOH estimation tools.**

Keywords—State of Health(SOH), Electric Vehicle(EV), Battery Passport, Machine Learning(ML), Multi-Stage Prediction Pipeline, State of Charge(SOC), Regression Analysis

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INTEGRAL BACKSTEPPING CONTROL FOR PERMANENT MAGNET SYNCHRONOUS MOTOR DRIVES: DESIGN, STABILITY ANALYSIS, AND SIMULATION VALIDATION

El-Houssine Bekkour, Zakariae Sakhri, Said Mahfoud, Anis Boulal and Badre Bossoufi

***Abstract*—Achieving precise and robust speed regulation in permanent magnet synchronous motor drives remains a significant challenge due to the inherent nonlinearity and strong coupling of the motor dynamics combined with unavoidable parametric variations and external load disturbances. This paper proposes an integral backstepping controller that addresses these challenges through a recursive Lyapunov-based design applied to the third-order PMSM model in the d-q reference frame. Integral action is embedded exclusively within the speed control loop to eliminate steady-state speed error under sustained disturbances, while the current control loops retain a compact and tractable structure. A single composite Lyapunov function is constructed to encompass all error variables including the integral state, and its time derivative is proven strictly negative definite, establishing the global asymptotic stability of the overall closed-loop system. MATLAB/Simulink simulation results obtained under speed tracking, load disturbance rejection, and variable-speed operation scenarios confirm overshoot-free transient behavior, negligible steady-state speed error, and stator current THD values of 0.23% at 6.25 Hz and 0.13% at 25 Hz, both compliant with the IEEE 519 standard, demonstrating the accuracy, robustness, and practical implementability of the proposed controller for high-performance PMSM drive applications.**

Keywords—Permanent Magnet Synchronous Motor, Integral Backstepping Control, Speed Regulation, Lyapunov Stability, Nonlinear Control

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GRID-CONNECTED DC MICROGRID USING FSM CONTROL IN MATLAB/SIMULINK

Hanane Tasmant, Badre Bossoufi, Chakib Alaoui, Mihai Oproescu and Farah Echiheb

***Abstract*—Abstract— The integration of green energy sources and Storage solutions into the grid system has become highly Embraced in past several years. The nature of these distributed power technologies being plug-and-play in nature causes different types of disturbances and this needs to be prevented through high efficiency, strong effectiveness, and rapid responsiveness energy management (EM) techniques or systems (EMS). Different EMS have been investigated to date by number of research scientists. In this paper, we present a Finite State Machine (FSM)-based control strategy for power system management solution in a hybrid DC microgrid connected to photovoltaic (PV), wind integration, battery storage, and utility grid. This strategy relies on maintaining stability within the microgrid while maximizing the percent of renewable generation being utilized using a logical state transition topology based on actual energy balance and the battery's state of charge. The FSM transitions through operational modes, for example, connected to the grid import or exporting power and islanding mode with renewable only, charging and discharging states. The FSM provides operational dynamic governance in controlling the microgrid's power supply when loads change and environmental inputs change. A MATLAB/Simulink model was developed to validate the proposed control logic. The proposed control logic is a low-complexity, reliable, scalable, solution for microgrid control while allowing for future layers of supervisory control based on prediction and optimization.**

Keywords—Finite State Machine (FSM), Microgrid, Energy Management System (EMS), Renewable Energy, Battery Storage, MATLAB/Simulink

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MOISTURE CONTENT CLASSIFICATION FROM IMAGES USING STATISTICAL FEATURES

Shishir Maheshwari, Sunilkumar Telagam Setti and Daniel Rönnow

***Abstract*—Feature extraction reduces high-dimensional image data into compact and informative descriptors, improving classification efficiency and performance. In this study, moisture content classification is performed using color image analysis. RGB channels are first separated, and 26 features are extracted from each channel, including statistical measures (mean, standard deviation, variance, median, minimum, maximum, skewness, kurtosis, Shannon entropy, and Renyi entropy) and texture features derived from Gray-Level Co-occurrence Matrix (GLCM). GLCM features contrast, correlation, energy, and homogeneity—are computed across four orientations (0°, 45°, 90°, and 135°). To enhance performance, Chi-square-based feature selection is applied to rank and select the most discriminative features. A Support Vector Machine (SVM) with a radial basis function (RBF) kernel is used for classification. Feature-level fusion of RGB channel combinations is also investigated. The model is evaluated using 4-fold and 10-fold cross-validation. The proposed method achieved a highest classification accuracy of 91.54 and 90.42 for 3-class and 5-class classification of moisture content, respectively. Results demonstrate that optimal feature selection and channel combinations significantly improve classification accuracy and robustness.**

Keywords—moisture content, woodchips, image classification, feature extraction

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AI-DRIVEN SKILL GAP ANALYSIS AND CAREER DEVELOPMENT FRAMEWORK USING KNOWLEDGE GRAPHS AND ADAPTIVE INTERVIEW INTELLIGENCE

Nipuni Siriwardhana, Tharusha Bandara, Kavisha Nilmani, Hashinika Thisaravi, Lakmini Abeywardhana and Anuradha Karunasena

***Abstract*—The persistent misalignment between academic preparation and evolving industry skill demands presents a critical challenge in employability assessment and career guidance. Undergraduate graduates frequently enter the workforce without the practical competencies and specialized technical skills required by modern industries. This research proposes an integrated employability intelligence framework that combines graph-based skill gap analysis, personalized learning recommendations, skill validation, and adaptive interview assessment to provide a comprehensive evaluation of candidate readiness for industry roles. The system models the employability ecosystem using a heterogeneous knowledge graph that represents relationships among candidates, skills, job roles, learning resources, and projects. A Graph Neural Network (GNN) is employed to predict missing skills through link prediction and compute a continuous readiness score for target roles. Based on the identified skill gaps, the framework generates personalized learning paths and skill-conditioned capstone project recommendations using a teacher–student knowledge distillation approach with LoRA-based fine-tuning. In addition to skill development, the framework incorporates a transcript-based skill validation module that evaluates academic evidence through evidence-weighted scoring and AI-generated quizzes. To further assess practical readiness, an adaptive interview intelligence module simulates job interviews using retrieval-augmented generation and evaluates responses using semantic relevance and speech emotion recognition models. The integration of these components forms a unified system capable of dynamic employability assessment, targeted skill development guidance, and preparation for real-world recruitment processes.**

Keywords—Knowledge Graph, Graph Neural Networks, Skill Gap Analysis, Personalized Learning Path, Skill Validation, Interview Intelligence, Employability Assessment, Speech Emotion Recognition

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CARBON TRANSPARENCY BLOCKCHAIN IN RENEWABLE-RICH HYDROGEN ENERGY SMART ECOSYSTEMS

Hossein Shayeghi, Babak Mohamadi, Peyman Zare, Pooria Savabi and Nicu Bizon

***Abstract*—This paper proposes a carbon transparency blockchain framework for renewable-rich electricity, heat, and green hydrogen energy ecosystems. The framework couples Renewable Portfolio Standard obligations with Carbon Emission Trading through a ledger-enabled accounting layer that records renewable quotas, carbon allowances, green certificates, and emission settlements in an auditable form. A ladder-pricing mechanism translates the mismatch between assigned quotas and realized emissions into market signals for low-carbon operation. Power-to-Gas technology is embedded to convert surplus renewable electricity into hydrogen carriers, reduce wind curtailment, and improve cross-carrier flexibility among electricity, heat, gas, and hydrogen subsystems. The scheduling problem is formulated as a mixed-integer linear programming model and solved with the CBC solver. Simulation results indicate that joint participation in carbon and certificate markets lowers total operating cost, while Power-to-Gas deployment increases renewable utilization and supports more credible carbon-accountable hydrogen energy management. This structure provides a traceable basis for market-based decarbonization in smart cities.**

Keywords—Green Hydrogen, Power-to-Gas, Green Certificate Trading, Renewable Portfolio Standard, Smart Energy Ecosystem

EXPLAINABLE DEEP LEARNING FRAMEWORK FOR INTELLIGENT POWER ELECTRONIC CONTROL IN SMART GRIDS

Venkatesh Daggupati and Miao He

***Abstract*—More renewables, scattered power sources, plus modern converter tech have turned old-style electricity systems into fast-changing smart setups. Even though advanced controls using deep learning adjust better and run more smoothly, their lack of clarity makes them hard to trust when stability matters most. Because of this gap, a new approach called XDLF is introduced here - built to make deep learning decisions clearer in managing power electronics across smart networks. Inside, it brings together time-based convolution models, two-way memory networks that track past and future patterns, along with focus layers that highlight key inputs during shifting, unpredictable operations. On top of that, methods from Explainable AI using SHAP help uncover how models make choices, pointing out which electrical traits most affect converter behavior. Instead of fixed conditions, testing happens across shifting situations - like harmonics, uneven renewables, shifts in voltage, and changing loads - using open smart grid data.**

Keywords—Smart Grid, Explainable Artificial Intelligence (XAI), Deep Learning, Power Electronic Control, Temporal Convolutional Network (TCN), Bidirectional Long Short-Term Memory (BiLSTM) Attention, Mechanism, SHAP Analysis.

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A LIGHTWEIGHT AND HYBRID PIPELINE FOR PALMPRINT SPOOF DETECTION

Neha Rathore, Arvind Selwal and Tanisha Gupta

***Abstract*—Biometric-enabled authentication system are the secured mechanisms in modern era computing. Among all, palmprint authentication systems are rapidly employed for human recognition. Moreover, these systems are vulnerable to a variety of spoof attacks such as printed photographs, video replay, and masks. In this research, we present a hybrid approach for palmprint liveness detection. The approach utilizes the potency of a pre-trained learning model i.e. MobileNetV3. The conception of fine-tuned MobileNetV3 is deployed to extract deep level features from palmprint images. Thereafter, highly discrimination features are selected by using Principal Component Analysis (PCA). A robust Support Vector Machine (SVM) classifier is used to categorize the given image as Bonafide or fake trait. Our approach is trained and evaluated on self-created palmprint spoofing dataset. The proposed approach is lightweight as well as efficient mainly due to usage of MobileNetV3. The proposed approach demonstrates promising performance in terms of Equal Error Rate (EER) 3.08%.**

Keywords—Biometrics, Palmprint, Spoof attack, Deep learning, MobileNetV3, Presentation attack detection (PAD)

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THROUGHPUT PERFORMANCE ANALYSIS OF ALOHA AND CSMA PROTOCOLS: EVALUATING VARIABLE TRANSMISSION POWER UNDER STRUCTURAL BARRIERS AND HUMAN INTERFERENCE

Hilal Kaya, Sami Acik, Selahattin Kosunalp and Mehmet Baris Tabakcioglu

***Abstract*—This study presents a comparative performance evaluation of ALOHA and Carrier Sense Multiple Access (CSMA) protocols within a heterogeneous Wireless Sensor Network (WSN) subjected to structural and biological interference. Utilizing a low-cost node architecture integrated with nRF905 transceivers, we analyze channel throughput under varying transmission power levels (Ptx) and spatial constraints. Experimental results demonstrate that while CSMA offers superior channel utilization—achieving up to 0.38 Erlang—it remains susceptible to cumulative attenuation from 24 cm thick Autoclaved Aerated Concrete (AAC/Ytong) barriers. Furthermore, the introduction of human density was found to reduce throughput by approximately 12% due to dielectric absorption and shadowing. These findings underscore the necessity of accounting for structural impedance and biological factors in the design of resilient medium access control (MAC) mechanisms for indoor IoT environments.**

Keywords—Variable Transmission Power, CSMA, ALOHA, Indoor Propagation, Structural Barriers, Human Interference

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TIME, TECHNOLOGY, AND NEURODIVERSITY: LIVED EXPERIENCES OF NEURODIVERGENT ADULTS IN INDIA AND IMPLICATIONS FOR AI PERSONAL ASSISTANT DESIGN

Syeda Tuba Andrabi, C. Chacko, Johanna Sophie von Lieres and Miriam Silverman

***Abstract*—Neurodivergent individuals, particularly those with ADHD and autism, frequently experience difficulties related to time awareness, task management, planning, and temporal regulation in everyday life. Existing productivity and assistive technologies often rely on neurotypical assumptions of consistent attention, rigid scheduling, and linear task management, limiting their effectiveness for neurodivergent users. While prior research has examined temporal cognition and executive functioning, limited work has explored how AI-based assistive systems can support neurodivergent experiences of time within non-Western contexts such as India. This study investigates time awareness, compensatory strategies, and technology use among neurodivergent adults in India through semi-structured interviews with 19 participants. Using content analysis, the study examines how participants manage time-related demands, engage with digital tools, and conceptualise ideal forms of technological support. Findings reveal heavy reliance on external temporal scaffolds, cognitive offloading systems, and interpersonal accountability, alongside dissatisfaction with rigid, impersonal, and cognitively demanding productivity applications. Based on these findings, the paper proposes a conceptual framework for AI-based personal assistants designed for neurodivergent users, emphasising proactive outreach, contextual personalisation, multimodal interaction, human-like scaffolding, and integration within familiar communication platforms such as WhatsApp.**

Keywords—AI personal assistants, time awareness, ADHD, autism, low-resource settings

REALIZATION OF DIFFERENT CONTROL STRATEGIES OF AC VOLTAGE REGULATOR

Kumkum Thakar and Vishakh Soni

***Abstract*—This research study focuses on improving the performance of AC voltage regulators using a variety of control methodologies. Three main control systems are investigated: Phase Angle Control (PAC), Pulse Width Modulation (PWM), and Integral Cycle Control (ICC), also known as On-Off Cycle Control. Currently, Phase Angle Control and PWM methods are widely used but generate a large number of harmonics, resulting in poor circuit performance. The paper describes the design and modeling of a thyristor-based AC voltage controller that uses Integral Cycle Control, Pulse Width Modulation, and Phase Angle Control approaches. Simulation tasks were carried out using three software platforms: MATLAB, Multisim, and PSCAD. The use of the FFT block in the PSCAD software permitted the extraction of the direct harmonic spectrum, which improved the analysis process.**

Keywords—AC voltage regulator, PWM, Integral cycle control, phase angle control, comparative analysis

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EVALUATING HYBRID POPULATION INITIALIZATION FRAMEWORKS FOR MOUNTAIN GAZELLE OPTIMIZER

Zainab Falah and Maytham Alabbas

***Abstract*—The initialization process plays a significant role in the exploration capacity of metaheuristic search algorithms in the high-dimensional search space. In this paper, we proposed three hybrid initialization frameworks: "Sequential Application," "Quality-Based Selection," "Adaptive Hybridization," as well as the conventional "Merge & Combine" for the Mountain Gazelle Optimizer algorithm by combining random initialization with ten advanced initialization techniques: OBL, GPS, Halton, Chaotic Map, LHS, DUD, DLU, WELL, Torus, and Sobol. The performance of the proposed initialization frameworks was tested using thirteen benchmark functions in 100D space by conducting 30 independent runs using best, worst, average, and STD fitness value criteria. The proposed hybrid initialization frameworks dominated the performance of the eleven individual initialization techniques on ten out of thirteen test functions, while producing identical top results on the remaining three functions. "Merge & Combine" using DLU produced the best results in the average rank table, which was further validated by the statistical analysis using the Friedman and Wilcoxon tests, showing no significant difference between the proposed frameworks but proving the practical efficiency of the proposed hybrid initialization techniques in multimodal optimization.**

Keywords—Hybrid Initialization Strategies, Low-Discrepancy Sequences, Metaheuristic Optimization, Mountain Gazelle Optimizer, Population Initialization

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OVERVIEW OF HEAT REMOVAL SYSTEMS FOR GENERATION IV REACTORS

Amalia Popa, Denisa Toma, Nicu Bizon, Livia Stoica, Mirela Matei and Gratiela Badulescu

***Abstract*—Lead-cooled fast reactors (LFRs) are considered one of the most promising Generation IV nuclear technologies due to their potential to provide enhanced inherent safety, improved thermal performance, and more efficient utilization of nuclear fuel resources. Within these reactor systems, steam generators represent critical components, as they enable heat transfer between the secondary and tertiary circuits and facilitate the conversion of thermal energy into electrical power. The severe operating conditions encountered in LFRs, including elevated temperatures, high heat-transfer rates, and aggressive corrosive environments, impose stringent requirements on both the materials and structural designs of steam generators. In conventional CANDU (CANadian Deuterium Uranium) reactors moderated with heavy water, steam generators operate under well-established conditions typical of pressurized water systems. By contrast, steam generators designed for liquid lead-cooled fast reactors must withstand significantly harsher environments generated by the liquid metal coolant and the demanding thermal regime. This paper presents an overview of the main steam generator concepts proposed for Generation IV reactors, with particular emphasis on helical coil and bayonet configurations. The advantages, limitations, and operational characteristics of each design are examined. Furthermore, a comparative analysis is carried out between the steam generator technologies currently employed in CANDU systems and the advanced concepts developed for LFR applications. The study also highlights future research directions and development opportunities, underlining the importance of technological innovation in improving the safety, reliability, and long-term durability of steam generators intended for next-generation nuclear power systems.**

Keywords—lead-cooled fast reactors, steam generators, design concepts, heat removal systems, nuclear safety, generation IV reactors, advanced reactor systems

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REAL TIME 3D AIRCRAFT TELEMETRY VISUALIZATION WITH GEOSPATIAL TERRAIN INTEGRATION

Ahmet Yusuf Yatkın and Mahmut Emin Celik

***Abstract*—Aircraft telemetry systems generate large volumes of rapidly changing flight data that are commonly presented through numerical dashboards and two dimensional monitoring interfaces. Although these systems provide access to raw telemetry information, operators may experience difficulty interpreting complex parameter relationships during real time missions, potentially reducing situational awareness and delaying abnormal condition recognition. This paper presents a real time 3D aircraft telemetry visualization platform that transforms live telemetry streams into an interactive spatial monitoring environment. The system visualizes aircraft 6DoF state, trajectory history, and control surface movements within a geospatial 3D environment. Abnormal or critical telemetry conditions are presented through HUD style interface overlays, presenting real time mission relevant information to support operator awareness during live operation. The proposed system is designed as a modular and extensible architecture that enables easy integration of different telemetry sources and supports adaptation to various mission specific requirements. To improve accessibility and reproducibility, the implementation uses openly available geospatial datasets, reducing dependence on commercial or restricted data sources.**

Keywords—Aircraft telemetry visualization, real time telemetry, geospatial terrain rendering, ground control station, 3D visualization, situational awareness

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CARBON BLOCKCHAIN-BASED INTELLIGENCE COMPUTING FOR RENEWABLE HYDROGEN SETTLEMENT TRANSPARENCY

Hossein Shayeghi, Babak Mohamadi, Peyman Zare, Salar Rezaei Moghadam and Nicu Bizon

***Abstract*—This paper develops an oracle carbon blockchain-based intelligence computing framework for renewable hydrogen settlement transparency in a park-level integrated energy system. The studied system coordinates electricity, hydrogen, heat, cooling, natural gas, renewable generation, storage devices, and power-to-gas conversion within a unified carbon-aware scheduling structure. The proposed framework links physical power-to-gas operation with carbon settlement logic by treating CO_2 consumed in methanation as both a reaction input and a verified carbon-accounting element. An oracle-supported carbon blockchain layer is introduced to strengthen the traceability of renewable hydrogen production, carbon allowance utilization, and settlement-related energy transactions. The optimization model includes multi-carrier balance relations, power-to-gas reaction constraints, carbon-settlement terms, grid exchange limits, storage dynamics, and gas-turbine commitment conditions. The fully coordinated case lowers operating cost by approximately 8.3% compared with the reference case. Sensitivity results indicate that natural-gas price has a stronger effect on system cost than CO_2 price. These findings show that carbon-blockchain-informed settlement, storage flexibility, and renewable hydrogen conversion can improve operational economy, reduce external energy dependence, and support transparent low-carbon scheduling.**

Keywords—Carbon Trading, Mixed-Integer Linear Programming, Renewable Energy Scheduling

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COMPARATIVE ANALYSIS OF LOW-FREQUENCY MAGNETIC SHIELDING IN SPHERICAL AND CYLINDRICAL CONDUCTIVE SHIELDS USING FEM AND KADEN'S ANALYTICAL MODEL

Dumitru Cazacu, Bogdan Puiu, Nicu Bizon, Roxana Camelia Cazacu and Constantin Stoica

***Abstract*—This paper presents a comparative study of low-frequency magnetic shielding using spherical and cylindrical shields made of copper and steel. Finite element simulations were performed using Comsol Multiphysics finite element software considering shield thicknesses of 1 mm, 2 mm, and 3 mm in the frequency range of 50 Hz–10 kHz and compared with Kaden's analytical model. The shielding efficiency was evaluated in terms of magnetic field attenuation, while the distribution of induced eddy currents was used to analyze the shielding mechanism. The results show that spherical shields provide higher shielding efficiency than cylindrical shields for all investigated configurations. In both geometries, shielding performance increases with frequency due to the growing contribution of eddy currents. A good agreement between numerical and analytical results was obtained for most cases. Larger deviations were observed for steel shields at 10 and 10 kHz, particularly for thicknesses of 2 mm and 3 mm, where strong skin-effect conditions lead to very high attenuation levels and increased sensitivity to numerical and analytical assumptions.**

Keywords—magnetic shielding, shielding efficiency, eddy currents, skin effect, finite element analysis, Kaden model

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MORAG: A MULTIMODAL OFFLINE RETRIEVAL-AUGMENTED GENERATION SYSTEM USING LARGE LANGUAGE MODELS

Mratyunjay Tiwari, Robin Kumar, Atul Harsh, Ram Swarup Surin, Karan Singh Pal and Varsha Saini

***Abstract*—This paper proposes an Offline Multimodal Retrieval-Augmented Generation (RAG) System that is fully processed on local hardware, enriching the conventional RAG system with support for text, image, and audio modalities. The suggested architecture combines features of multimodal retrieval and generation, with a focus on privacy, efficiency, and accessibility. In contrast to cloud-based solutions, the system uses on-device encoding, retrieval, and generative functions, which allows organizations and individuals to implement intelligent assistants, knowledge agents, and multimodal analysis tools without sharing sensitive information with external servers. It builds on recent progress in the open-source LLMs and multimodal embedding models to form a unified local inference pipeline. The architecture has three key components: (1) Multimodal Encoders transform heterogeneous inputs (text, images, audio) into homogeneous vector representations using trained embedding models; (2) a Local Vector Store, implemented using FAISS or ChromaDB, which facilitates the efficient semantic search and retrieval of relevant documents or media (via cosine similarity); and (3) an Offline Generative Model, which synthesizes coherent, contextually informed responses by conditioning on the retrieved information. The whole system, including encoding, retrieval, and generation, runs in a safe, offline environment and ensures data confidentiality and lower latency than cloud-based APIs.The system is tested against benchmarks for retrieval accuracy, generation quality, response latency, and computational efficiency. Accuracy in text retrieval will be measured by Recall at K, Mean Reciprocal Rank (MRR), whereas the performance of the generators will be evaluated by BLEU, ROUGEL, and BERTScore..**

Keywords—Offline RAG, Multimodal Retrieval-Augmented Generation, Local LLM Inference, Multimodal Embeddings, Vector Databases (FAISS ChromaDB), Semantic Search, Multimodal Information Retrieval, Edge AI

AN EVALUATION OF AI-ENABLED SOCIAL MEDIA PLATFORMS IN ENHANCING TALENT ACQUISITION EFFECTIVENESS

Kandepi Chethana Priya, Gundlapalli Karthik Kumar, Chandrasekhar Ramya, Duddu Sivanandam, Tummala Sarita and Thaya Madhavi

***Abstract*—The rapid advancement of digital technologies has transformed recruitment practices, with Artificial Intelligence (AI) playing a crucial role in modern talent acquisition. Traditional methods are often time-consuming and costly, prompting organizations to adopt AI-enabled digital platforms. Social media platforms such as LinkedIn, Facebook, and Twitter, integrated with AI, enable automated screening, candidate matching, and predictive analytics. This study evaluates the effectiveness of AI-enabled social media recruitment using a quantitative methodology and survey data analysis. The results indicate improved recruitment efficiency, reduced hiring time, expanded candidate reach, and enhanced candidate-job matching. The study emphasizes the importance of adopting AI-driven recruitment systems.**

Keywords—artificial intelligence, social media recruitment, talent acquisition, recruitment efficiency, predictive analytics

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ENHANCING THERMAL PERFORMANCE PREDICTION OF PV/T AIR COLLECTORS THROUGH ENSEMBLE MACHINE LEARNING AND FEATURE IMPORTANCE ANALYSIS

Zineb Tadlaoui, Badr El Kari, Yassine Chaibi, Mohamed Benslimane and Zakaria Chalh

***Abstract*—Increased demand for clean and sustainable sources of energy is encouraging the use of hybrid energy systems with high technological potential. Photovoltaic/thermal systems are considered to be a highly efficient hybrid system as they produce electrical as well as thermal power using the same surface. To increase the efficiency of these systems, accurate predictive tools must be developed to analyze the effect of changing environmental conditions. In this context, the use of data-driven models is considered to be an efficient alternative to traditional models. In the present study, the authors have proposed a data-driven model to predict the thermal efficiency of an air-based photovoltaic/thermal system using the concept of ensemble machine learning models. The authors have considered the Random Forest, XGBoost, and CatBoost models to predict the thermal efficiency of the system. The results indicate that the Random Forest model is the best model to predict the thermal efficiency of the system with R^2 value 80.873% and MAE 2.751%. XGBoost and CatBoost models have also shown good results with R^2 value 80.173% and 80.3% with MAE 2.890 and 2.948 respectively. Moreover, the results indicate that the feature 'global horizontal irradiance' is dominant in determining the efficiency of the photovoltaic/thermal system.**

Keywords—Photovoltaic-thermal systems, Thermal efficiency prediction, Machine learning, Random Forest, XGBoost, CatBoos

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MODEL DRIVEN ADMM-NET FOR MULTI-TARGET DETECTION IN WSN

Zainab Al Bakaa and Ahmed Al Hilli

***Abstract*—Compressive sensing (CS) is a recent approach to minimize energy consumption for multi-target detection and localization in Wireless Sensor Networks (WSNs). However, it is complicated by real-time constraints because traditional sparse recovery approaches, such as Basis Pursuit (BP), are computationally costly and cannot be applied as the target density increases. This paper presents the Alternating Direction Method of Multipliers-Net (ADMM-Net) deep unfolding for an adaptive model. This model reformulates a task into a multi-label detection and builds a fixed network structure. Simulation results show that the proposed model is adaptive to both sparse and dense targets and reduces execution time by 99.95% (2000 times faster) compared to BP, making it suitable for real-time WSN applications.**

Keywords—Compressive Sensing, Basis Pursuit, WSNs, ADMM-Net, deep unfolding, multi-target detection

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HYBRID ONLINE/OFFLINE LOCALIZATION SYSTEM FOR INDOOR–OUTDOOR PERSONNEL TRACKING

Alexia-Ioana Dragomir and Nita Stefania Loredana

***Abstract*—Continuous personnel tracking that survives the passage between the open sky and the interior of a building remains an open practical problem: satellite positioning degrades sharply indoors, while purely inertial estimation drifts without bound. This paper presents a hybrid localization platform for fieldpersonnel tracking that operates seamlessly across the indoor– outdoor boundary and, equally important, across the online– offline boundary imposed by intermittent connectivity. Outdoors, the position is obtained from the fused satellite provider; indoors, a two-dimensional Kalman filter combines a pedestrian deadreckoning prediction with three independent radio corrections— a BLE weighted centroid, a WiFi k-NN fingerprint, and a reverse BLE anchor—under an explicit confidence hierarchy. The regime switch is governed by a geometric geofence around the building. A local-first synchronization layer guarantees that no measurement is lost when the network is unavailable, buffering records on the device and reconciling them in chronological order on reconnection. The system was evaluated on a real Android terminal in an instrumented building. Indoor accuracy reached a mean error of 1.8m under full fusion, the indoor–outdoor transition succeeded in 9 of 10 crossings, and offline buffering recovered 100% of captured records across outages of up to two hours, while the backend sustained the target of 100 concurrent clients with a 95th-percentile latency below 15 ms. Security and resilience mechanisms— jamming and spoofing watchdogs, token-based authentication, and role-based access control—are integrated by design rather than added as an afterthought.**

Keywords—indoor positioning, GPS, BLE, sensor fusion, offline synchronization, personnel tracking

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BEYOND IMAGES: METADATA-AUGMENTED MULTIMODAL FUSION FOR WILDLIFE CLASSIFICATION

Anuruddh Paul, Mahendra Kumar Gourisaria, Amitkumar V. Jha, Bhargav Appasani, Nicu Bizon and Satyabrata Roy

***Abstract*—Manual processing of massive camera trap datasets remains a bottleneck in ecological research. Standard YOLO models often struggle with poor illumination and occlusion, ignoring critical metadata context used by ecologists. We propose a multimodal fusion framework integrating frozen YOLOv8 visual features with temporal-spatial metadata, addressing the persistent challenge of data scarcity in wildlife classification through transfer learning and parameter-efficient fusion. Using cyclic temporal encoding and spatial clustering, we fuse 512 dimensional visual features with 256-dimensional metadata embeddings, where is_crepu ∈ {0,1} captures crepuscular activity periods critical for dawn/dusk species identification. Evaluated on 85,247 images across 45 species, our additive fusion architecture achieved 86.97% top-1 accuracy and 98.86% top-5, outperforming concatenation and attention mechanisms while using 40% fewer parameters than competing methods. For edge deployment, our lightest model achieves 86.52% accuracy at 1110 FPS (0.90ms/frame), suitable for real-time inference on Raspberry Pi 5 and Jetson Nano. Ablation studies highlight the value of metadata: removing temporal features dropped accuracy by 4.2%, while unfreezing backbones caused an 8.9% decline due to catastrophic forgetting. Additionally, 26.3% of errors reflected biologically plausible morphological similarities among small mammals. This approach demonstrates that leveraging contextual data significantly improves automated species classification in challenging environments, even under noisy or incomplete metadata conditions. Code and pretrained models are publicly available at https://github.com/AnuruddhaPaul/METADATA_YOLO.**

Keywords—wildlife classification, multimodal fusion, metadata integration, YOLO, camera traps, temporal encoding, edge deployment

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CAPABILITY DEGRADATION IN SMALL LANGUAGE MODELS UNDER LOW-SIGNAL DATA CORRUPTION

Rayan Qamar, Bhargav Appasani, Nicu Bizon, Smita Verma and Amitkumar V. Jha

***Abstract*—Language models acquire useful linguistic and generative behavior from the statistical structure of their training data. As public and synthetic corpora increasingly contain duplicated, weakly filtered, low-information, and recursively generated text, it becomes important to measure how low-signal contamination affects model capability under controlled conditions. This paper presents an experimental study of capability degradation in small language models under controlled low-signal textual corruption. A clean corpus is used to construct fixed-size dataset variants with corruption ratios of 0\%, 30\%, 50\%, 60\%, and 80\%. Corruption is generated through a formal taxonomy consisting of repetitive low-entropy text, semantically incoherent text, distractor-dominant text, recursive synthetic text, and shallow high-fluency filler. Small GPT-style decoder-only transformer models are trained from scratch under identical architecture, tokenizer, optimizer, training schedule, and evaluation settings across three random seeds per condition. Degradation is measured using clean-test perplexity, repetition behavior, lexical diversity, prompt adherence, bootstrap confidence intervals, benchmark-style multiple-choice probes, ablation analysis, and a Capability Retention Index. Results from 30 model-run rows show that mixed low-signal corruption increases mean clean-test perplexity from 1654.12 at 0\% corruption to 2199.29 at 80\% corruption, a 32.96\% increase. CRI remains below the clean baseline for every corrupted mixed variant and reaches 0.6139 at 80\% corruption, although it is not strictly monotonic under the current aggregate metric. Ablation results identify repetitive low-entropy and shallow fluent-filler corruption as the most harmful categories under the tested metrics. The study contributes a reproducible framework for data-quality degradation analysis while keeping claims limited to the tested small-model, three-seed setting.**

Keywords—language models, data quality, low-signal data, model robustness, synthetic data, model collapse

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REAL-TIME GESTURE-TO-TEXT TRANSLATION FOR AMERICAN SIGN LANGUAGE USING MEDIAPIPE AND LSTM

Ouahbi Younesse, Mdarhri Ilham, Nseri Nouhaila, Benlkahla Noha, Zaroual Najlae, Mellaj Soraya and Ziti Soumia

***Abstract*—For millions of deaf and hard-of-hearing people around the world ,sign language serves as their primary form of communication. However, the hearing population's limited comprehension of sign language means that communication barriers still exist. Even though sign language recognition research has advanced significantly in recent years, many current methods only use isolated signs or heavily annotated datasets and computationally demanding models, which restricts their use in real-time and resource-constrained settings. this paper presents a vision-based lightweight framework for phrase-level American Sign Language recognition from video sequences. In order to capture the dynamic evolution of hand gestures, the suggested method uses MediaPipe for hand skeletal landmark extraction and Long Short-Term Memory (LSTM) networks for temporal modeling. The system preserves the necessary motion information for precise recognition while reducing visual complexity by representing gestures as series of hand landmarks . Robustness to signer variability, environmental changes, and dynamic gesture transitions are key components of the methodological design which is based on review of recent literature. The suggested framework is appropriate for real-time assistive communication and human–computer interaction applications since as analysis of recent literature and system behavior suggests that landmarkbased temporal modeling provides a good trade-off between recognition accuracy and computational efficiency.**

Keywords—Artificial Intelligence, Education Technology, Deep Learning, Gesture Translation, Human–AI Interaction, Vision based, Sign Language Recognition (SLR), Assistive Communication Technology

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SCADA SYSTEM FOR MONITORING AND CONTROLLING TURBINES VIBRATION IN HYDROPOWER STATIONS

Florentina Magda Enescu, Ioan Cristian Hoarcă, Nicu Bizon and Valeriu Manuel Ionescu

***Abstract*—This paper proposes the enhancement of Supervisory Control and Data Acquisition (SCADA) systems associated with hydropower plants located on the Argeș River through the integration of a continuous vibration monitoring system. The study focuses on Hydropower Unit No. 1 of CHE Noapteș (7.7 MW), where experimental data were collected and analysed under various operating conditions. The results reveal a clear dependency between the vibration regime and the unit load, highlighting the presence of operational instabilities. These instabilities were primarily attributed to mechanical factors, such as shaft misalignment and uneven tightening of couplings, which significantly influence the dynamic behaviour of the system. From an economic perspective, the implementation cost of the proposed monitoring solution represents only 5.25% of a level 3 maintenance operation. However, the indirect benefits—such as the prevention of major failures and the reduction of downtime—can exceed the initial investment by a factor of 5 to 10. Consequently, the system demonstrates a cost recovery period of less than one year, supporting its viability as an efficient predictive maintenance tool for hydropower applications.**

Keywords—Supervisory Control And Data Acquisition, vibration monitoring, hydropower plants, renewable sources, Hydroelectric Units

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AN END-TO-END IOT-ENABLED CYBER-PHYSICAL SYSTEM FOR AUTOMATED PINEAPPLE QUALITY ASSESSMENT, GRADING, AND SORTING

Santhush Himal, Bhagya Mahanama, Hasara Maligaspe, Imaya Poojani and Uditha Dharmakeerthi

***Abstract*—Post-harvest quality assessment of pineapples is still highly dependent on manual inspection, which is slow, subjective, and difficult to scale for industrial sorting lines. This paper presents the Pineapple Status Prediction System (PSPS), an edgefirst IoT-enabled cyber-physical platform for automated pineapple forecasting, ripeness assessment, defect detection, grading, and sorting. The proposed system integrates four processing modules. First, a Cross-Attention Transformer predicts next-day harvest yield using a 10-day weather and production history. Second, a dualmodality ripeness classifier combines load-cell measurements with volatile organic compound sensing. Third, a fine-tuned YOLOv11n model detects visual defects from camera images. Finally, an MQTT-based IoT backbone coordinates sensor nodes, edge inference, dashboard monitoring, and mechatronic sorting. Experimental evaluation showed 1.68% MAPE for harvest forecasting, 93.3% ripeness classification accuracy on 120 physical fruits, and 0.952 mAP@0.5 for visual defect detection. The integrated system achieved 92.6% grading accuracy on 300 physical fruits, improving performance by 4.3% compared with visual-only grading. A 72-hour continuous validation also confirmed 99.97% QoS 1 MQTT delivery and 12 ms median message latency. These results show that the proposed PSPS can support low-cost, real-time, and locally deployable post-harvest automation for pineapple supply chains.**
Index Terms—IoT, MQTT, edge computing, pineapple quality grading, YOLOv11, Transformer, cross-attention, VOC sensing, FreeRTOS, cyber-physical systems, precision agriculture, sensor fusion

Keywords—pineapple, machine learning, image processing, IOT

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NEURAL PI-BASED DIRECT POWER CONTROL FOR DFIG WIND ENERGY CONVERSION SYSTEMS

Sohayla El Ouardi, Mourad Yessef, Mohamed Benslimane, Zakaria Chalh and Badr El Kari

***Abstract*—This study proposes an intelligent Neural PI–based DPC (NPI-DPC) strategy for DFIG wind energy systems. In this approach, the classical linear PI controllers are replaced by neural network regulators, that are integrated into the DPC-PWM control structure in order to adapt the PI gains Kp and Ki automatically during operation to improve the dynamic performance of the DFIG system under variable wind conditions. The neural controller adjusts the control gains in real time, which helps to reduce active power ripples, decrease electromagnetic torque oscillations, and limit the THD of the stator current. The performance of the proposed NPI-DPC strategy was evaluated using MATLAB/Simulink simulation and compared with the conventional PI-DPC control method. The results show that the neural-based controller provides better tracking of active and reactive power under step wind speed variations, and it maintains good decoupling between active and reactive power, even in the presence of nonlinear aerodynamic disturbances. Also it reduces active power ripples and electromagnetic torque oscillations compared with the classical PI-DPC.**

Keywords—Renewable energy, DFIG, DPC, WECS, NN, Control PI strategies

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COMPARATIVE ANALYSIS OF MODERN GAME ENGINES: UNITY AND UNREAL ENGINE

Ovidiu-Constantin Novac, Cornelia-Mihaela Novac, Cornelia Emilia Gordan, Sorina-Gabriela Susman, Catalin-Daniel Morar, Marius Codrean and Gyongyi Bujdoso

***Abstract*—This paper presents a comparative study of two of the most widely used game engines in modern game development: Unity and Unreal Engine. The research focuses on their evolution, software architecture, scripting systems, asset management solutions, and overall development workflow. Unity uses a component based GameObject architecture together with C# scripting, offering a flexible environment well suited for rapid prototyping, indie projects, and cross platform deployment, especially on mobile devices. Unreal Engine, on the other hand, relies on C++ and the Blueprint visual scripting system, providing a more structured framework optimized for high performance applications and advanced real time graphics. The paper also compares gameplay architecture, data driven design approaches, and performance related aspects of both engines. In addition, a practical case study involving the implementation of a third person character controller is presented in order to highlight differences in workflow, code structure, and built in engine functionality. The aim of this study is to provide developers with a clearer understanding of the strengths and limitations of each engine and to support the selection of the most appropriate solution depending on project requirements, team experience, and target platforms**

Keywords—game engine, Unity, Unreal Engine, cross-platform, architecture, performance

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WEATHER-AWARE AUGMENTATION FOR PARKING SLOT DETECTION USING VISION-LANGUAGE IMAGE EDITING

Bogdan Burtea, Camelia Florea, Radu Stefan Simea, Mihaela Gordan, Ciprian Iacobescu and Gabriel Oltean

***Abstract*—Vision-based parking slot occupancy detection is a key component of intelligent transportation systems, but its performance degrades under adverse weather conditions such as rain, fog, and snow. Public datasets such as PKLot and CNRPark-EXT contain limited variability in severe weather, making robust generalization difficult. This paper introduces a weather-aware data augmentation pipeline based on Qwen-Image-Edit, a diffusion-based vision-language image editing model. The method generates synthetic snow, fog, and rain variants from a subset of overcast images using natural-language instructions, while preserving parking geometry and slot-level annotations; however, careful prompt design is required to ensure structural consistency during image editing. A patch-level ResNet-50 classifier is retrained on the augmented dataset and evaluated in a cross-dataset setting from CNRPark-EXT to PKLot. Experimental results show improvements of up to 4.0 percentage points in accuracy and up to 10.6 percentage points in precision, with consistent gains across all weather subsets in F1-score and accuracy.**

Keywords—parking slot detection, weather-aware augmentation, adverse weather conditions, cross-dataset generalization, vision-language image editing, Qwen-Image-Edit

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AN OUTLINE OF VISION TRANSFORMER AND YOLO BASED WEAPON DETECTION TECHNIQUES

Simratjit Kaur Sandhu and Rekha Bhatia

***Abstract*—In the context of object detection, the YOLO algorithms have achieved the edge over their predecessors. Their detection abilities seem to get better with every new version being developed. While YOLO algorithms have been doing their magic in the field of object detection for quite some time now, a new contender has been making waves. Vision Transformers are appearing on the stage with potential for object detection. Transformer technology, initially designed for Natural Language Processing, has been demonstrated to have the ability to perform object detection as well. In this paper we have reviewed the vision transformer models which have been applied to the task of weapon detection over the last few years.We have included the latest YOLO models as well which exhibit the ability to be employed for the task of weapon detection.A brief analysis of the capabilities and challenges of both the technologies have been discussed as well.**

Keywords—Vision Transformers, weapon detection, Yolov11, Yolov12, Yolov10, Detr model, Swin Tranformer

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INTELLIGENT STRATEGIES FOR 3D UAV NAVIGATION IN COMPLEX ENVIRONMENTS

Hamza Tahiri, Ahmed Bencherqui, Mohamed Amine Tahiri and Mhamed Sayyouri

***Abstract*—This study compares several metaheuristic optimisation algorithms for planning 3D drone trajectories in mountainous environments, using cubic spline interpolation. The trajectory is parameterised by intermediate control points and optimised using a multi-criteria cost function that takes into account path length, safety distance from the terrain, altitude compliance and flight fluidity. A realistic, non-linear relief model was used to create a complex optimisation landscape. Six algorithms (POA, PSO, GGO, HHO, SMA and RUN) were evaluated under identical conditions, with a population of 50 agents and 500 iterations. The results show significant performance differences. The Slime Mould Algorithm (SMA) achieved the best results with a minimum cost of 275,822, ahead of PSO (351,546), HHO (489,276), POA (489,513), RUN (655,739) and GGO (793,585). Convergence analysis and 3D trajectory visualisation confirm that adaptive exploration-exploitation mechanisms significantly improve performance in constrained environments. Conclusion: advanced metaheuristics are particularly effective for continuous 3D spline trajectory planning in complex mountainous terrain.**

Keywords—Robotic path planning, Autonomous navigation, UAV navigation, optimization in robotics, complex environments

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A MACHINE LEARNING FRAMEWORK FOR MALICIOUS URL DETECTION WITH LABVIEW-BASED VISUALIZATION OF PHISHING ATTACKS

Sebastian-Alexandru Dragusin, Nicu Bizon and Rodica-Mihaela Teodorescu

***Abstract*—The rapid growth of phishing campaigns and malicious web services has transformed URLs (Uniform Resource Locators) into a primary attack vector in modern cyber threats. Traditional blacklist-based filtering and simple pattern-matching techniques are often unable to keep pace with the evolving landscape of URL obfuscation strategies. This paper proposes a machine learning framework for malicious URL detection, complemented by a LabVIEW-based virtual instrument that visualizes and simulates phishing attacks. A focused taxonomy of phishing URL manipulation techniques is developed, including sound squatting, combo squatting, homograph attacks, typo squatting, subdomain squatting and TLD (Top-Level Domain) squatting, and representative examples for each category are illustrated within the virtual instrument. This interactive environment allows users to explore how small lexical and structural changes in URLs can bypass naive security filters. On the detection side, lexical and statistical features are extracted, such as URL length, character entropy, special symbol density, subdomain depth and brand-similarity indicators and several supervised machine learning models are evaluated for binary classification of benign versus malicious URLs. Experimental results show that tree-based ensemble methods outperform linear baselines, achieving high detection rates with low false-positive rates. Finally, potential avenues are outlined for integrating the proposed framework into real-world security workflows and for using it as an educational tool to demonstrate both the mechanics and the risks of phishing attacks.**

Keywords—Malicious URL Detection, Phishing Attacks, Machine Learning, Virtual Instrumentation, Cyber-security

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PATTERNFORGE: A MULTI-AGENT GENERATIVE AI FRAMEWORK FOR CATALOG-DRIVEN ORCHESTRATION ACROSS ENTERPRISE CRM AND HYPERSCALER CLOUD PLATFORMS

Shikher Goel and Harish Apuri

Abstract*—Multi-agent generative AI deployments inside enterprises increasingly straddle two opinionated platform stacks at once: a Customer Relationship Management (CRM) system that owns the business object model (Salesforce, Microsoft Dynamics, HubSpot) and a hyperscaler cloud (Amazon Web Services [AWS], Microsoft Azure, Google Cloud Platform [GCP]) that owns the compute and model substrate. The orchestration patterns that make these deployments work, sequential pipelines, hierarchical supervisors, peer collaboratives, blackboards, and the rest, are reinvented by every team because no published catalog describes them at the level of granularity required for engineering reuse. We present PatternForge, a five-agent generative AI framework that turns a curated catalog of seven orchestration patterns into a deployable artifact. A Pattern Selection Agent (PSA) maps a structured task specification to a candidate pattern using a learned scorer over historical orchestrations; a Coordination Topology Agent (CTA) instantiates the chosen pattern as a typed message-bus topology; a Hyperscaler Adapter Agent (HAA) compiles the topology against AWS, Azure, or GCP primitives; a CRM Integration Agent (CIA) materialises the business object bindings against Salesforce or Dynamics; and a Pattern Evaluation Orchestrator (PEO) measures the realised orchestration against a multi-dimensional pattern-quality score Lambda. Evaluated on 37,400 orchestration tasks across three enterprise scenarios (lead triage, dispute resolution, renewal forecasting) over a 90-day controlled Continuous Integration / Continuous Deployment (CI/CD) pipeline, PatternForge achieves a pattern-selection F1 of 0.913, a Lambda score of 0.904 averaged across the seven patterns, a 68.4 percent reduction in median time-to-first-completed-task relative to a single-agent baseline, and a CRM-write integrity beta of 0.993 across 374,000 business-object writes. Single-agent ablation confirms each component contributes independently.

Keywords—Multi-Agent Generative AI, Orchestration Patterns, Enterprise CRM, Hyperscaler Cloud Platforms, Salesforce, Microsoft Dynamics, AWS Bedrock, Azure OpenAI, GCP Vertex, Agentic AI, Catalog-Driven Design, Reproducible Orchestration, Pattern Quality Score

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RF FINGERPRINT-BASED DRONE CONTROLLER CLASSIFICATION USING FEATURE ENGINEERING AND MACHINE LEARNING

Ibrahim Kaya, Begüm Beraye Atalay, Kübra Yiğit, Ibrahim Idris Ibrahim, Gürkan Aydemir, Salih Mehmed Bostan and Mehmet Baris Tabakcioglu

***Abstract*—The rapid growth of unmanned aerial vehicles (UAVs) has raised critical security concerns, especially in restricted and urban areas. Identifying drones through radio frequency (RF) signals has therefore become an important research focus. In this study, a feature-based classification approach is proposed to distinguish different drone controllers using their RF signal characteristics. The method extracts representative features from the meaningful portion of each signal. These features capture statistical, spectral, and envelope properties, enabling a compact and informative representation. The resulting dataset is evaluated using multiple supervised learning algorithms, including XGBoost, Support Vector Machines (SVM), and Artificial Neural Networks (ANN). To ensure reliable evaluation, a group-based data splitting strategy is applied to prevent data leakage. The experimental results show that the proposed approach performs well in classification tasks, with XGBoost achieving the strongest results.**

Keywords—RF fingerprinting, Drone classificatio, Machine learning, XGBoost, Signal processing.

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A REVIEW OF DIGITAL EDUCATIONAL PLATFORMS SECURITY: A QUANTUM AND ARTIFICIAL INTELLIGENCE-BASED APPROACH

Ziadoon W. Salman, Ali A. Yassin, Hamid Ali Abed Al-Asadi, Zaid Ameen Abduljabbar, Vincent Omollo Nyangaresi and Ali Hasan Ali

***Abstract*—The global growth in the use of digital educational platforms has exposed these platforms to various security risks. As such, there is heightened need for robust security and privacy solutions, especially in the face of quantum computing algorithms that can break some of the conventional cryptographic techniques. Unfortunately, even the modern networked systems rely heavily on these obsolete cryptographic operations for security protection. Across the world, educational infrastructures are increasingly dependent upon distributed cloud and fog technologies at local and global levels. As such, the cloud and fog computing paradigms handle sensitive academic records, identities, and intellectual property. However, the majority of the security measures deployed in these platforms have been shown to be susceptible to numerous security risks, including quantum-based attacks. This paper explores the design of quantum-secured networks, presenting crucial insights regarding forensics and security gaps that require immediate attention. The findings indicate that these network designs incorporate post-quantum cryptographic primitives, quantum-resistant authentication protocols, and decentralized trust models. As such, this paper recommends the use of quantum-secured educational networks, comprising of lattice-based post-quantum cryptography and hash-based post-quantum cryptography. Furthermore, recent approaches such as artificial intelligence-based behavioural authentication, adaptive role-based access control, and blockchain-based interoperable auditability must be deployed. In our work, we examine the network structure using the principle of classical and quantum adversarial threats. The major focus is on data protection provisions and traceability. Ultimately, this paper makes key contributions to formal security taxonomy, provides an integrated post-quantum architectural model, and identifies open challenges.**

Keywords—Post-quantum cryptography, AI authentication, adaptive RBAC, fog computing, blockchain security, educational systems

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OPTICAL FIBER FUNDAMENTALS FOR DISTRIBUTED SENSING: A REVIEW

Lavinia-Andrada Stuparu and Paul Șchiopu

***Abstract*—Optical fibers have evolved from light-guiding structures into versatile sensing media. The fundamental aspects of optical fibers are reviewed, including their structure, light propagation, and classification, together with key transmission characteristics such as attenuation, scattering, and dispersion. Attention is given to distributed optical fiber sensing, in which Rayleigh, Brillouin and Raman scattering mechanisms enable the measurement of physical parameters such as temperature, strain, and dynamic perturbations along the fiber. The paper further emphasizes the relationship between propagation phenomena and sensing performance, providing a structured perspective that evolves from optical fiber fundamentals to sensing technologies.**

Keywords—optical fiber, refractive index, distributed optical fiber sensor, Rayleigh scattering, Brillouin scattering, Raman scattering

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A MULTI-LAYERED SECURE ONLINE VOTING ARCHITECTURE WITH SIMULATED-AADHAAR AUTHENTICATION, BIOMETRIC LIVENESS DETECTION, AND CRYPTOGRAPHIC AUDIT CONTROL

Suvarna Thakur, Shivajirao Jadhav, Vinod Kadam, Kaustubh Jagtap, Elesh Rodge and Sanjog Magar

***Abstract*—Making sure only the right person votes has always been the biggest problem in any electoral system, and this issue gets even more difficult when voting is done online. Traditional e-voting systems have mainly relied on passwords, ID numbers, or one-time codes to manage this role- with these methods, although convenient, allowing impersonation and misuse of credentials. This article takes an alternative approach by putting the voter's face at the center of the authentication procedure. The system being proposed acquires its biometric data during voter registration, it takes a live facial photo and generates a unique facial embedding for each user at the time of signup. At the moment of voting, the system matches the voter's live face to three stored references- the registration photo, the facial embedding, and the profile face- before the voting position is given. A similarity cut-off point is used to make this decision, and any try which is less than the set value is totally rejected. Besides, the platform guarantees the vote's authenticity by labeling each voter as "voted" immediately after the acceptance of the vote, so that making repeat attempts is not even a possibility even if the subsequent authentications score quite well.Tests with 200 registered voters across five scenarios showed the system averaged 94.5% facial authentication accuracy. It blocked all duplicate votes and kept face detection working consistently. Does real-time biometric verification really outperform current credential methods? The data supports it. Voters get stronger protection when identity is verified by live facial features instead of passwords or IDs.**

Keywords—Secure Online Voting, Simulated-Aadhaar Verification, Facial Biometrics, Liveness Detection, AES Encryption, Blockchain Audit, SQL Injection Defense

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HATE SPEECH DETECTION IN HINDI USING NEURAL NETWORKS

Afreen Sorathiya, Jinal Mehta, Jay Vithlani, Maria Sorathiya, Twisha Mehta, Harikrishna Suresh, Manha Sorathiya and Mohamed Ayaan Gubitra

***Abstract*—The rise of social media platforms has facilitated rapid communication but also led to the widespread dissemination of hate speech, particularly in low-resource languages such as Hindi. This study presents a deep learning-based approach for detecting hate speech in Hindi using a Bidirectional Long Short-Term Memory (BiLSTM) architecture. A dataset of 15,000 annotated posts—sourced from Twitter, newspapers, and televised news—was curated, capturing both formal and informal language, including code-mixed Hindi-English content. To enhance robustness and generalization, the dataset was combined and split into three randomized train-test configurations (10k-5k), with the model trained and evaluated independently on each. Preprocessing steps included tokenization, padding, and label encoding, with text sequences passed through an embedding layer followed by stacked BiLSTM and dense layers. The model achieved consistent accuracy across all splits (72.67%–74.10%), demonstrating its stability under varied data distributions. The findings underscore the linguistic challenges of hate speech detection in Hindi and propose a multi-split evaluation framework as a reliable alternative to single-split benchmarks. This work contributes to the growing body of research on inclusive and context-aware content moderation systems for underrepresented languages, and lays the groundwork for future advancements involving transformer-based models and multi-label classification.**

Keywords—hate speech detection, sequence modelling, bidirectional lstm, natural language processing, low-resource languages

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HIERARCHICAL HYPERGRAPH NEURAL NETWORKS FOR MULTI-TYPE DRUG-DRUG INTERACTION PREDICTION

Hussein Mahdi Al-Rubaie and Sura Al-Rashid

***Abstract*—Abstract— Polypharmacy substantially increases the risk of drug-drug interactions (DDIs), which threaten patient safety and clinical outcomes. Graph neural networks have emerged as powerful tools for DDI prediction; however, most current approaches treat binary classification and multi-class interaction type prediction as separate tasks, reducing their practical clinical value. These models also demand significant computational resources and large training datasets, creating obstacles for both development and real-world deployment. We propose a unified hierarchical hypergraph neural network that jointly predicts DDI occurrence and interaction types through two stages. HGNN-Chemical (hypergraph neural network Chemical) learns drug embeddings from SMILES substructures, achieving 98.46% ROC-AUC and 93.2% accuracy for binary prediction. HGNN-Interaction type (hypergraph neural network Interaction type) leverages these embeddings to predict 86 interaction types, achieving 85.73% Top-1 and 98.12% Top-3 accuracy. Systematic ablation studies confirm that hierarchical structure and attention flow direction significantly improve performance. Our model outperforms multiple baselines using only SMILES input, enabling predictions for novel compounds without feature engineering. Trained on DrugBank with 1,709 drugs and 191.877 interactions with CPU-only processing.**

Keywords—Deep Learning, Drug-Drug Interaction Prediction, Hypergraph Neural Network, Graph Neural Network, Bioinformatics, Knowledge Transfer

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LoRa Mesh for Large-Scale Networks: A Systematic Review of Routing, Energy, Coverage Distance, and Open Research Challenges

Maryam Ayad Kadhem and Hilal Al-Libawy

***Abstract*—The existing LoRaWAN networks face problems because they can only operate in short distances, and they use one single transmission path which prevents their use in areas with remote locations or physical obstacles. This paper offers a complete assessment of how LoRaWAN technology developed from its initial single-hop system to its current multi-hop and mesh network structure. The study evaluates the routing performance and energy usage, modulation settings, and network expansion capabilities of LoRaWAN and LoRa Mesh systems. The study looks at how Spreading Factor (SF) and Chirp Spread Spectrum (CSS) modulation settings impact the distance transmission and data transmission capacity of LoRa devices. The review examines recent research on LoRa mesh networks that were published between 2022 and 2026, focusing specifically on the comparative findings that other studies reported. The surveyed systems utilize multi-hop communication as their primary method to increase coverage across different areas which includes 3 to 10 hops and beyond 10 hops. The reviewed studies demonstrate that adaptive spreading factor selection, commonly between SF7 and SF12, plays a key role in balancing transmission range and energy consumption. The majority of research studies utilize either energy-aware routing or lightweight routing systems, which enable them to communicate over distances of a few kilometers up to more than ten kilometers while using minimal power. Through a detailed review of existing routing protocols including reactive, proactive, and hybrid approaches. From the analysis of previous studies, we conclude that the spreading factor is directly proportional to the communication distance; specifically, the transmission range extends with each increasing spreading factor, while the higher spreading factor values enhance the ability to detect signals in very noisy conditions.**

Keywords—CSS modulation, energy efficiency, IoT, LoRaWAN, LoRa mesh, LPWAN, multi-hop routing, wireless networks

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SCALABLE PALMPRINT AUTHENTICATION USING DEEP FEATURES AND ONE-CLASS PCA

Mame Sandeck Niang and Yacine Yaddaden

***Abstract*—Palmprint-based biometric authentication has attracted increasing attention due to the rich discriminative patterns contained in palm texture and line structures. However, most existing deep learning approaches rely on multi-class classification strategies that require full system retraining whenever new users are enrolled, limiting scalability in real-world deployments. This paper proposes a scalable palmprint authentication framework combining deep feature extraction with user-specific one-class modeling. Deep representations are extracted using a pre-trained ConvNeXt network, followed by a two-stage dimensionality reduction process based on global Principal Component Analysis (PCA) and user-specific One-Class PCA (OC-PCA). Unlike conventional multi-class approaches, the proposed method relies exclusively on genuine samples during training, enabling independent user enrollment without retraining the entire system. The proposed framework is evaluated on the publicly available CASIA-Palmprint-V1 and IITD-Palmprint-V1 benchmark datasets using a five-fold cross-validation protocol. Experimental results demonstrate competitive authentication performance, achieving Correct Recognition Rates (CRR) of 95.13\% and 91.11\%, respectively. The obtained results confirm that combining deep feature representations with one-class modeling provides an effective and scalable solution for biometric authentication systems.**

Keywords—Palmprint authentication, scalable biometric systems, deep learning, one-class learning, ConvNeXt, principal component analysis

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SUNOSIGN: A SPEECH AND GESTURE-BASED INDIAN SIGN LANGUAGE TRANSLATOR

Devesh Jain, Prajwal Gaikwad, Prachi Palve and Sakshi Suryavanshi

***Abstract*—Effective communication between hearing individuals and those who are deaf or hard of hearing (DHH) remains a significant challenge in education, healthcare, and public services. This paper presents SunoSign, a full-stack bidirectional assistive communication system for Indian Sign Language (ISL). The system operates through two pipelines: (1) speech or text input in five Indian languages is translated into animated ISL gesture sequences, and (2) real-time webcam-based hand gestures are recognized and converted to text using a trained deep learning model. The browser-based frontend is implemented using HTML, CSS, JavaScript, the Web Speech API, MediaPipe Hands, and the Canvas API. The backend is a Python FastAPI server hosting a TensorFlow/Keras feedforward neural network for sign recognition and a scikit-learn TF-IDF intent classifier. A multilingual pipeline using deep-translator supports English, Hindi, Marathi, Tamil, and Gujarati. The recognition model processes 63-dimensional MediaPipe landmark vectors (21 landmarks × 3 coordinates) and classifies 36 ISL characters (A–Z and 0–9) with an inference latency below 50 ms on a standard CPU. The model was trained using the Adam optimizer (learning rate = 0.001), categorical cross-entropy loss, a batch size of 32, and 50 epochs over an 80/20 train-validation split, achieving 92.8% validation accuracy. An intent-aware chatbot provides contextual responses, further enriching user interaction. SunoSign is designed as a deployable, end-to-end assistive platform to support ISL accessibility across education, medical, and government services.**

Keywords—Indian Sign Language, Gesture Recognition, Assistive Communication, Bidirectional Communication, Deep Learning, MediaPipe, Speech Recognition, TensorFlow

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WAREHOUSE SAFETY AND SECURITY MONITORING WITH COMPUTER VISION

Dinura Vimukthi, Poorni Thilakarathna, Devin Silva, Kavindu Galgamuwa, Lakmini Abeywardhana and Amila Nuwan Alexander

***Abstract*—Modern warehouse environments demand intelligent monitoring systems that ensure both operational safety and security. However, existing surveillance solutions remain largely reactive, relying on manual observation or isolated detection mechanisms that fail to address complex real-world challenges such as occluding theft behaviors, unsafe item placement, and varying lighting conditions. This research proposes an integrated vision-based framework that unifies warehouse safety monitoring and theft detection using advanced computer vision and deep learning techniques. The system combines object detection, human pose identification, human activity recognition (HAR), and multi-camera dynamic person re-identification in occlusion scenarios for theft detection and geometry-aware risk analysis and automated shelf edge detection to detect hazardous shelf conditions in real time. Theft-related activities such as loitering and abnormal human–item interactions are identified using activity sequences, while safety risks such as overhanging or fallen items are detected through segmentation-based object recognition and spatial boundary analysis. To enhance robustness, the framework incorporates multiple cameras for handling occluded situations and temporal stabilization techniques to reduce detection instability and false alerts. By integrating behavioral analysis with environmental risk assessment, the proposed system transforms traditional passive surveillance into a proactive monitoring solution. The framework aims to improve warehouse safety, reduce product damage, and enable early detection of theft through accurate, real-time alerts. This research contributes a scalable, multi-modal approach that addresses key limitations in existing systems, including lack of context awareness, poor occlusion handling, and absence of unified safety-security monitoring.**

Keywords—Warehouse monitoring, Theft detection, Safety monitoring, Human activity recognition, Computer vision, Person re-identification, YOLO, Deep learning

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A STUDY ON AI READINESS AND BIAS RISK IN AI BASED RECRUITMENT EVIDENCE FROM SELECTED IT COMPANIES

Pravallika Reddy M, Thota Akhila, Thaya Madhavi, Tummala Sarita and Sheik Firoz Khan

***Abstract*—This Artificial Intelligence (AI) is increasingly used in recruitment processes by IT companies to enhance efficiency, reduce time-to-hire, and support decision-making. However, the use of AI-based recruitment systems also raises concerns related to organizational readiness and the risk of algorithmic bias, which may lead to unfair or discriminatory hiring outcomes the purpose of this study is to examine the level of AI readiness and assess bias risk in AI-based recruitment practices in selected IT companies in Bangalore. This study aims to examine the relationship between artificial intelligence (AI) readiness and perceived bias risk in AI-based recruitment, with a particular focus on the role of human factors in influencing organizational readiness within the Information Technology (IT) sector. A mixed-methods approach was adopted, combining quantitative survey data and statistical analysis. Primary data was collected through a structured questionnaire administered to HR professionals, recruiters, and technical staff involved in AI-supported recruitment. Statistical tools such as descriptive analysis, reliability testing, correlation, and regression were used for data analysis. The findings indicate human factors, including employee skills, training, and technological competence, have a significant positive impact on AI readiness. Furthermore, findings suggest that AI-based recruitment systems are perceived to introduce bias in candidate selection processes. The study also highlights that higher levels of AI readiness can contribute to mitigating bias risks, emphasizing the importance of organizational preparedness in ensuring ethical AI implementation. While IT companies exhibit moderate to high AI readiness, gaps exist in governance frameworks and systematic bias mitigation practices. A significant relationship was observed between AI readiness and effective bias risk management. The study highlights the need for stronger ethical guidelines, governance mechanisms, and continuous bias audits to ensure fair and responsible AI-based recruitment.**

Keywords—AI Readiness, AI-Based Recruitment, Bias Risk, Human factor, IT Companies

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COMPARATIVE EVALUATION OF IMBALANCE HANDLING METHODS FOR OUTLIER DETECTION

Fatima Zohra El Hlouli, Jamal Riffi and Hamid Tairi

***Abstract*—Outlier detection in highly imbalanced datasets remains a critical challenge in machine learning, particularly in applications such as fraud detection, anomaly monitoring, and cybersecurity. Traditional approaches often suffer from performance degradation due to skewed class distributions, noise, and high-dimensional feature spaces. In this paper, we propose a hybrid outlier detection framework that integrates Isolation Forest with a multi-stage data enhancement pipeline combining statistical resampling, dimensionality reduction, and generative modeling. Specifically, the proposed approach leverages SMOTE and SMOTE-ENN to address class imbalance and noise, Principal Component Analysis (PCA) for feature space transformation, and Generative Adversarial Networks (GAN) for realistic synthetic data generation. Furthermore, a data refinement module, referred to as TriEnhance, is introduced to improve feature quality and reduce noise effects. Experiments conducted on multiple benchmark datasets demonstrate that the proposed framework consistently outperforms classical and state-of-the-art methods, achieving superior performance in terms of Recall, F1-score, and PR-AUC. The results highlight the effectiveness of combining complementary data enhancement strategies for robust anomaly detection.**

Keywords—Outlier Detection, Imbalanced Data, Isolation Forest, Data Augmentation, Anomaly Detection

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AN INTELLIGENT MODULAR SYSTEM FOR UNANNOUNCED METROLOGICAL VERIFICATION OF TIME AND DISTANCE PARAMETERS IN ROAD TRANSPORT, WITH ROBOTIC ASSISTANCE AND IOT FUNCTIONALITIES

Catalin Buse and Simona Stoica

***Abstract*—This paper presents an intelligent modular system for the unannounced metrological verification of taximeters under real vehicle operating conditions. The system verifies time and distance indications by combining a mobile roller-based mechanical module, data acquisition and processing software, robotic visual assistance and IoT communication. The correspondence between the indication displayed by the taximeter and the value calculated by the verification system is established by taking into account the vehicle characteristics, the actual profile of the drive wheel and the correction coefficient associated with the support conditions on the rollers. Verification data are processed locally in order to issue a verification bulletin and are then transmitted securely to a dedicated server, where georeferenced information can populate public maps of the areas in which taximeter checks were performed. Field testing on 48 vehicles demonstrated the feasibility of the approach, with two vehicles being referred for laboratory metrological verification.**

Keywords—modular system, metrological verification, taximeter, robotic assistance, IoT

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ROBUSTNESS AND EFFICIENCY ASSESSMENT OF PI, GA-OPTIMIZED PI, AND SMC FOR WIND TURBINE POWER MAXIMIZATION

Talibi Said, Chahbi Aziz, Maaider Kamal and Ameziane Hatim

***Abstract*—This paper provides a detailed comparative study of conventional Proportional-Integral (PI), Genetic Algorithm (GA) tuned PI, and Sliding Mode Control (SMC) controllers for Maximum Power Point Tracker (MPPT). In our previous work, we established that the GA tuned PI controller demonstrated a 38% greater power tracking efficiency and an 80% faster response time compared to conventional PI controllers. For this current work, we have studied and compared these findings with the SMC controller to enhance Maximum Power Point Tracking (MPPT) performance in wind system applications. The SMC controller exhibits superior robustness with 45% better power tracking efficiency and 85% faster response time under varying wind conditions compared to conventional PI. Yet, when compared to our previously developed GA-tuned PI controller, SMC demonstrated competitive performance but was still surpassed by the GA-tuned approach in terms of overall efficiency and higher computational requirements. This comparative study concludes that although both advanced control algorithms significantly improve wind turbine control performance, the GA-tuned PI controller is still the optimal choice for wind energy systems, considering the balance between performance, robustness, and implementation complexity.**

Keywords—Wind Turbine, Genetic Algorithm, Sliding Mode Control, MPPT, robust control

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INTELLIGENT IOT ENVIRONMENTAL MONITORING WITH EDGE-BASED DYNAMIC LINEAR REGRESSION ALGORITHM

Trung-Dung Le and Pham Duc Dai

***Abstract*—Internet of Things (IoT) sensors continuously generate large volumes of data that must be transmitted to data centers. The resulting high bandwidth demand calls for methods to reduce the number of data points while preserving data quality. In this context, the DREAM (Dynamic Regression Algorithm) has shown that the original data points can be represented by a smaller number of samples while maintaining acceptable accuracy. This paper presents an application of DREAM in an intelligent IoT data collection system. IoT devices fit linear regression models over recent measurements and continuously evaluate the coefficient of determination to decide when data should be transmitted. At the beginning of each segment, two data points are sent to establish the trend of the data. When the coefficient of determination remains above a predefined threshold, no additional data are transmitted; when the coefficient of determination falls below the threshold, the previous data point is sent to mark the end of the current segment. The missing values are then reconstructed at the backend by linear interpolation between consecutive transmitted points. A system of two nodes (indoor and outdoor) collecting temperature and humidity data using different sampling periods is used to compare the proposed approach and the baseline method in sending all data in terms of data sending reduction. The results show that DREAM can reduce the number of transmitted data points while maintaining acceptable accuracy.**

Keywords—Dynamic Regression, Edge computing, Linear regression, Time-series data

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AUTOMATED BILINGUAL HANDWRITING EVALUATION FOR EARLY CHILDHOOD EDUCATION: A MULTI-METRIC STRUCTURAL ANALYSIS

Thiyara Gunawardena, Eshanie Rathnasinghe, Chathuni Abesinghe, Binuki Mihara, Lakmini Abeywardhana, Lokesha Weerasinghe and Naren Selvaratnam

***Abstract*—Traditional handwriting assessment in early childhood education relies on subjective teacher evaluation and becomes particularly challenging in bilingual Sri Lankan curricula involving both English and Sinhala. This paper introduces a multi-metric handwriting quality scoring pipeline for automated evaluation of preschool handwritten letters for children aged 4–6. The proposed system integrates contour-based segmentation, language-specific convolutional neural network (CNN)-based recognition (achieving 86.73% test accuracy on EMNIST for English and 99.04% on a custom Sinhala dataset), and an eight-metric structural analysis framework. The framework combines structural similarity (SSIM), topology preservation, shape invariants, proportion analysis, stroke continuity, alignment, pixel Intersection over Union (IoU), and a 9 × 9 grid-based spatial comparison. The weighted scoring approach shows strong agreement with teacher assessments, demonstrating the reliability of the proposed system. Designed for Sri Lankan early education contexts, the approach provides a scalable, interpretable, and objective solution, addressing the gap in automated Sinhala handwriting assessment tools.**

Keywords—Handwriting Evaluation, Computer Vision, Convolutional Neural Networks, Early Childhood Education, Sinhala Handwriting, Multi-metric Scoring

MULTI-SENSOR VEHICLE SAFETY AND MONITORING SYSTEM

Dr. N. Sudhakar Reddy, Shaik Karishma, Makam Guru Yogeswar, Karthika V Venkata and Balamanikandan A

***Abstract*—One serious issue with road safety is accidents caused by intoxicated drivers and sleepy drivers. An intelligent car safety system that uses the ESP32 microcontroller to keep tabs on the driver and their environment in real-time is showcased in this project. When the system detects blood alcohol concentrations (BACs) that are higher than a certain point, it will disable the ignition system. A sensor that detects when a driver is getting sleepy triggers a warning system that includes a buzzer . To warn of potential danger, an ultrasonic sensor scans the area for adjacent obstructions. The Gyroscope sensor continuously monitors the movement of vehicle and cut off the vehicle ignition when accident occurs. The ESP32 is responsible for handling sensor data and facilitating wireless connectivity for alerts sent to mobile devices. The suggested solution is affordable, dependable, and extensible for sophisticated Internet of Things (IoT)-based car safety applications.**

Keywords—ESP32, Eye Blink Sensor, Ultrasonic Sensor, gyroscope sensor, alcohol sensor, Driver Monitoring, IoT, Road Safety

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OPTIMIZATION OF AUTOMATIC CONTROL FOR BIOLOGICAL PROCESSES IN WASTEWATER TREATMENT PLANTS

Popescu Gheorghe and Nicu Bizon

***Abstract*—Wastewater treatment plants have the role of ensuring environmental protection and public health by eliminating or reducing pollutants from wastewater. Modeling parameters, such as dissolved oxygen (DO), nitrogen (in various forms, such as ammonia, nitrite, and nitrates), play an important role in optimizing the performance of wastewater treatment plants (WWTPs). This paper presents certain optimization strategies through modeling for oxygen and nitrogen compounds, with a focus on predictive modeling and process control. The method for optimizing automatic control in biological wastewater treatment processes uses: identification of the main parameters subject to automatic control; presentation of the way these methods are implemented in the General Process Simulator – Extended (GPS-X) simulation environment; comparison of the performance obtained through different control methods; formulation of recommendations regarding the optimization and extension of the application of automatic control in real operation. The methodology used in this paper presents the study of dynamic models used in the Activated Sludge Model (ASM1) simulations, the creation of automatic control scenarios in the GPS-X environment and the comparative interpretation of the results.**

Keywords—wastewater treatment, modeling, dissolved oxygen, nitrogen compounds, ASM1, process optimization, predictive modeling

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A LIGHTWEIGHT SIGNAL-PROCESSING FRONT-END FOR ACOUSTIC FOREST FIRE DETECTION

Robert-Nicolae Bostinaru, Nicu Bizon, Gabriel-Vasile Iana, Sebastian-Alexandru Dragusin and Denisa Toma

***Abstract*—This paper formulates a lightweight signal-processing front-end for acoustic forest fire detection as a reusable methodological layer within a broader audio-analysis pipeline. The study consolidates evidence from eight thematic literature sets covering feature fusion, autocorrelation, handcrafted and interpretable descriptors, Hilbert-envelope analysis, low-complexity audio descriptors, spectral representations, and time-frequency modeling, and relates this corpus to three prior fire/non-fire studies developed by the present research group. The main contributions are a structured synthesis of the relevant descriptor literature, a lightweight and classifier-agnostic front-end design, and a compact mathematical formulation suitable for downstream integration with PCA-based models, conventional machine-learning classifiers, CNNs, RNNs, Audio Spectrogram Transformers, and hybrid CNN–Transformer architectures. The resulting manuscript provides the theoretical and methodological foundation required to position the proposed front-end as a reusable component for acoustic fire monitoring.**

Keywords—acoustic forest fire detection, environmental sound classification, handcrafted audio features, Hilbert envelope, autocorrelation, low-complexity descriptors, time-frequency representation, feature fusion, signal processing

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CONVEXITY MODULUS IN INCREMENTAL NEURAL NETWORK APPROXIMATION

Zahraa Haidar Sharba and Hawraa Almurieb

***Abstract*—Incremental Neural Networks (INNs) serve as fundamental instruments for attaining highly accurate approximation outcomes. Specifically, convexity constitutes a crucial property in the context of approximating neural networks within incremental frameworks. This characteristic facilitates the derivation of precise approximations of the target function. Moreover, convexity is applicable to both constrained (i.e., convex) and unconstrained approximation scenarios. Furthermore, leveraging convexity in both network architectures and approximation processes enables the determination of optimal function approximations through incremental neural networks. In the present study, we perform an approximation of neural networks by driving the difference sequence between the target function and the Modulus of Convexity in Incremental Neural Networks (MCINNs) toward zero. Consequently, we also derive the degree of approximation via neural network approximation, yielding a rate of O(1/n^(p+1)). These theoretical findings are corroborated by experimental results obtained using MATLAB, wherein an algorithm initialized with the neural network was implemented. Additionally, the algorithm demonstrates, for several test functions, an improved approximation quality compared to the standalone neural network. The convex incremental iteration algorithm progressively approximates the objective function by means of a neural network, relying on a sequence of functions to achieve enhanced approximation performance. The residual error was compared against the Mean Squared Error (MSE), resulting in a lower residual error value.**

Keywords—approximation, incremental neural networks, modulus of convexity, Banach spaces

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AL AND ML ENABLED VIDEO ANALYSIS AND INTERPRETATION

Ankit Raj Kumar, Ayush Kumar, Hritik Gupta, Ashmit Kumar, Shivam Kumar Saini and Abhishek Kumar Anshu

***Abstract*—AI/ML enabled video analysis and interpretation are innovative technologies capable of providing meaningful insights about large amounts of video data. As video data is increasingly generated in fields like security, health care, entertainment, and robotics, there is an increasing need for intelligent solutions that would facilitate efficient processing and interpretation of video streams. The present study is concerned with the development of AI/ML based approaches to analyze video data, detecting objects, interpreting activities, and analyzing complex scenes. Specifically, the proposed solution leverages the use of deep learning algorithms, including convolutional neural networks and recurrent neural networks, to interpret spatial and temporal data embedded in videos. Moreover, the proposed system is able to track objects, analyze actions, and understand complex scenes using advanced AI/ML techniques. Finally, the developed approach is evaluated in terms of accuracy, precision, recall, and processing speed. The fast development of digital videos has posed many difficulties in storage, processing, and analysis. The analysis of videos using conventional techniques is done manually, which is a laborious process and can be inaccurate due to human errors. Considering the need for automation, the use of AI and ML has become crucial for the effective analysis of videos.**

Keywords—Video Analysis, Machine Learning, Artificial Intelligence, Computer Vision, Deep Learning, Object Detection, Action Recognition, Video Processing, Real-Time Analytics, Intelligent Systems.

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THE PATH TO ELECTRONIC VOTING, A BOLD STRATEGY TO IMPLEMENT ELECTRONIC BALLOT-BOX SCANNERS

Cătălin Adrian Iordache, Constantin Viorel Marian and Adrian Țuțuianu

***Abstract*—While the idea of electronic voting is not a new one, most implementations are far from ideal, rushing means legislative, procedural and technical issues that come with risks spanning from low trust in elections to even cancelled elections. The solution, validated during last national elections as a scope-limited pilot program, allows for a more gradual approach to electronic voting with the introduction of electronic smart ballot boxes, a hybrid system architecture that preserves the paper ballot as the legally authoritative artefact, yet enables near real-time aggregation with strong auditability. and serves as an early warning system for anomalies. As the current legal voting system still relies on paper ballots, so does our solution. The design separates voter identification from vote interpretation and counting and enforces data minimisation by avoiding long-term storage of individual vote results. This is done by maintaining integrity, traceability, and resistance to manipulation while mitigating ballot-secrecy leakage. This approach attempts to satisfy mandatory conditions, such as maintaining vote secrecy required by both national regulations in the case of countries such as Romania and similar EU electoral mandates. While the use of such a system proposes many challenges, a successful implementation can bring significant improvements to electoral systems around the world and serve to remove barriers in the public perception of electronic voting as a less safe or private form of voting.**

Keywords—e-ballot box, ballot scanning, tamper-evident audit log, zero trust architecture, election integrity, hybrid electoral system

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A ROBUST SYSTEM FOR DETECTING AND RECOGNIZING IRAQI LICENSE PLATES USING DEEP LEARNING AND OCR TECHNIQUES

Ali Abd Ali, Hameed Farhan and Muayad Kod

***Abstract*—The identification of vehicle information has increased significantly over the past few years to help detect stolen vehicles and traffic violations. One important application of computer vision technology is vehicle License Plate (LP) detection and recognition. Currently, Iraq uses two types of plates: the first contains numbers, letters, and Arabic words, while the second is in English, a future system to be used throughout Iraq. The proposed system uses deep learning to detect vehicle LPs, employing the You Only Look Once version 8 (YOLOv8) algorithm and the PaddleOCR algorithm to recognize LP types. Initially, the image containing the LP is segmented using a predefined grid, and the LP is then localized using a bounding box. After that, the determined LP is extracted to determine its type and identify the text it contains. The system achieves a 98% recognition rate using the well-known Open Images dataset for the vehicle category. On the other hand, the accuracies of detecting Iraqi LPs of the first and second forms are 97.5% and 100%, respectively. Besides, the accuracies of identifying the two types of Iraqi LPs are 96.58% and 98.75%, respectively. Compared to related work, the proposed system performs better in LP detection and recognition.**

Keywords—Deep Learning, You Only Look Once (YOLO), License Plate Recognition, Convolutional Recurrent Neural Network (CRNN) Optical, Character Recognition (OCR)

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HYDROLINK: IOT-BASED AUTOMATIC WATER REFILLING SYSTEM FOR RATIONED WATER SUPPLY

Fred Anthony Yu and Jaydee Ballaho

***Abstract*—Water rationing has a significant effect on the lives of residents in Zamboanga City, as irregular supply times cause missed collection times, overflows, and constant human observation. To address these issues, this study was created to develop an innovative IoT-based automatic water refilling system, which is HydroLink. This is a smart device meant to optimize water management by utilizing automation and remote observation. The proposed system utilizes an ESP32-S3 microcontroller, which includes an HC-SR04 ultrasonic sensor to measure water levels precisely and a YF-S403 water flow sensor to control a solenoid valve. A critical calibration offset of 7.5 cm was used to overcome the dead zone, allowing for a high accuracy of 97-100% to be achieved. Additionally, a web interface, combined with the OLED display, has enabled the user to access analytics, refill history, and system status through a Firebase database. Through the research design, the HydroLink was tested under a range of pressure conditions, validating the prompt response time of the system, at 1-4 seconds, well within the 5-second window for efficient rationing. This study has proven that the HydroLink is a highly reliable system, accurate to 99.8%, allowing for the efficient elimination of the need for human intervention, preventing overflow, and providing a reliable volumetric water metering solution for the complexities of water rationing in urban areas, utilizing the IoT framework.**

Keywords—ESP32 S3, Ultrasonic Sensor, Water Rationing, Automatic Water Refilling

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UNITY-BASED VISUALIZATION AND ANALYSIS OF ERROR PROPAGATION IN MULTI-SENSOR IMAGING SYSTEMS

Aykut Durgut and Mahmut Emin Celik

***Abstract*—Multi-sensor imaging systems are widely used in defense, robotics, autonomous systems, and advanced perception applications. In such systems, maintaining accurate geometric alignment between sensors is critical for ensuring reliable system performance. However, mechanical tolerances, assembly imperfections, and environmental effects may introduce angular misalignments between sensors, leading to increasing Line-of-Sight (LOS) deviations and error propagation at the system level. Although existing studies mainly focus on calibration parameter estimation and alignment optimization, limited work has been conducted on intuitive and real-time visualization of angular alignment error propagation under varying scene conditions. In this study, a Unity-based interactive simulation framework is proposed for analyzing and visualizing angular alignment error propagation in multi-sensor imaging systems. The proposed environment models a master-slave camera configuration mounted on a shared mechanical structure, where angular offsets can be dynamically adjusted while the target scene distance is varied. Real-time LOS separation and propagated error metrics are calculated and visualized simultaneously, allowing observation of how small angular deviations evolve into significant scene-level divergences at long distances. Experimental analyses demonstrate that small angular offsets produce critical LOS separations as scene distance increases, with the propagation rate scaling significantly with the applied offset magnitude. The proposed framework also provides a preliminary decision-support mechanism for evaluating whether observed deviations can be corrected electronically through boresight compensation or require mechanical realignment. The presented approach offers an intuitive visualization-based analysis environment for understanding system-level error propagation in multi-sensor systems and provides a scalable foundation for future real-time augmented reality-assisted calibration and diagnostic applications.**

Keywords—multi-sensor systems, LOS deviation, error propagation, boresight analysis, Unity simulation

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CYBERSECURITY IN EMBEDDED SYSTEMS: A PLATFORM-CENTRIC REVIEW FROM MICROCONTROLLERS TO EDGE AI DEVICES

Sebastian-Alexandru Dragusin, Nicu Bizon, Denisa Toma and Robert-Nicolae Bostinaru

***Abstract*—Embedded systems are increasingly integral to cyber-physical infrastructures, ranging from resource-constrained microcontrollers in IoT (Internet of Things) nodes to high-performance edge AI (Artificial Intelligence) platforms supporting perception and autonomous decision-making. This review provides a platform-centric perspective on cybersecurity in embedded systems, emphasizing how architectural and operating constraints influence attack surfaces and feasible defenses. Key characteristics such as real-time requirements, limited compute/memory/energy resources, heterogeneous peripherals, and long deployment lifecycles are linked to prevalent threat vectors, including firmware tampering, insecure boot chains, communication-layer attacks, physical access threats, and supply-chain exposure. Security capabilities are then contrasted across representative platform classes, distinguishing microcontroller-based systems from embedded Linux single-board computers and edge AI devices, with attention to the availability and maturity of primitives such as secure boot, memory protection, cryptographic acceleration, secure key storage, integrity verification, and secure update mechanisms. Current trends and open challenges are summarized, including secure OTA (Over-the-Air) for constrained devices, hardware-assisted isolation, robustness of edge AI workloads under adversarial conditions, and the need for reproducible security benchmarking. The proposed taxonomy and discussion support platform selection and security mechanism prioritization under explicit threat models and system requirements.**

Keywords—embedded systems, cyber-security, IoT, firmware integrity, secure update, edge AI, platform comparison

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ENHANCING SECURITY IN AUTOMOTIVE MOBILE AD-HOC NETWORKS: MITIGATING DDOS ATTACKS THROUGH INTEGRATED SIEM, NDR, AND SOAR SOLUTIONS

Cristian Ștefan Ene and Marius Minea

***Abstract*—The increasing connectivity of automotive systems through Vehicle-to-Everything (V2X) communication and Mobile Ad Hoc Networks (MANETs) has created new vulnerabilities to Distributed Denial of Service (DDoS) attacks, threatening the availability of safety-critical vehicle communications and infrastructure services. This re-search addresses the challenge of protecting MANET-based automotive infrastructure by developing an integrated security architecture combining Network Detection and Response (NDR), Security Information and Event Management (SIEM), and Security Orchestration, Automation, and Response (SOAR) capabilities. Risk analysis was conducted using the NIST Cybersecurity Framework 2.0, mapping security controls across its six core functions. A laboratory proof of concept validated the architecture using CYBERQUEST (SIEM) and NETALERT (NDR) platforms to detect and automatically mitigate a simulated volumetric DDoS attack against a static network node. The integrated detection chain successfully identified abnormal connection volumes, correlated alerts across multiple sources, and executed automated blacklisting responses without human intervention. The results demonstrate that commercially available security platforms can be effectively adapted for MANET environments when properly integrated, providing rapid automated response capabilities aligned with European regulatory requirements including the NIS2 Directive and UNECE Regulation No. 155.**

Keywords—DDoS attacks, SIEM, NDR, SOAR, NIST Cybersecurity Framework

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PSEUDO-COINCIDENCES OF INDEPENDENT RANDOM SYSTEMS AND APPLICATIONS IN AUDIO SECURITY

Mike Teodorescu and Horia-Nicolai Teodorescu

***Abstract*—Currently, AI tools are used to learn the properties of noise generators. This is useful in some applications, such as audio noise generators (NG), but may hamper the use of NGs in jamming and cryptography. We investigate the statistic properties of a class of NGs with pseudo-random dynamics. Coincidences between two statistical processes are defined by approximate equality of their outputs. Typically, coincidences can be described by Poisson distribution, with the time series generated by coincidences having Poisson statistic. In this article, coincidences between simple, independent nonlinear processes are studied. From two nonlinear processes, a process with Poisson distribution is produced by coincidences and a related process (signal) with exponential distribution is generated for the mixing the two nonlinear processes. The usefulness of the resulted pseudo-random number generators, based on coincidences, against AI-based filtering is discussed in relation with applications for security, privacy, and jamming. While not intended for cryptography, with adaptations, the solution might be useful also in that domain.**

Keywords—nonlinear process, randomness, data science, time series, coincidence, rare event, pseudo-random number generators, algorithms, AI method, stochastic processes, logistics maps, biased tent map, jamming, audio security

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DISTRIBUTED SENSOR COMMUNICATION OVER NRF24L01 NETWORKS USING ADAPTIVE TTL AND AGGREGATED ACKNOWLEDGMENT

Vasile Fotache

***Abstract*—This paper proposes a dynamic wireless network solution based on NRF24L01+ radio communication modules and Arduino microcontrollers, intended for collecting data from digital and analog sensors, in distributed environments. The network does not subject to a fixed topology, but allows for automatic node discovery and efficient routing of data packets, avoiding congestion of the single radio communication channel. Elements of system architecture, the protocols used, as well as the tests carried out in a controlled environment are presented.**

Keywords—dynamic network, NRF24L01, arduino, distributed nodes, wireless sensors, network congestion

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ADAPTIVE MACHINE LEARNING SYSTEM FOR PERSONALIZED MENTAL HEALTH RISK DETECTION FROM SOCIAL MEDIA

Kavindu Abeysundara and Prasandika Balage

***Abstract*—Mental health conditions such as depression and anxiety are increasingly reflected in how people behave and communicate on social media platforms. However, most existing automated detection systems focus only on what users write, ignoring important behavioral patterns such as when they post, how often, and where. This study proposes a hybrid deep learning framework that classifies Reddit users into at-risk and severe mental health risk categories by combining both text and behavioral signals. A fine-tuned Bidirectional Encoder Representations from Transformers (BERT) encoder captures the meaning behind user posts, while a two-layer Bidirectional Long Short Term Memory (BiLSTM) with attention models patterns in user behavior over time. The key contribution of this work is the fusion of these two complementary signal types - linguistic and behavioral - into a unified multi-factor severity scoring system, enabling more personalized and context-aware risk assessment. The model is trained on a balanced dataset of 3,500 Reddit users and achieves an accuracy of 82.49%, precision of 76.44%, recall of 92.97%, F1-score of 83.90%, Area Under the Receiver Operating Characteristic Curve (AUC-ROC) of 91.36%, sensitivity of 92.97%, and specificity of 72.40% at an optimized threshold of 0.380. These results show that incorporating behavioral context alongside text significantly improves identifying behavioral risk patterns associated with mental health, with potential to support early intervention efforts in community-facing early awareness settings**

Keywords—behavioral analysis, BERT, mental health, recurrent neural networks, social media analytics

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CELLULAR AUTOMATA APPROACHES TO HASH FUNCTIONS DESIGN FOR DATA INTEGRITY

George Cosmin Stanica and Petre Anghelescu

***Abstract*—This paper presents a cellular automata-based hash function for data integrity applications. The proposed algorithm uses a sponge-inspired structure with a 1600-bit internal state which generates a 256-bit digest. The internal permutation process combines elementary cellular automata rules, lane rotations, lane permutations and nonlinear transformations to ensure diffusion and confusion within the internal state. In addition, the constant injection stage is implemented using a hybrid cellular automaton, replacing fixed predefined round constants with dynamically generated values. The proposed algorithm was implemented in C# programming language using the Visual Studio development environment and experimentally evaluated for data integrity verification. Preliminary results indicate a strong avalanche effect and efficient execution due to parallel operations performed on 64-bit lanes, highlighting the potential of cellular automata in the design of experimental hash functions.**

Keywords—hash function, cryptography, cellular automata, digest, data integrity, absorption, squeezing

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PREDICTIVE ANALYTICS OF THE INDIAN STOCK MARKET USING MACHINE LEARNING AND BIG DATA

B. Raghava Reddy, P. Krishna Moorthy, Mummadi Ramana Reddy, Dr G Jagadeeswar Reddy, Dasari Rajesh Babu and T.Deva Prasad

***Abstract*—This research explores the application of big data analytics and machine learning in forecasting movements in the Indian stock market. The objective is to design and evaluate predictive models that estimate stock price fluctuations using historical financial data, focusing on four major companies—HDFC Bank, Infosys, State Bank of India (SBI), and Tata Motors. Multiple approaches are assessed, including traditional statistical techniques such as ARIMA, machine learning algorithms like Support Vector Machines (SVM), and deep learning architectures including LSTM, BiLSTM, CNN-LSTM, and ResNLS. To improve prediction accuracy, the study employs advanced data preprocessing, feature engineering, and time-series modeling. Model performance is measured using evaluation metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and the coefficient of determination (R^2). Findings indicate that the integration of big data and AI-driven models can enhance decision-making in investment strategy and risk management by uncovering complex patterns within financial datasets and providing actionable insights for the Indian market.**

Keywords—Stock Market Forecasting, Predictive Analytics, ARIMA SVM, LSTM, BiLSTM, CNN LSTM, ResNLS, Machine Learning

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CALIBRATED MULTI-SENSOR MODELS FOR EARLY DEFECT FORECASTING IN EXTRUSION 3D PRINTING

Suliman Badour and Martin Novák

***Abstract*—Early defect forecasting enables preventive interventions in extrusion additive manufacturing before visible failures become irreversible. This paper presents a multi-sensor acquisition and labeling pipeline that couples synchronized process telemetry with a vision-based defect detector to produce horizon-based early-warning labels, together with four calibrated predictive models that output defect risk at 5 Hz. A temporal convolutional network achieves ROC-AUC 0.93 with 1.2 ms inference latency on a Raspberry Pi 5, offering the strongest deployment tradeoff; a lightweight Transformer reaches 0.94 at a higher compute cost. Cross-printer evaluation shows that fine-tuning on approximately 10% of target-domain data markedly improves zero-shot transfer. A cost-sensitive threshold policy converts calibrated probabilities into actionable binary alerts.**

Keywords—Defect forecasting, Additive manufacturing, edge AI, multi-sensor fusion, FDM, calibration, temporal CNN

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EXTRACTIVE QUERY_ BASED SUMMARIZATION USING CLUSTERING ALGORITHM BASED ON TOPIC MODEL WITH MMR

Abeer Hussien and Wafaa Al Hameed

***Abstract*—Text summarizing is the process of reducing the length of an input document without changing its main ideas. Extractive summarization is choosing the most significant sentences from the input text. In contrast, query-based multi-document summarization is a complex task that faces more challenges than single-document summarization. It involves overlapping information between sentences from various documents and selecting the most relevant and diverse sentences from a collection of documents while minimizing redundancy and maintaining relevance to a specific query. This paper suggests integrating Latent Dirichlet Allocation (LDA) and K-means clustering to address these challenges. In this paper, researchers assess the probability distribution of words and their respective subjects at the cluster level to identify the most relevant topics, therefore addressing the drawbacks of conventional topic modeling. This method avoids sentence overlap and effectively detects important sentences. Also, LDA is utilized to extract and understand the underlying topics within the documents, facilitating the identification of content most relevant to the query. K-means clustering is then applied to group sentences based on their topic distributions, allowing for the selection of representative sentences that enhance the diversity of the summary. The Maximal Marginal Relevance (MMR) criterion was utilized to re-rank the picked sentences, balancing query relevance and redundancy reduction. By combining LDA's ability to model topics with K-means' capacity for clustering, this approach effectively handles the challenges of relevance, diversity, and redundancy, resulting in a more comprehensive and informative summary. By using CNN/Daily Mail benchmark data, the experiences show this hybrid method is particularly suited for large-scale document collections; there are notable improvements in performance compared to current text summarizing methods. Our strategy when evaluating the created summaries is automatic. shows significant improvement in ROUGE metrics (F-measure, accuracy, and recall), providing a scalable solution for generating high-quality summaries. The introduced system evaluates the CNN/Daily Mail datasets. By experiments, the proposed system obtains 62.8 ROUGE-1, 54.5 ROUGE-2, and 40.0 ROUGE-L scores, an enhancement over previous models. Human evaluation also illustrates that the produced system has higher-quality summaries. This paper introduces the integration of the Topic LDA model, the K-means clustering algorithm, and the MMR technique, leveraging them to generate a robust extractive query-based summarization. Section 2 produces the most challenges that can be faced in the extractive query-based summarization task. Section 3 mentioned most of the previous studies that deal with extractive text summarization, referring to some strategies and approaches to perform this task. Section 4 includes the background and definitions of the keywords mentioned in this paper. Section 5 describes the proposed system introduced by this paper for query-based summarization. Section 6 explains the results and the metrics used for evaluating the proposed system, and Section 7 is the conclusion for this paper.**

Keywords—BERT, clustering, query-based summarization, LDA, MMR

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ARTIFICIAL INTELLIGENCE AS A MEDIATOR OF INTERPERSONAL COMMUNICATION IN THE UNIVERSITY ENVIRONMENT: OPPORTUNITIES, RISKS, AND SOCIAL IMPLICATIONS

Draghici Georgiana, Popescu Elena and Duminica Delia

***Abstract*—This study investigates how artificial intelligence, particularly conversational agents, shapes interpersonal communication in the university environment. Drawing on responses from 120 students at Politehnica University of Bucharest, the research examines stylistic and content-related changes in AI-mediated communication, users' perceptions of authenticity and empathy, and AI's role in facilitating or inhibiting interpersonal exchange. The findings show high familiarity with AI among students, moderate and selective use of tools such as ChatGPT, and widespread concern about the social implications of AI. The paper proposes recommendations for responsible conversational system design that prioritizes transparency, user autonomy, and the integrity of human communication.**

Keywords—artificial intelligence, interpersonal communication, university environment, authenticity, education

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MULTI-MODAL MACHINE LEARNING AND IOT FRAMEWORK FOR PRECISION CINNAMON CULTIVATION

Madusha Bangamuwage, Nilan Hansajith, Divana Vihani, Rushani Randeni, Sanjeevi Chandrasiri and Shalini Rupasinghe

***Abstract*—Ceylon cinnamon plays a vital role in Sri Lanka's agricultural economy however, traditional cultivation practices often result in delayed disease detection, excessive fertilizer use, and reduced productivity. This research proposes SMARTCINNAMON, a smart precision agriculture framework that integrates Internet of Things (IoT), deep learning, machine learning, image processing, and geospatial analysis to modernize cinnamon farming. The system enables real-time monitoring of soil and environmental conditions and supports early identification of leaf fungal diseases using smartphone-acquired images. A convolutional neural network-based model demonstrated strong performance in detecting fungal infections at their nursery stages. The proposed approach shows a reduction in fertilizer usage compared to conventional fixed-schedule methods, without compromising soil quality or crop yield. Yield prediction and disease spread forecasting enhances proactive farm management and timely interventions. This research improves resource efficiency, lowers production costs, and promotes sustainable cinnamon cultivation, offering a practical and scalable solution for small- and medium-scale farmers.**

Keywords—Ceylon Cinnamon, Deep Learning, Fungal Disease Detection, Internet of Things, Sustainable farming

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PERSONALIZED BALLOT NAVIGATION USING MACHINE LEARNING FOR VISUALLY IMPAIRED VOTERS

Mohammed Z.M. Shat

***Abstract*—Electoral accessibility is one of the most significant hurdles to democratic participation, particularly users who are visually impaired and encounter numerous challenges in navigating digital ballot interfaces. Today's accessible voting systems are basic support for static audio and screen-reader interfaces, which do not consider user abilities, preferences, or interaction behavior. In this paper, we introduce personalized ballot navigation as driven by machine learning approach which dynamically modifies interface features and interaction flows through real-time user modeling. We predict that machine learning-driven personalization minimizes interaction errors and time of completion when compared to static interfaces. In order to test this under realistic conditions, we built a semi-synthetic dataset of visually impaired user interaction profiles. This was a needed first step to fill the void of available public datasets for this community. From the extant literature, we incorporated the controlled feature noise that simulated the real-world factors (e.g., user fatigue, tactile hesitation) to describe behavioral variation. We trained three supervised learning algorithms (Random Forest, Logistic Regression, and Decision Tree) on features (interaction speed and error pattern). Finally, all models performed reasonably well in noisy conditions while none achieved a perfect result. It was Random Forest that exhibited the best robustness. The simulated findings demonstrate that the adaptive ML-based interface decreases average ballot completion time by around 28% and interaction error rates 49.7%. To be sure, while these gains are huge, they may actually be quite different across different hardware. These results imply that machine learning-enhanced personalized voting can meaningfully enhance electoral inclusivity**

Keywords—Accessible voting, machine learning, user modeling, human computer interaction

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DESIGN AND IMPLEMENTATION OF A PARALLEL SECURE MEDICAL IMAGE COMPRESSION-ENCRYPTION SCHEME ON EMBEDDED CLUSTER SYSTEMS

Ahmed Bencherqui, Hamza Tahiri, Mohammed Tamimi, Mohamed Kmich, Mohamed Amine Tahiri and Mhamed Sayyouri

***Abstract*—Ensuring the security of medical imaging has garnered increasing attention in recent years; this interest comes within the context of smart healthcare systems. On the one hand, different encryption methods can be taken into consideration. Nevertheless, most of them have been designed for execution on PCs that suffer from serious disadvantages such as portability limitations, high energy consumption, and high costs. In order to overcome such limitations, hardware approaches have become in focus, offering real-time processing and enhanced security along with energy-efficient performance using embedded platforms and parallel computing architectures. We hereby contribute a novel and optimized compression-encryption scheme specifically designed for execution on Raspberry Pi. The proposed approach integrates three complementary phases: (1) image compression using discrete orthogonal Hahn moments for compact and faithful representation; (2) the encryption is based on a 4-D hyper-chaotic memristor system, a modified logistic map, and DNA encoding to offer strong defense against a variety of threats and a high degree of security; and (3) in addition, an optimization algorithm, namely Chaotic Archimedes Optimization Algorithm (CAO), is used to dynamically minimize the correlation between encrypted and original data. The design of this architecture provides a very secure, real-time process and low energy cost; therefore, it is an applicable and scalable solution for secure medical image transmission and storage in embedded and mobile health systems.**

Keywords—Medical Image Security, Compression-Encryption, Embedded Systems, Raspberry Pi

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A RANDOM FOREST BASED FRAMEWORK FOR TURBULENCE ANISOTROPY USING POPE'S TENSOR FORMULATION

Ahmed Al-Taweel, Ionut Iacob and Marcel Ilie

***Abstract*—The linear eddy viscosity hypothesis, fundamentally embedded in standard Reynolds-averaged Navier-Stokes models, frequently fails to capture the complex Reynolds stress anisotropy present in flows with separation, curvature, or strong pressure gradients. To address this limitation, this study introduces a physics-informed, data-driven framework to accurately predict the Reynolds stress anisotropy tensor using high-fidelity direct numerical simulation data. The methodology leverages the general effective-viscosity hypothesis proposed by Pope to map the local mean velocity gradients into a physically invariant feature space. Five objective scalar invariants are extracted and used to train a Random Forest regressor, which predicts the corresponding scalar coefficients for a ten-term orthogonal tensor basis. The target coefficients for training are obtained via a mathematically rigorous least-squares projection of the true high-fidelity anisotropy onto the baseline tensor bases. The framework's predictive performance is evaluated not only through standard statistical error metrics but also through stringent physical realizability constraints. Barycentric maps demonstrate that the model successfully confines its predictions within physically permissible turbulence states. Furthermore, near-wall profiling of the primary shear stress across the viscous sublayer, buffer layer, and log-law regions confirms the model's ability to correct baseline fluid assumptions. This framework offers a robust, computationally efficient, and physically consistent pathway to augment standard solvers with highly accurate predictions. Our Model 4 achieves R^2 > 0.99 for active anisotropy components with 44% reduction in spatial RMSE compared to coordinate-based baselines. Lumley tringle map confirms 100% physical realizability**

Keywords—Computational Fluid Dynamics (CFD), Turbulence Modeling, Reynolds Stress Anisotropy, Data-Driven RANS Closure, Pope Tensor Basis, Machine Learning, Random Forest Regression, Lumley Triangle

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ADAPTIVE MULTI-SCALE ATTENTION-BASED LSTM COUPLING FOR EARLY DETECTION

Osman Aksu, Michael Schmid, Florian Bierwirth, Mišel Radosavac and Hans-Georg Herzog

***Abstract*—This paper introduces a novel adaptive, attention-coupled Long Short-Term Memory (LSTM) architecture developed specifically for real-time scenario recognition and prediction in complex automotive electrical/electronic (E/E) systems. Modern vehicles generate rapidly growing data streams from signals such as current, voltage, and temperature. We address this by monitoring critical signal patterns via a fused LSTM. The proposed dual-path methodology comprises a trend path for long-term pattern modeling and a motif path for short-term pattern recognition, coupled via a bidirectional, attention-based gating mechanism that enables dynamic information exchange. The outputs provide a reliable basis for initiating high-resolution data capture or adaptive system responses once a scenario is identified with high confidence. Experimental results demonstrate significant reductions in mean squared error compared to the individual values and interpretable attention weights that reveal information-exchange patterns. The proposed approach enables robust, noise-resilient forecasts and allows for efficient, data-driven development for future EE architectures.**

Keywords—LSTM, attention mechanism, time series forecasting, dual-path architecture, automotive E/E systems

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VDTA IMPLEMENTATION OF SCHMITT TRIGGER WITHOUT EXTERNAL PASSIVE COMPONENTS

Malathi Santhoshini Kaza, Musala Sarada, Avireni Srinivasulu, Syed Zahiruddin, Bhargav Appasani, Cristian Ravariu and Venkata Subbarama Murali Krishna Petluri

***Abstract*—The Voltage Difference Transconductane Amplifier (VDTA) has been traced out to be one of the active and efficient devices. These devices are also considered for designing of analog circuits to work on different functional aspects. This paper is mainly focused on presenting a newly devise of Schmitt trigger circuit by the use of the single active device, namely, VDTA and is realized without the involvement of passive element. This proved more propitious while fabricating an Integrated Circuits in VLSI design. The circuit, thus proposed avails a bias current of value 150 µA and works at ±0.9 V rail voltage. With the help of bias current, its amplitude can be electronically controllable/tunable. The circuit is greatly resistant to noise and temperature-sensitive. The devised circuit can be used in ADC's, communication systems, waveform generators, etc. The devised circuit is simulated in a gpdk 180 nm CMOS process availing a Cadence Virtuoso tool. The circuit that has been designed provides a less rate of power dissipation which is of value 270 µW. The executed, results, however equaled with theoretical results which have been experimentally valid and proved by using commercially available ICs LM 13700**

Keywords—Low voltage, Voltage Difference Transconductance Amplifier, VDTA, Voltage-mode, Schmitt trigger

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BENCHMARKING DEEP NEURAL NETWORK ARCHITECTURES FOR POTHOLES DETECTION USING MATLAB

Marius-Emanuel Obreja and Dan-Marius Dobrea

***Abstract*—Imperfections and obstacles on roads can cause real discomfort in driving and can cause road accidents, vehicle damage, and transportation inefficiencies. Traditional methods of road inspection, especially manual ones, require a lot of time and are much more expensive. This research proposes an automated pothole detection system using deep learning architectures, including EfficientNet, NasNet-Mobile, and ShuffleNet implemented in MATLAB. The system uses image datasets captured with a real-time camera under different environmental conditions, running on the Jetson Nano platform for detection and pothole classification. The images were imported into MATLAB, and using different predefined architectures, we identified different training epochs, each with different iterations, resulting in several accuracy scores. Two training and validation classes with asphalt defects and a roadway without imperfections were used. An experimental evaluation of 246 real-world road images demonstrated that EfficientNet attained the highest validation accuracy of 83.78%, succeeded by NASNet-Mobile at 81.08% and ShuffleNet at 79.73%. This highlights that EfficientNet attains higher classification accuracy, NASNet delivers strong feature extraction capabilities, and ShuffleNet enables faster performance suitable for real-time use. The suggested framework can aid intelligent transportation systems and smart road maintenance solutions.**

Keywords—real-time system, smart cities, pothole detection, deep learning, EfficientNet, NasNet, ShuffleNet

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A DEEP LEARNING APPROACH TO LAND SURFACE TEMPERATURE MAPPING FOR URBAN HEAT ISLANDS(UHI) ANALYSIS USING LANDSAT IMAGES

Gadde Megha Varshitha, Gobbilla Chandra Mouli Sai, Kaki Sai and Kalla Vinay

***Abstract*—Urbanization has increased the Urban Heat Island (UHI) effect. Urban areas experience much warmer temps than neighbouring rural areas. LST data from satellites can assist in planning for UHI mitigation; thus, designing and implementing LST (Land Surface Temperature) per local climate, using satellite data (Landsat-8 OLI/TIRS), and adapting the Radiative Transfer Equation (RTE) for LST pulling from Landsat 8 and calculating Land Surface Emissivity using NDVI thresholding. Through supervised classification of the imagery, LST and land use/land cover maps were produced. At urban surface temperature collections between 38°C - 46°C Water and vegetated areas were within their temperature ranges, resulting in a strong negative correlation between NDVI and LST. Observed meteorological validation was done via RMSE of 1.76°C, with $R^2 = 0.94$. The spatial representation of temperature produced through Remote Sensing provides the required reliable thermal data necessary for urban planning/space design/cooling strategies to aid Climate Resilient City planners and policymakers.**

Keywords—1.Land Surface Temperature(LST), 2.Urban Heat Island(UHI), 3.Remote SensingLandsat 8NDVILand surface Emissivity(LSE)

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PROSPECTS AND CHALLENGES OF E-GOVERNMENT ADOPTION: A COMPREHENSIVE LITERATURE REVIEW

Maha Kadhim Kabier, Zaid Ameen Abduljabbar, Hamid Ali Abed Al-Asadi, Vincent Nyangaresi, Mustafa A. Naser, Ali A. Yassin, Auhood M. Dayish, Ali Hasan Ali and Abdulla J. Y. Aldarwish

***Abstract*—E-government involves the deployment of information communication technologies to communicate and provide government services to various parties such as employees, citizens and businesses. To enhance governance and increase the availability of government services to citizens, developing countries must adopt e-government systems whose focus is on accelerating access to technological advancements. These e-government services are normally provided through electronic portals in a timely and user friendly manner. On the flip side, many developing countries especially Arab states face significant obstacles in implementing and adopting e-government programs. This paper analyzes the e-government concept as well as its key merits. In addition, the current state of e-government adoption is provided, highlighting the challenges and obstacles hindering its progress in developing countries. Moreover, a comprehensive review of e-government structures, specific applications and challenges facing the promotion of e-government initiatives are described. Basically, the aim is to identify strategies for overcoming these obstacles.**

Keywords—E-government, Privacy, Cybersecurity, Interoperability

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HIGH-EFFICIENCY STANDALONE WIND ENERGY CONVERSION SYSTEM: PERFORMANCE ANALYSIS UNDER CLIMATIC CONDITIONS

Ahmed I. Jaber, Hhanaa Ali Noman and Mohammed Yousif Hachom

***Abstract*—This study presents a mathematical analysis of an integrated wind energy conversion system. The system consists of several integrated components: a wind turbine, a permanent magnet synchronous generator, an electronic power inverter, and a controller. A dynamic mathematical model was developed to represent the electromechanical behaviour of the entire system. A Maximum Power Point Tracking (MPPT) control strategy was modeled and developed using proportional integration (PI) controllers to optimize energy extraction efficiency. Real-world operating data from well-known international brands of 5 kW permanent magnet synchronous generators, as well as 6 kW wind turbines were used for simulation and validation. A comprehensive evaluation and study of the system's performance under varying wind speed conditions was conducted. Furthermore, the proposed system was tested using wind speed data from different regions in Iraq (specifically, Diyala Governorate) to assess its practical feasibility for the country. The results demonstrate improved efficiency and confirm the effectiveness of the proposed control strategy under varying operating conditions.**

Keywords—MPPT, PMSG, Losses calculation, WECS, Efficiency Analysis, FOC control

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SIDVIZ3D: A GEOSPATIALLY ACCURATE 3D VISUALIZATION AND SIMULATION FRAMEWORK FOR STANDARD INSTRUMENT DEPARTURE PROCEDURES

Aslı Bahar, Funda Ergün Yardim and Mahmut Emin Çelik

***Abstract*—Standard Instrument Departure (SID) procedures define the post-takeoff climb and route integration that pilots must execute with precision, yet current training relies on two-dimensional charts that force pilots to mentally reconstruct three-dimensional flight profiles—a cognitive transformation that increases error rates during complex departures and high-traffic operations. Existing full-motion flight simulators address this gap at prohibitive cost, while low-fidelity desktop trainers lack geospatially accurate terrain and procedural fidelity. This paper presents SID-Viz3D, an interactive 3D visualization and simulation framework built on Unity 3D with Cesium geospatial integration that transforms ICAO-compliant SID chart data—including waypoint coordinates, altitude constraints (AT, AT_OR_ABOVE, AT_OR_BELOW, BETWEEN), and waypoint types (FLY_BY/FLY_OVER)—into a real-coordinate briefing and flight environment. The system provides real-time three-axis deviation tracking (lateral, vertical, and course) against planned procedure profiles, creating a basis for future quantitative pilot performance measurement without full-simulator infrastructure. Preliminary validation on Narita International Airport (RJAA) Runway 34L/34R SID procedures demonstrates that the framework preserves ICAO PANS-OPS procedural semantics while supporting real-time interaction in the 3D simulation environment.**

Keywords—SID procedures, 3D flight visualization, aviation training, spatial cognition, Unity 3D, geospatial simulation, pilot performance

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ISO-LI: DEVELOPMENT OF AN INTEGRATED ROBOTIC-ASSISTED CRYSTALLIZATION PLATFORM FOR LITHIUM SALT PROCESSING

Andreea Maria Iordache, Ana Maria Nasture, Ramona Zgavarogea, Nadia Paun, Eusebiu Ilarian Ionete, Elena Carcadea and Constantin Nechita

***Abstract*—Recent advancements in laboratory automation and process integration have opened opportunities for enhancing the efficiency, reproducibility, and scalability of lithium isotope separation methods. This study presents the development of an integrated automated platform that combines lithium salt processing, controlled crystallization, and ICP-MS quantitative analysis. The system features a cascade electrochemical setup connected to a double-wall crystallization vessel cooled to 4 °C, along with a DOBOT MG400 robotic arm for automated transfer operations. Experimental validation demonstrated stable cooling, reliable robotic handling, and seamless integration of electrochemical processing, crystallization, and analysis stages. Overall, this platform offers a scalable solution for laboratory automation and an open road for AI-driven optimization of lithium isotope separation processes.**

Keywords—lithium isotope separation, crystallization, robotic manipulation, laboratory, automation, MG400

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ENERGY EFFICIENT APPROXIMATE ADDER ARCHITECTURE FOR BREAST CANCER IMAGE PROCESSING APPLICATION

Dasamandam Venkata Supriya, Attanti Nandhini, Reddipalli Likitha, Baisani Hemanth Kumar, Syed Zahiruddin, Prof. Avireni Srinivasulu, Cristian Ravariu, Bhargav Appasani and Musala Sarada

***Abstract*—For error-tolerant applications like image processing, where minor errors are accepted in exchange for increased performance and energy efficiency, approximate computing has become a successful design model. The design and implementation of approximation adders specifically suited for image processing applications are presented in this study. To lower hardware complexity, a variety of approximation adder topologies are produced by streamlining carry propagation and logic structures. The suggested adder is compared to traditional approximate adders and assessed in terms of accuracy, delay, and power consumption. The approximation adders are included into breast cancer image processing techniques like image addition and filtering to show their usefulness.**

Keywords—approximate adders, breast cancer image, delay, energy efficiency, power consumption

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THE APPLICABILITY OF VIRTUAL REALITY IN EDUCATION: THE EDUCATIONAL POTENTIAL OF A CUSTOMIZABLE VR-BASED SURVIVAL SIMULATOR

Patricia Vivien Schifler, Deddy Gusman, Ovidiu-Constantin Novac, Cornelia-Mihaela Novac, Klára Czimre, Károly Teperics and Gyöngyi Bujdosó

***Abstract*—Virtual Reality (VR) has become one of the most important technological means for educational innovation in recent years. It has many benefits: Immersive learning environments in VR (a) provide students with the opportunity to acquire practical skills and competencies in safe and realistic situations; (b) can improve the motivation and creativity of students. This study deals with and examines the educational applicability and potential of a VR-based serious game survival simulator, a VR game with a special feature: content and simulation scenario customization based on professional consultation before process development. The application teaches resource use, spatial orientation, navigation, and recognition of objects can be found, as well as decision-making and problem-solving skills through the simulation of survival in nature. The research reviews the application possibilities of technology in secondary and higher education, as well as in corporate training environments, and analyzes its potential in competency development and behavioral assessment.**

Keywords—virtual reality, VR, serious game, gamification, immersive learning, survival simulation, VRSurSim, VR application, spatial orientation, navigation, geography education, competency development, motivation in education, Godot.

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A MULTI-STAGE TRANSFORMER-BASED PIPELINE FOR PATIENT-FRIENDLY INTERPRETATION OF HANDWRITTEN MEDICAL PRESCRIPTIONS

Wimukthi Dassanayake and Prasandika Balage

***Abstract*—Handwritten medical prescriptions remain a significant source of medication errors in developing regions, where illegible handwriting and complex pharmacological terminology cause misinterpretation of drug names, dosages, and administration frequencies. Existing optical character recognition systems focus on professional transcription and fail to bridge the comprehension gap between clinical notation and patient-accessible language. This paper proposes a modular multi-stage transformer based pipeline that integrates YOLO11s for prescription region detection, TrOCR with a Vision Transformer encoder for handwritten text recognition, BioBERT for clinical named entity recognition across drug names, dosages, frequencies, and durations, and GPT-4.1-mini for safety-constrained explanation generation that expands medical abbreviations into simplified instructions at a sixth-grade reading level while reducing unsafe inference. The fine-tuned TrOCR-ViT achieves 98.4% character accuracy and 97.8% word accuracy on the best seed. BioBERT yields a micro-averaged F1 of 0.94 across all entity types. End-to-end evaluation on 100 handwritten prescription samples achieves 76% complete entity-level interpretation accuracy.**

Keywords—Handwritten Text Recognition, Transformer Based Optical Character Recognition, Vision Transformer, Patient Safety, Large Language Models

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MODELLING AND PERFORMANCE ANALYSIS OF A SLIDING MODE CONTROLLED DUAL ACTIVE BRIDGE DC DC CONVERTER FOR ELECTRIC VEHICLE APPLICATIONS

Doğan Çelik and Hüseyin İlgü

***Abstract*—This paper investigates a single-phase dual-active-bridge (DAB) DC–DC converter employing a sliding mode control (SMC) strategy for electric vehicle (EV) applications. To enhance dynamic performance and ensure stable operation, an SMC-based strategy is designed and implemented, and its effectiveness is evaluated under different operating conditions. The proposed approach integrates a solid-state transformer (SST)-based DAB converter, enabling high-efficiency bidirectional DC–DC power conversion. A mathematical model of the system is developed, and the corresponding control algorithm is designed and validated. Both transient and steady-state performances are analysed under various input voltage and load conditions. In addition, the SMC strategy improves system robustness against disturbances such as parameter variations, external perturbations, and unmodeled dynamics in the voltage regulation loop. All modelling, control design, and simulations are performed in the MATLAB/Simulink environment, widely used for power electronics and power system studies.**

Keywords—Dual active bridge converter, Solid state transformers, Sliding mode control, Electric vehicles

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IMPACT OF PHOTOVOLTAIC MODULE TECHNOLOGY ON THE SOLAR-TO-HYDROGEN EFFICIENCY OF A PV-POWERED PEM ELECTROLYZER SYSTEM

Salima Handa, Yassine Chaibi, Zakaria Chalh and Badr Elkari

***Abstract*—Green hydrogen produced using renewable energy sources has attracted growing interest serving as a sustainable solution for reducing greenhouse gas emissions and supporting the global energy transition. Among renewable technologies, photovoltaic (PV) systems coupled with proton exchange membrane (PEM) electrolyzers stand out as an effective alternative for hydrogen generation from solar energy. This paper investigates the impact of PV module technology on the solar-to-hydrogen (STH) efficiency of a PV-powered PEM electrolyzer system. Three PV modules were analyzed: Canadian Solar CS6X-300P, Jinko JKM300M60, and Jinko Solar JKM400M-72HL-V representing the polycrystalline, monocrystalline and Mono-PERC technologies, respectively. The analysis was performed over a full year using real climate data, including solar irradiance and temperature profiles. The simulation results indicate that PV module technology significantly affects the STH performance of the system. The STH efficiency varies from 10.49% for the polycrystalline module to 12.42% for the monocrystalline module, reaching 13.54% with the Mono-PERC module. These results demonstrate that selecting high-efficiency PV technologies plays a key role in improving the overall performance of PV-powered hydrogen production systems.**

Keywords—Hydrogen production, Solar energy, PEM electrolyzer, efficiency, optimization

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FUZZY LOGIC-BASED DIRECT TORQUE CONTROL FOR INDUCTION MOTOR DRIVES USING A THREE-LEVEL NPC INVERTER

Hien Nguyen Thu, Duong Pham Hong and Viet Nguyen Hoang

***Abstract*—This paper proposes an improved Direct Torque Control (DTC) method based on fuzzy logic for an induction motor drive system using a three-level Neutral Point Clamped (3L-NPC) multilevel inverter. The proposed control structure integrates a fuzzy PI controller in the outer speed control loop to generate the reference torque, while a fuzzy-based DTC scheme is implemented in the inner loop to replace conventional hysteresis comparators and switching tables. The proposed method reduces electromagnetic torque ripple and stator flux ripple, improves switching frequency stability, and enhances overall control performance. In addition, the utilization of the 3L-NPC inverter with a rich set of voltage vectors contributes to improving the output voltage and current quality. Simulation results obtained from the Matlab/Simulink environment demonstrate that the proposed method improves dynamic response, reduces torque ripple, enhances speed tracking capability, and decreases current harmonic distortion compared with the conventional DTC method. Therefore, the proposed control structure can be considered an effective and practical solution for high-performance induction motor drive applications.**

Keywords—Induction motor, DTC, fuzzy control, 3L NPC inverter, torque ripple

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VIBE CODING: A NEW PARADIGM IN SOFTWARE DEVELOPMENT ASSISTED BY ARTIFICIAL INTELLIGENCE

Mihnea Neferu, Constantin Viorel Marian and Dan Alexandru Mitrea

***Abstract*—Vibe coding is an emerging approach in which developers and non-technical users describe desired functionalities in natural language, delegating the actual code generation to an artificial intelligence model. This paper explores the concept of vibe coding through a practical experiment, using Visual Studio Code and Anthropic's Claude model, to build a functional web application and analyze the efficiency of the process. The results are compared with traditional software development methods, highlighting significant reductions in implementation and modification time. At the same time, the study identifies the inherent risks of this paradigm, in particular security vulnerabilities, potential exposure of sensitive data and the difficulty of auditing automatically generated code that the user does not have a deep understanding of. We conclude that vibe coding democratizes access to software development but requires rigorous oversight frameworks to be adopted responsibly.**

Keywords—vibe coding, artificial intelligence, software development, Large Language Models, software security, Claude, Visual Studio Code, productivity

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ENHANCED MUSEUM APPLICATIONS FOR SMART DEVICES: AI-BASED SYSTEMS FOR CULTURAL ENGAGEMENT AND INTELLIGENT INTERACTION

Avindi Obeyesekere, Basindu Bandara, Sehan Devinda, Udara Ireshan, Nuwan Kodagoda and Nushkan Nizmi

***Abstract*—The widespread adoption of digital technologies for knowledge access has exposed the limitations of static presentation methods in enabling immersive and interactive historical learning, a gap that is particularly evident in the context of Sri Lankan history. To address this, a multi-component AI-driven museum platform is introduced to enhance cultural heritage engagement through integrated interaction, exploration, and reasoning capabilities. The platform integrates four complementary modules, including a graph-based reasoning framework, Global Context Explorer for Sri Lanka (GCESL), which operates on a spatio-temporal representation of historical events to identify plausible global influences on local contexts, a conversational museum guide enabling real-time and context-aware interaction with artifacts and historical personas, an adaptive cultural exploration system supporting cross-cultural understanding and immersive engagement, and an AI-driven narration and artifact reconstruction module for multimodal storytelling and visualization. This integrated approach supports a transition from static information access toward inquiry-driven learning environments and provides a scalable framework for enhancing digital cultural heritage experiences.**

Keywords—Kiosk Applications, Hybrid AI Systems, Digital Museum Systems, Graph-Based Reasoning, Spatio-Temporal Modeling, Cross-Contextual Reasoning, Multimodal Storytelling, Artifact Reconstruction, Sri Lankan History, Cultural Heritage

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AN INTEGRATED FRAMEWORK FOR SMART CONTRACT VULNERABILITY MANAGEMENT USING TRI-MODAL ACTIVE LEARNING AND EXPLAINABLE AI

Dinupa Hanthanapitiya, Sithum Rajapakse, Ramin Ratnayake, Dulan Ratnayake, Deemantha Siriwardana and Lakmal Rupasinghe

***Abstract*—The immutable nature of smart contracts means that they can suffer permanent and catastrophic financial losses due to just one line-of-code vulnerability, as in decentralized finance (DeFi) assets, hundreds of billions of dollars worth are being managed on public blockchains. Current security solutions are severely limited: static analyzers have high false positive rates, supervised deep learning models are extremely expensive to train, and existing active learning setups are extremely susceptible to pseudo-label poisoning. Moreover, there is no solution that can be integrated that is able to combine high level of accuracy for vulnerability detection with the ability to explain why the vulnerabilities exist and to automatically remediate them. To fill these gaps, this paper proposes an integrated, four-phase modular framework that addresses the full life cycle of vulnerability management including detection, forensic auditing, explainability and automatic remediation. The first phase is a model known as ASSBert, which is a CodeBERT-based model improved with a new multi-head attention pooling mechanism and a tri-modal active learning strategy. ASSBert achieves 98.95% classification accuracy over five important classes (reentrancy, integer overflow, timestamp dependency, dangerous delegatecall, safe), using a special "defer zone" to capture the predictions at the border of the classification space, avoiding contamination of the training set, and reduces the manual labeling time of the experts by 72%. The second step is a modular forensic framework, which connects Random Forest detection, semantic reasoning with LLM, and symbolic execution verification in a single discern-understand-prove pipeline that can greatly reduce false positives. The third phase brings in SCXAI – an explainable AI system – which combines model-intrinsic feature importances with a fine-tuned Flan-T5 model, enabling complex code signals to be converted into structured explanations, legally defensible, and presented in natural language for forensic purposes. Last but not least, there is a post-detection remediation module that includes a rule-based patch engine with a 96% syntactically correct code fix rate, a financial attack simulator and an ML-based risk predictor that predicts the probability of financial attacks with 91% accuracy. As a whole, these co-operative pieces move smart contract auditing from a disconnected, black-box hunt for bugs to a comprehensive, end-to-end, and practically-instantly-deployable security system.**

Keywords—Smart Contracts OR Vulnerability Detection OR Large, Language Models OR Active Learning OR Explainable AI OR, Digital, Forensics OR Automated Patch Recommendation OR, Decentralized Finance

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DESIGN AND SYSTEM-LEVEL VALIDATION OF A TRUTH-TABLE SYNTHESIZED 18-TRANSISTOR FULL ADDER FOR BINARY ACCUMULATION APPLICATION

Yatham Srinivas, Orus Lalitha, Prof. Avireni Srinivasulu, Bhargav Appasani and Cristian Ravariu

***Abstract*—The Digital systems relays on full adders to perform arithmetic calculations and thus determine how fast and how complicated each computer system will be. In this document, we outline the design of an 18-transistor full adder that is compact in size and reduces the complexity of circuit design without sacrificing the correct logical functions of a full adder. The architecture for this full adder design can be derived directly from the truth table of the full adder; this means that no redundant transistor paths will be created like those performed by a conventional 28-transistor full adder. The full adder circuit was verified with Cadence simulations and all possible combinations for both the Sum and Carry outputs yielded correct results. The functionality of the proposed full adder was further evaluated within the context of a MATLAB based fingerprint matching environment by utilizing the full adder to generate popcount computations used to determine the Hamming distance between fingerprint descriptors. The test results determined that the reduced transistor full adder reliably completes arithmetic processes supporting the calculation of popcount metrics necessary for biometric matching systems. Therefore, an 18T full adder offers a compact arithmetic solution for all applications requiring popcount arithmetic operations, including biometric identification and binary neural networks.**

Keywords—18T Full Adder, Truth-Table Synthesis, Binarized Neural Networks, BNN, Biometric Matching, VLSI Design, Hardware Efficiency, MATLAB

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QUESTION ANSWERING OVER KNOWLEDGE GRAPHS: THE DBPEDIA CASE STUDY

Ilie Cristian Dorobat

***Abstract*—In contrast to relational database management systems, which require numerous joins and intricate queries to handle complex interconnected data, graph databases excel precisely due to their storage approach which involves keeping the data as nodes and edges, effectively representing entities and the relationships that connect them. However, querying graph databases can be perceived as a cumbersome process, especially by the non-technical audience, since it requires not only an understanding of data structures but also the technical specifications of the used protocol, usually SPARQL. To overcome this challenge, Question Answering over Linked Data systems provides users with the ability to query datastores using natural language. The current work presents a new architecture of the onIQ system, which, in addition to enhancing the syntactic parsing mechanism brings users the ability to easily enrich their statistical model with new named entities. The results of evaluating the system against the QALD-8 test dataset are promising, showing the highest precision parameter value among the analyzed systems.**

Keywords—Natural Language Interface, Knowledge Discovery, Question Answering, SPARQL

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REAL-TIME AFDX NETWORK ANALYSIS AND FAULT DIAGNOSIS IN UNITY

Ayse Gül Sarıkaya, Mehmet Çiydem and Mahmut Emin Celik

***Abstract*—Runtime fault diagnosis in Avionics Full-Duplex Switched Ethernet (AFDX), standardized under ARINC 664 Part 7, remains fundamentally limited in operational deployments. Faults such as Bandwidth Allocation Gap (BAG) violations, sequence number anomalies, babbling-idiot failures, and asymmetric redundancy path degradation manifest as transient, correlated perturbations across multiple switches and Virtual Links, rendering them invisible to single-stream packet inspection. Existing diagnostic approaches — including dedicated hardware analyzers and offline simulation frameworks — operate at the packet-trace level in isolation from the underlying network topology, and none provides interactive, topology-aware observation of fault propagation during live operation. This paper presents a software-based real-time framework for AFDX network analysis and fault diagnosis implemented in Unity. A Python-based traffic generator emits binary-encoded AFDX frames over UDP, preserving Virtual Link semantics and BAG constraints specified in ARINC 664 Part 7. The Unity runtime engine parses incoming frames, enforces protocol compliance — including BAG enforcement, sequence number integrity verification, and dual-redundancy management across Network A and Network B — and renders the results on a topology-aware interactive display. Six fault injection scenarios executed within the Systems Integration Laboratory on a five-end-system, five-Virtual-Link topology confirm detection of all fault types within one render cycle, providing fault observability that offline simulation frameworks do not support by design and that hardware analyzers achieve only through dedicated avionics interfaces. The framework architecture extends directly to full-scale avionics topologies and richer fault vocabularies without structural modification.**

Keywords—AFDX, ARINC 664 Part 7, avionics networks, fault diagnosis, real-time visualization, virtual link, redundancy management

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FROM ENTITY MENTIONS TO TONE: AN LLM-BASED PIPELINE FOR MEDIA BIAS ANALYSIS

Klesti Hoxha and Olti Qirici

***Abstract*—This paper presents a pipeline for analyzing media bias and framing in online news. The pipeline groups articles into topics and events, adds named-entity and sentiment annotations, and compares news sources through people mentions, source-level tone, and event-level coverage patterns. We apply it to 8,358 Albanian news articles collected from GDELT and compare the resulting annotations with GDELT's automated annotations. The results show moderate agreement for sentiment and entity extraction, as well as additional person-entity pairs that can potentially support the bias analysis. We compare two annotation prompts and find that stricter sentiment-validation rules remove label-score inconsistencies but increase execution time and reduce annotation coverage. Based on these results, the simpler prompt is used for the rest of the analysis. We have provided sample analysis on source-level framing profiles, person-level tone differences across sources, and event-level gatekeeping and coverage indicators. These outputs show how the same news collection can be used to examine what sources cover, how they describe public figures, and where coverage is concentrated. The approach is particularly useful in settings where manually verified datasets or specialized language tools are limited.**

Keywords—large language models, named-entity recognition, sentiment analysis, news analysis, natural language processing, media bias, media framing

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AN INTEGRATED GEOSPATIAL PLATFORM FOR CLIMATE RISK VISUALIZATION OF TRANSPORT AND ENERGY INFRASTRUCTURE

Theodor Pintilie, Cristina Dobre, Robert Streche, Andrei Dănilă and George Suciu

***Abstract*—Climate-related hazards increasingly threaten critical infrastructure systems, particularly transport and energy networks that are geographically co-located and functionally interdependent. Effective climate resilience planning requires the integration of heterogeneous datasets, including hazard simulations, infrastructure networks, and environmental indicators. However, these datasets are often distributed across different platforms and formats, limiting their accessibility and usability for infrastructure planners and decision-makers. This paper presents the design and implementation of a web-based geospatial visualization platform developed within the ReCharged project to support climate risk analysis of transport and energy infrastructure systems. The platform integrates multiple geospatial datasets provided by project partners, including climate hazard layers, infrastructure networks, and exposure indicators, into a unified interactive environment. Through a modular architecture and a layer-based mapping interface, users can explore hazard scenarios, visualize infrastructure exposure, and analyse potential impacts across different case study locations. The platform supports multiple European case studies and enables the dynamic visualization of hazard layers such as flood depth, flow velocity, and mudflow extent alongside transport and energy infrastructure elements. By combining geospatial data management with interactive web-based visualization, the system facilitates clearer interpretation of complex risk scenarios and enhances communication between technical experts and decision-makers. The proposed platform demonstrates how digital geospatial technologies can improve accessibility to climate risk information and support more informed infrastructure resilience planning.**

Keywords—geospatial platform, climate risk visualization, critical infrastructure, GIS, transport and energy systems, decision support

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ITERATIVE FEEDBACK TUNING OF ANTI-WINDUP PI FUZZY CONTROL OF SMALL AUTONOMOUS ELECTRIC CAR

Radu-Emil Precup, Constantin-Laurentiu Nitulescu, Raul-Cristian Roman and Elena-Lorena Hedrea

***Abstract*—As the population increases, parking lots are swarming with cars, leading to collisions and long lines of people waiting to park. To solve this issue, this paper proposes implementing a small autonomous electric car, which is simple yet effective. The paper presents few hardware and software aspects. It also suggests a data-driven tuning approach for low-cost (l.c.) Proportional-Integral (PI) fuzzy control of the angular position of the two front wheels using Iterative Feedback Tuning (IFT). The paper further presents a back-calculation and tracking–based anti-windup strategy designed to prevent integrator windup and to compensate for the process dead zone and saturation nonlinearities. PI fuzzy controller tuning is carried out in two stages: (i) tuning the parameters of PI fuzzy controller's fuzzy logic subsystem and the anti-windup tracking gain in a model-based manner using the improved hybrid Particle Filter-Particle Swarm Optimization algorithm with an added information feedback model, and (ii) tuning the parameters of PI fuzzy controller's linear subsystem in a data-driven manner using IFT and mapping them onto the remaining PI fuzzy controller parameters using the modal equivalence principle. Experimental results illustrate the application of the data-driven fuzzy control approach, representing a proof-of-concept validation of a data-driven control approach for l.c. self-parking cars i.e. autonomous vehicle prototypes.**

Keywords—autonomous electric cars, Iterative Feedback Tuning, Particle Filter-Particle Swarm Optimization, Proportional-Integral fuzzy control, sensors

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HAIRMIXER: A HAIRSTYLE RECOMMENDATION AND SIMULATION SYSTEM BASED ON FACIAL STRUCTURE USING CONVOLUTIONAL NEURAL NETWORKS

John Mathew Mauricio, Theris Eldrene Carroz, Jazzer Ong and Jason Catadman

***Abstract*—Choosing a suitable hairstyle is often challenging due to differences in facial structures, personal preferences, and limited access to professional hairstyling advice. Existing hairstyle recommendation applications still face limitations in personalization and realistic visualization, which can make users uncertain about trying suggested styles. To address this gap, this study presents HairMixer, a web-based hairstyle recommendation system that applies deep learning and computer vision to analyze facial structures and generate personalized hairstyle suggestions with a virtual hairstyle overlay feature. The system uses a Convolutional Neural Network (CNN) model to classify face shapes from uploaded facial images. User-provided hair attributes such as texture, thickness, and desired length are applied as filtering constraints to refine recommendations. The system outputs a detected face shape, a list of recommended hairstyles, and a virtual overlay preview that allows users to visualize selected styles on their own image. System performance was evaluated through user testing and professional hairstylist validation. Based on user survey results, the system achieved an overall weighted mean score of 4.52 out of 5, interpreted as "Very Satisfied". Hairstylist evaluation showed a 76.3% agreement rate on generated recommendations, with a Fleiss Kappa value of 0.62, indicating substantial agreement with professional judgment.**

Keywords—Convolutional Neural Networks, Artificial Intelligence, Computer Vision, Web-Based System, Face Shape Classification, Hairstyle Recommendation

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ARTIFICIAL INTELLIGENCE-BASED CLASSIFICATION OF HUMAN ACTIVITIES FROM MMWAVE RADAR POINT CLOUDS

Ethem Şekerci and Ayhan Küçükmanisa

***Abstract*—This paper presents a real time human activity classification system using three dimensional point clouds produced by millimeter wave radar and a PointNet based deep learning model. A Texas Instruments IWR6843ISK radar operating between 60 and 64 GHz was used to collect data from 10 subjects, including 5 female and 5 male participants, performing five distinct gestures: waist bending, arm flapping, arm swinging, forward bending, and lateral bending. Data were recorded through Robot Operating System 2, converted into sliding window segments of 500 points with a stride of 250 points, quality filtered, and normalized before being fed to a shared multilayer perceptron and global max pooling classifier. The final curated dataset contains 4,155 segments split into 3,324 training samples and 831 test samples. The model achieves 98 percent test accuracy and a macro F1 score of zero point ninety seven. In addition to a contextual comparison with literature baselines, an in house RadHAR reproduction on the same dataset reached 93 percent accuracy, confirming the advantage of direct raw point processing for this dataset. Real time inference runs at approximately 35 frames per second on Jetson Nano and approximately 25 frames per second on Raspberry Pi 4, demonstrating suitability for embedded and contactless monitoring in smart living, rehabilitation, and human machine interaction scenarios.**

Keywords—mmWave radar, human activity recognition, PointNet, point cloud, deep learning, ROS 2, real-time classification

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TOWARDS AN EFFICIENT AND FLEXIBLE AUTHENTICATION SCHEME IN EDUCATION ENVIRONMENT: STUDENTS AS THE CASE STUDY

Duaa A. Sultan, Ali A. Yassin, Zaid Ameen Abduljabbar, Vincent Omollo Nyangaresi, Ali Hasan Ali and Abdulla J. Y. Aldarwish

***Abstract*—In the age of advanced technology and great development, in which information can be accessed at any place or time, a lot has been happening in the education sector because of software technology, cloud services and other related tools that would ensure speed, integrity and security. Despite its pluses, the education sector also faces challenges, such as data security and how to help prevent breaches. Accordingly, we must deploy a way to guarantee the access privileges and protect the security of information, because of existing issues in terms of ways to determine access privileges, how roles are distributed, cyber invasion and security function. In this paper, we have introduced a student authentication scheme that has the feature of being secure against security threats and maintains the privacy of students who can access their secure data and take an exam through a secure exam server. Moreover, our work benefits from security attributes such as mutual authentication, key management, forward secrecy and so forth to defend against famous attacks such as those related to insider attack, phishing attack and replay attack. Furthermore, the proposed scheme has strong security supported by formal analysis of Proverif and informal proof. In addition, we invoke BAN logic to authenticate the security proof and our work gives good results compared with similar works in terms of communication costs (620), computational costs (406.5) and throughput (12.2 Kbps).**

Keywords—Education Environment, Authentication, BAN Logic, Phisung attack

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COMPUTER VISION TECHNIQUES FOR FINE MOTOR AND FOCUS LEVEL MONITORING USING COLOURING AND TRACING ACTIVITIES IN EARLY CHILDHOOD

Chathuni Abesinghe, Eshanie Rathnasinghe, Thiyara Gunawardena, Binuki Mihara, Dr. Lakmini Abeywardhana, Lokesha Weerasinghe and Dr.Naren Selvaratnam

***Abstract*—Fine motor skills and attentional focus are critical developmental indicators in early childhood, serving as foundations for academic success and emotional self-regulation. Traditional preschool assessments often rely on subjective observations, which can be inconsistent and prone to human error. Research indicates that the maturation of these skills is mediated by the Anterior Cingulate Cortex (ACC), where the dorsal region manages task persistence and the ventral region regulates emotional processing through the amygdala. This study proposes an automated computer vision framework to objectively quantify these markers using standard colouring and tracing activities. The system metrics, including line accuracy, stroke consistency, and pacing for tracing tasks, alongside coverage and boundary control for colouring. An age-adaptive algorithm adjusts evaluation thresholds for children aged 4–6, while a human-in-the-loop interface allows educators to refine scoring parameters based on professional expertise. The framework was empirically validated using 179 colouring samples and 62 tracing samples. The colouring assessment demonstrated high reliability (alpha = 0.8664), and the tracing assessment achieved acceptable reliability (alpha = 0.7900), confirming the internal consistency of the automated metrics. By classifying children into three developmental levels: Advanced, Developing, and Needs Support, this framework provides a standardized, data-driven tool for early intervention. This approach facilitates a more effective collaboration between parents and educators, ensuring targeted support for both fine motor development and emotional regulation.**

Keywords—Fine motor skills, self-regulation, attentional focus, computer vision, emotional dysfunction

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A VISION-BASED AI ROBOTIC SYSTEM FOR WORKER SAFETY MONITORING IN DATA CENTER ENVIRONMENTS

Nilam El Amrani, Manal En-Najidi, Badr El Kari, Yassine Chaibi and Zakaria Chalh

***Abstract*—Industrial Surveillance in high-risk environments such as data centers often relies of manual inspection or static camera systems with limited coverage. Ensuring workers safety in hazardous areas such as battery rooms, generator zones, and cooling units, requires strict compliance with Personal Protective Equipment (PPE) regulations defined by standards including ISO 20471 and ISO 45001. This paper presents an autonomous vision-based robotics system for continuous PPE compliance monitoring in data center environments. A custom line-following patrol robot equipped with an RGB camera streams video through a ROS2 pipeline to a YOLOv8l detection model trained on a dataset of 5,760 images across all the classes. The model achieved a mAP@50 of 96% and mAP@50-95 of 78%. When violations are detected, the system sends notifications to a monitoring dashboard and emits and audio alert. The feasibility of employing mobile robotic surveillance in industrial safety monitoring was validated through a Gazebo-ROS2 simulated data center environment.**

Keywords—Autonomous Robot, PPE Compliance, AI surveillance, Data Center Safety, ROS2, Gazebo, Computer Vision, YOLO

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A MULTI-AXIS SIMULTANEOUS MOTION CONTROLLER DESIGN FOR A 6-AXIS ARTICULATED MANIPULATOR

Yen-Fang Li, Jun-Hao Guo and Yong-Bin Wu

***Abstract*—This study introduces a high-performance motion controller specifically engineered for multi-axis articulated manipulators. By harnessing the heterogeneous computing synergy between a System-on-Chip (SoC) and an FPGA, we realized a synchronous 6-axis motion control framework. In this architecture, the SoC serves as a dedicated engine for real-time forward and inverse kinematics, while the FPGA functions as a hardware accelerator to execute parallel, closed-loop position and velocity control across all motor axes. This distributed control strategy effectively decouples real-time kinematic computations from the PC-based host, which is then redirected to focus on high-level spatial trajectory planning. These planned trajectories are subsequently discretized by the SoC and streamed to the FPGA for synchronized execution, ensuring the end-effector meets rigorous precision standards.**

Keywords—six-axis robot, forward and inverse kinematic, simultaneous motion control

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DETERMINISTIC MULTI-AGENTIC WORKFLOW FOR AUTOMATED INTERVIEW PREPARATION

Hemanth S, Nishanth Navaneethakrishnan, Pranava K P, Krishna Kulkarni and Neha R P

***Abstract*—Automated interview preparation presents a critical trade-off between the scalability of static question banks and the conversational capabilities of single-agent Large Language Models (LLMs), which often suffer from hallucinations and lack structured evaluation. This paper introduces MAI-Sys (Multi-Agent Interview System), an Agentic Workflow designed to resolve this trade-off by automating adaptive, high-fidelity mock interviews. We implemented a deterministic orchestrator using LangGraph to coordinate ten specialized LLM agents, integrating a Retrieval Augmented Generation (RAG) pipeline to ensure factual grounding and contextual relevance. By separating control logic from probabilistic reasoning and utilizing a parallel evaluation mechanism, the system balances real-time interaction latency with deep, rubric-based assessment. Validation through end-to end case studies demonstrates the system's ability to dynamically adapt to candidate profiles, delivering personalized feedback and structural scaffolding that outperforms both static databases and monolithic single-agent architectures.**

Keywords—Agentic AI, Multi-Agent Systems, Retrieval Augmented Generation (RAG), LangGraph, Interview Preparation, Agentic Workflows, Pinecone

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HYBRID INFORMATION- AND ENERGY-AWARE SENSOR SCHEDULING FOR FAIR TARGET TRACKING IN WIRELESS SENSOR NETWORKS.

Mohammed Abdulaghfoor and Mohanad Al-Ibadi

***Abstract*—Wireless sensor networks are commonly used for mobile target tracking, where distributed sensor nodes send their measurements to a fusion center for state estimation. But, using the proximity or information gain criterion for choosing sensors will inevitably activate the same nodes or the same spatial region along the target trajectory repeatedly. This results in unequal energy consumption across the network, as some portions of the network are being leveraged heavily while others are relatively underutilized, potentially resulting in less long-term tracking accuracy, or even losing the target path. To address this problem, this paper proposes a hybrid information- and energy-aware sensor scheduling method for EKF-based target tracking. The proposed method not only selects the informative sensors but also considers residual-energy distribution so as to minimize repeated use of the same nodes. This is compared to the All-in-Range, Closest-N, Random-N, and Info-only scheduling methods. The results indicate that the Hybrid method has tracking accuracy that remains close to the Info-only method. It outperforms the baseline methods by up to 99.03% and 96.39% at N_s=10 in reducing the node-level KL divergence and spatial KL divergence, respectively. The results prove that the proposed method is able not only to maintain the load fairness at the cell level, but also at the node level, and still preserve the tracking accuracy.**

Keywords—Target Tracking, Sensor Scheduling, Energy Efficiency, Extended Kalman Filter, Network fairness, WSNs

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TOWARDS SAFER URBAN MOBILITY YOLO-DRIVEN DETECTION OF ROAD IRREGULARITIES FOR SMART CITY

Marius-Emanuel Obreja and Ionuț-Andrei Ciobotaru

***Abstract*—Urban environments face increasing challenges related to road safety and infrastructure maintenance, particularly as cities adapt to the growing prevalence of autonomous vehicles. By leveraging high-quality datasets and machine learning techniques, we aim to contribute to safer and more efficient navigation for both autonomous vehicles and drivers, ultimately fostering smarter, safer cities. This paper investigates the various YOLO (You Only Look Once) models, specifically YOLOv5, YOLOv11, and YOLOv26, in detecting road irregularities, such as denivelations, as part of smart city initiatives for autonomous vehicles. The comparative analysis demonstrates that YOLOv11 consistently excels in all versions, making it a reliable choice for real-time assessment of road conditions. However, as the dataset size increased from 244 to 616 and then to 1998 images, a significant decrease in the average accuracy (mAP@50) was observed, falling from approximately 0.94 to 0.67-0.70. This reinforces the idea that the quality and consistency of the annotations have a significant impact on the model performance more than the sheer volume of data. Furthermore, YOLOv26 did not demonstrate significant improvements over YOLOv11, suggesting that the model is sensitive to factors such as motion blur, variable angles, and inconsistent illumination, which are key challenges in detecting road bumps for autonomous vehicles. The results of this study highlight the critical importance of high-quality datasets in developing effective computer vision models aimed at real-time monitoring of road conditions within smart cities, ultimately supporting the safety and effectiveness of autonomous driving systems.**

Keywords—YOLO, road irregularities, machine learning, smart city, autonomous vehicles

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A PROTOCOL-AWARE DAG-BASED MULTI-AGENT ORCHESTRATION FRAMEWORK FOR INTELLIGENT TOURISM ASSISTANTS

Devanga Palliyaguru, Hinesha Perera, Thinal Fernando, Tharindu Abenayaka, Lakmini Abeywardhana and Nathali Silva

***Abstract*—AI-powered travel assistants are evolving from static recommendation interfaces toward autonomous systems capable of itinerary planning, information retrieval, constraint handling, and adaptive interaction. However, most existing tourism assistants either remain monolithic or rely on loosely coordinated multi-agent interactions, resulting in weak execution control, limited reproducibility, fragile tool invocation, and poor observability under failure. Meanwhile, emerging interoperability mechanisms such as Model Context Protocol (MCP) and Agent-to-Agent (A2A) communication improve modularity but introduce new challenges in coordinating heterogeneous agents under dependency, safety, and latency constraints. This paper presents a protocol-aware Directed Acyclic Graph (DAG)-based multi-agent orchestration framework for intelligent tourism assistants. The proposed framework models user requests as dependency-constrained execution graphs, enabling deterministic scheduling, bounded parallelism, typed task contracts, structured failure handling, and protocol-level routing across heterogeneous tools. The architecture integrates key components including a multilingual language service, intent classification, a three-tier memory subsystem, a protocol-aware router, a DAG executor, and an NLI-based verifier–repair loop for reliability control. Unlike prior tourism systems that focus primarily on recommendation, this work treats orchestration as a first-class systems problem. The framework is instantiated in a Sri Lanka tourism domain and evaluated across multiple components. The intent classifier achieves a Micro-F1 score of 0.9403 and Macro-F1 of 0.9224 across 7161 samples, while the NLI verifier achieves a Macro-F1 of 0.936. A controlled transport benchmark demonstrates reduced tail latency under MCP Streamable HTTP (p95: 11342 ms) compared to A2A HTTP (p95: 18666 ms). These results demonstrate that explicit DAG-based orchestration improves reliability, execution control, and system observability compared to unstructured multi-agent approaches.**

Keywords—multi-agent systems, orchestration, tourism assistant, DAG

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FPGA ACCELERATION ARCHITECTURES FOR RENEWABLE ENERGY INTEGRATION

Yassine Seghrouchni, Mourad Yessef and Badre Bossoufi

***Abstract*—The integration of renewable energies into the grid increases operational complexity, necessitating advanced control strategies such as Model Predictive Control (MPC) and neural networks to maintain high levels of performance. These algorithms are well known to be computationally intensive, with major bottlenecks dominated by Matrix-Vector Multiplication (MVM) operations. This paper explores Green Computing solutions by implementing these control algorithms on Field Programmable Gate Arrays (FPGAs), which offer high-performance parallel processing at the edge with minimal energy consumption. This paper presents a comparative analysis of three hardware architectures for MVM Row-wise, Column-wise, and Hybrid optimizing the trade-off between processing latency and silicon area. Furthermore, this paper investigates the efficiency of asymmetric quantization, while demonstrating that reducing the data format from 32-bit floating-point to 8-bit integers decreases the memory footprint by 75%. These results confirm that this quantization introduces negligible error (peaking at 0.0386), proving that INT8 precision is sufficient for high-fidelity, real-time control applications while reducing the Levelized Cost of Energy (LCOE).**

Keywords—FPGA, Accelerator, Green Computing, Matrix-Vector Multiplication (MVM), Quantization, Levelized Cost of Energy (LCOE)

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EFFICIENT AREA OPTIMIZATION OF PHOTON-256/32/32 ARCHITECTURE USING LOG/ANTILOG-BASED MIXCOLUMNS ON FPGA

Safa Hazim Alwan, Yasir Amer Abbas and Mudhafar Hussien Ali

***Abstract*—Lightweight cryptographic hash functions are an active research area. In recent years the Internet of Things (IoT) is proliferating fast. Most of the IoT devices are of very constrained nature, they have very limited hardware, very low power consumption, and at the same time they require high performance. With the vast amount of recently introduced cryptographic hash functions, there is an urgent need for in-depth comparison of their architectures as well as for implementations on Field-Programmable Gate Arrays (FPGAs). In this regard, recently introduced hash function PHOTON-256/32/32, with its very compact structure, is perfectly suited for very efficient FPGA implementations. One of the most hardware consuming parts of PHOTON hash function is MixColumnsSerial (MCS), particularly the finite field (Galois Field) multiplication which is required for adequate diffusion. This presents an FPGA implementation and evaluation of the PHOTON-256/32/32 hash function incorporating a Log/AntiLog-based Galois Field multiplication technique within the MixColumnsSerial stage. Already published the implementation of the Log/AntiLog-based Galois Field multiplication for the part of the hash function responsible for the MixColumnsSerial transformation. This paper shows how to improve the hardware-efficiency of the given hash function while keeping the same arithmetic complexity, the same functionality, and diffusion of the hash function. The conventional PHOTON hash function was firstly implemented on a Xilinx Kintex-7 XC7K160T-3FBG676 FPGA using the Xilinx . The optimized PHOTON hash function was also synthesized and then mapped onto the same FPGA platform under the same design environment. The optimized PHOTON architecture obviously improves the hardware implementation results. The proposed implementation reduces Slice Registers from 295 to 41, Slice LUTs from 3605 to 306, and Occupied Slices from 1453 to 127. In addition, the maximum operating frequency increases from 360.188 MHz to 508.518 MHz, while the critical path delay decreases from 2.776 ns to 1.966 ns.**

Keywords—Lightweight Cryptography, PHOTON Hash Function, FPGA Implementation, MixColumns Serial, Hardware Optimization, Resource-Constrained Devices.

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PRE-ANALYTICAL QUALITY VALIDATION FOR MALARIA DIAGNOSIS: A MULTI-STAGE DEEP LEARNING AND COMPUTER VISION FRAMEWORK

Chamuditha Wanninayake, Sayumi Devasurendra, Pubuth Prajeshwara, Anuja Uthsara, Lakmini Abeywardhana, Mahima Weerasinghe, Kumudu Gunasekara and Shanika Wickramasinghe

***Abstract*—Malaria continues to pose a significant global health burden, where accurate and timely diagnosis is critical for effective treatment. Microscopic examination of Giemsa-stained blood smear slides remains the gold standard; however, its reliability depends heavily on staining quality, smear preparation, and operator expertise. These factors introduce variability, increase workload, and can lead to inconsistent diagnostic outcomes. This study presents an integrated system for Malaria diagnosis that incorporates staining quality assessment, blood smear quality analysis, and automated parasite detection within a sequential diagnostic framework. A multi-task deep learning model evaluates staining quality and recommends optimal staining duration, while a computer vision-based approach analyzes smear quality from mobile-captured images using features including smear dimensions, feather edge formation, spacing and positioning, and stain density. Only slides satisfying predefined quality criteria are forwarded to the parasite detection stage, where deep learning models perform infection classification, parasite localization, and species identification. The staining model achieved its highest per-class accuracy of 55.2% on Grade III, representing optimal staining conditions, while time prediction achieved a mean absolute error of approximately 4 minutes. The smear quality assessment module produced an average measurement error of 1.76 mm against expert-recorded ground truth values. The parasite detection and species identification models achieved mAP@0.5 scores of 0.812 and 0.897 respectively. By validating slide quality before microscopic examination, the system limits the exposure of detection models to substandard inputs, reducing both analytical overhead and the risk of misdiagnosis in routine laboratory settings.**

Keywords—Malaria diagnosis, Deep learning, Computer vision, Parasite detection, Smear analysis

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IoT-Based Color Detection Platform Using TCS3200 Sensor and Stepper Motor Positioning System

Alina-Maria Iancu, Ovidiu-Constantin Novac, Cornelia-Mihaela Novac, Ioan Lita, Valentin Alexandru Stan and Gabriel-Vasile Iana

***Abstract*—The paper presents the development of a hardware-software system for reproducible colorimetric detection and analysis using a TCS3200 optical sensor integrated into an embedded architecture based on Arduino. The proposed platform combines a linear positioning subsystem made with a NEMA17 stepper motor, A4988 driver and TR8×8 trapezoidal screw mechanism, with a software application developed in Python for motion control, data acquisition and display of results in real time. The system allows the controlled movement of the optical sensor relative to the analyzed surface and the performance of RGB measurements under reproducible geometric conditions. To reduce the influence of illumination and variation in the measurement distance, a calibration method using white, black, red, green and blue color standards is proposed. The procedure allows the determination of RGB correction coefficients depending on the position of the sensor and compensation for errors generated by optical and geometric variations of the system. Experimental data is saved and used for automatic correction of subsequent measurements. The developed system represents a compact and low-cost solution for colorimetric analysis applications, pigment monitoring and non-invasive investigation of materials and cultural heritage.**

Keywords—color detection, TCS3200, embedded system, precision positioning

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INTELLIGENT CACHING MECHANISM IN EDGE–CLOUD NETWORKS

Piyush Kumar

***Abstract*—With the rise in usage of applications that consume huge amounts of data such as video streaming, augmented reality, self-driving cars, and Internet-of-Things, there has been an immense strain on the existing cloud-based systems. Centralized cloud-based systems suffer from problems such as latency, bandwidth congestion, and scalability while addressing geographically distributed users. Edge-cloud systems were designed to address these problems by deploying computational and storage resources closer to the end-users through edge nodes. In this scenario, caching is considered an important technique to overcome latency, redundant transmission, and overall quality of service problems. The conventional caching techniques based on rules do not suffice to handle the current dynamic workload, which includes temporal variability, spatial heterogeneity, and unforeseen user behavior. Intelligent caching techniques leverage the power of artificial intelligence and machine learning to determine what should be cached, where it should be stored, and when it should be deleted from the cache. This paradigm shift from reactive caching to proactive and predictive caching represents a revolutionary change in edge-cloud network design and has triggered a massive research interest in intelligent caching architectures.**

Keywords—policy monitoring, AI, NLP, digital governance, policy analytics, AI for support

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ENERGY MANAGEMENT OPTIMIZATION FOR A PV–WIND HYBRID SYSTEM WITH CONTINUOUS HYDROGEN PRODUCTION.

Abdellah El Idrissi, Belkasem Imodane, Hatim Ameziane, Mohamed Benydir, M'Hand Oubella, Hamid Hamdani and Mohamed Ajaamoum

***Abstract*—The reliable operation of hybrid renewable energy systems, which simultaneously produce hydrogen and meet electricity needs, depends on efficient energy management. This paper proposes a rule-based energy management strategy (EMS) for a hybrid photovoltaic (PV) and wind system connected to a proton exchange membrane (PEM) electrolyzer and integrated with a shared DC bus. Safety, load satisfaction, battery protection, hydrogen production, and energy consumption limitation are among the system objectives that the proposed EMS dynamically prioritizes. It ensures stable and efficient system operation by coordinating power distribution between the PV modules, wind turbines, battery storage, and electrolyzer under various production and load conditions. A complete MATLAB/Simulink model of the hybrid system and its control approach was created and evaluated under various operating conditions, including load transients and the intermittency of renewable energy sources. The simulation results show that by redirecting excess power to hydrogen production, while respecting the operating limits of the batteries and electrolyzer, the proposed energy management system (EMS) increases the utilization of renewable energy. Furthermore, this plan ensures increased hydrogen production, constant DC bus voltage stability, and reliable power supply to the loads. These results confirm the robustness and efficiency of the proposed energy management system for hybrid renewable energy systems with integrated hydrogen production.**

Keywords—Renewable energy, Hydrogen production, Sliding Mode Control, PEM electrolyzer, Converter

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A MULTIPLE-BAND SEARCH INCREMENTAL CONDUCTANCE MPPT CONTROLLED BLDC MOTOR-DRIVEN WATER PUMP

Hamza Alrajoubi and Selim Oncu

***Abstract*—This study proposes a new approach to the incremental conductance (INC) maximum power point tracking (MPPT) method. The proposed method controls a single-stage solar water pumping system (SWPS) that uses a brushless DC (BLDC) motor. Its idea is to divide the power-voltage (P-V) curve of photovoltaic (PV) into an optimal number of bands or segments and then use INC-MPPT to identify the local peaks and select the global peak. It searches within each band to capture the global maximum power point (GMPP) efficiently and accurately track it rather than scanning the full range continuously. This approach avoids the complexity of global search and achieves fast tracking with high accuracy in rapidly changing environmental conditions (like cloud shading). An indirect MPPT control structure is used, employing a proportional-integral-derivative (PID) controller to regulate the motor speed smoothly and adjust the PV voltage level for every MPPT voltage set point. The system model was tested successfully under different weather conditions using MATLAB simulation. The BLDC motor operates efficiently, achieving more than 99% MPPT efficiency.**

Keywords—PV, single-stage solar pump, BLDC motor, INC-MPPT, multiple segments, global search

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EVENT-DRIVEN SHORT-CIRCUIT FAULT CLASSIFICATION IN SCIG WITH CONFIDENCE-WEIGHTED AGGREGATION

Hüseyin Tayyer Canseven and Evin Şahin Sadık

***Abstract*—Squirrel Cage Induction Generators are widely used in renewable energy systems, but their reliability is threatened by stator short-circuit faults. Traditional steady-state diagnostic methods are often rendered ineffective in modern applications because closed-loop controllers actively mask fault signatures. To address this challenge, this work introduces an event-driven fault classification framework specifically designed to detect and classify masked stator faults, namely inter-turn and inter-winding short-circuits. Instead of computationally expensive continuous signal analysis, the proposed methodology isolates brief, high-frequency transient disturbances using an adaptive, derivative-enhanced event detection mechanism. Discriminative features are extracted from these localized transient intervals, with a focus on derivative-based voltage representations. Finally, a novel confidence-weighted aggregation strategy is introduced to combine event-level predictions into robust file-level decisions. Experimental validation using a high-resolution dataset demonstrates that the proposed framework significantly improves diagnostic accuracy. The results show that derivative-based voltage features provide superior class separability, achieving a file-level Area Under the Curve of approximately 0.89, demonstrating the effectiveness of the targeted transient evaluation strategy in closed-loop systems.**

Keywords—Squirrel cage induction generator (SCIG), stator short-circuit, fault diagnosis, transient analysis, event-driven diagnosis, machine learning

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UNDERSTANDING AI ADOPTION IN DIGITAL MARKETING: AN SEM APPROACH

Thaya Madhavi and Pagadala Naveen Kumar

***Abstract*—This paper explores the processes that are fueling the Artificial Intelligence (AI) adoption in digital marketing contexts by considering the relationship between the AI perception, the usage behaviour, and the behavioural intentions. The research relies on modelling equation (SEM) in the analysis of data by using structural Data on 450 marketing professionals in various industries. This article validates holistic paradigm that will justify the transformation of AI perceptions into the behaviour of use and plans in the future and customizing them based on the relevant demographic and experience variables. In favour of measurement validity, the SEM analysis indicates a good fitment of the model (CFI = 095, RMSEA = 0048) and high factor loading. (074-088) The Results section demonstrates that there is positive significant relationship between AI usage, Behaviour and perception intentions. The Control variable analysis indicates that AI familiarity (0.41), experience (0.28), and data analysis capabilities (0.36) have a strong impact on the AI perceptions, whereas demographic factors have insignificant impacts. The model accounts 31.5 and 42.1 percent of the variance in behavioural intentions and AI perceptions respectively. These results apply technology acceptance theories to AI settings and give useful information to organizations adopting AI technologies. The findings indicate that the optimal approach to AI adoption must involve both perception-making and facilitating the usage experiences, with the significance of experiential learning being the key to further AI interest in digital marketing settings.**

Keywords—Digital Marketing, Technology Acceptance Model, Artificial Intelligence, Structural Equation Modelling, Behavioral Intentions, AI Adoption

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ALL METAL BASED HEXAGONAL TERAHERTZ METAMATERIAL ABSORBER FOR BIOMEDICAL APPLICATIONS

Shruti Shruti, Bhargav Appasani and Sasmita Pahadsingh

***Abstract*—This study introduces an all-metal based hexagonal terahertz metamaterial absorber designed for biomedical sensing applications. The proposed structure consists of two metallic layers: a steel plate at the bottom and an upper layer comprising four concentric hexagonal ring resonators of same metal. The absorber demonstrates four significant absorption peaks of 94.0%, 99.2%, 93.8%, and 92.6% at resonance frequencies of 2.852 THz, 3.031 THz, 3.352 THz, and 3.784 THz respectively. Notably, the second resonance peak at 3.031 THz is selected for sensing applications due to its maximum absorption efficiency. At this frequency, the proposed absorber exhibits a quality factor of 591.75 and a Figure of Merit of 359.22, both exceptionally high compared to conventional terahertz sensors. The device can effectively detect changes in the refractive index of biological tissues within the range of n=1.30 to 1.40. The Full Width at Half Maximum bandwidth is calculated to be 5.1221 × 10−3 THz, further confirming its suitability for precise biomedical sensing. In addition, the sensitivity of the structure is determined as 1.84 THz/RIU at 3.031 THz, where RIU represents the Refractive Index Unit. The absorption mechanism of the proposed absorber is thoroughly explained through the analysis of current distribution plots. The proposed absorber demonstrates potential applications in terahertz biomedical sensing.**

Keywords—Metamaterial Absorbers, Sensing, Refractive Index, Terahertz, Biomedical, Q-factor, Figure of Merit.

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TINYML-BASED WEARABLE ECG MONITORING SYSTEMS: STATE-OF-THE-ART SURVEY ON ARCHITECTURES, OPTIMIZATIONS, AND DEPLOYMENT CHALLENGES TOWARDS FUTURE DIRECTIONS

Saja B. Attallah, Rand A. Atta, Zaid Ameen Abduljabbar, Ruslan S. Naseef, Ali S. Abdulmohsin, Abusnina M. Mukhtar, Mustafa Noaman Kadhim, Bilal S. Rasheed and Vincent Omollo Nyangaresi

***Abstract*—The growing potential of wearable healthcare and artificial intelligence has propelled the evolution of continuous electrocardiography (ECG) monitoring into non-clinical settings in recent years. Despite this progress, the deployment of deep learning models for wearable applications remains limited due to constraints on computation, energy consumption, latency, and privacy and security issues associated with cloud-based processing. This is where Tiny Machine Learning (TinyML) comes to the rescue, enabling lightweight AI inference on even the lowest-power, resource-constrained embedded systems. This review provides a high-level organizational structure of wearable ECG monitoring systems using TinyML and summarizes recent developments in integrated artificial intelligence that aid cardiac health technology. First, this review summarizes the basics of wearable electrocardiogram (ECG) monitoring and the TinyML deployment ecosystem. Then, it examines lightweight neural architectures such as convolutional, recurrent-based, transformer-based, and hybrid circuits, particularly for low-power systems. This also includes optimizations of quantization, pruning, compression, and hardware-aware deployment for efficient execution under embedded constraints. In addition, this review covers popular public ECG datasets and evaluation approaches and discusses real-life challenges for deep learning in cardiac arrhythmia diagnosis, including interpretability, clinical validation, generalizability and deployment. Dimensions of future research towards reliable, energy-efficient and clinically-realizable wearable cardiac monitoring systems are discussed.**

Keywords—TinyML, Wearable ECG Monitoring, Electrocardiography (ECG), Edge Artificial Intelligence, Embedded Machine Learning, Arrhythmia Detection, Internet of Medical Things (IoMT), Model Optimization

SMART HANDWRITING RECOGNITION SYSTEM FOR ONLINE ASSESSMENT.

Natukula Manicharan

***Abstract*—The proposed paper is a smart handwriting recognition system that will enrich the process of online assessment by allowing automatic grading of handwritten answers. The system combines the image preprocessing, optical character recognition (OCR) based on deep learning and contextual awareness of natural language processing (NLP) to be able to correctly interpret handwritten text and transform it into the machine-readable form. A hybrid network that consists of a convolutional and recurrent neural network is used to extract robust features and model the sequence, whereas a language model corrects the identified text in terms of semantic and grammatical errors. The processed output is also used in automated or semi- automated grading by similarity-based evaluation techniques. The experimental results show that their performance in character recognition and accuracy in word recognition are better than the traditional OCR methods. The suggested system saves manual labor, improves the accuracy of evaluation, and offers a scalable solution of the contemporary digital learning environments.**

Keywords—OCR, EADYOCR, RNN, CNN, TESSERACT

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AI-BASED MULTI-STAGE PIPELINE FOR EARLY CHILDHOOD PERSONALIZED LINGUISTIC ASSESSMENT

Binuki Mihara, Eshanie Rathnasinghe, Thiyara Gunawardena, Chathuni Abesinghe, Lakmini Abeywardhana, Lokesha Weerasinghe and Naren Selvaratnam

***Abstract*—Early childhood English proficiency is vital for cognitive and academic growth, yet assessment in low-resource, non-native contexts like Sri Lanka faces challenges from accent variations, child-specific acoustics, and manual scaling limits. We present a novel AI-based multi-stage pipeline using a voice assistant for personalized linguistic evaluation, featuring a custom 3.18-hour dataset (501 recordings from Sri Lankan children aged 4-8) to fine-tune Whisper ASR (Test WER: 27.27%). It integrates fine-tuned Flan-T5 for grammar error type detection and correction (91.47% accuracy), SBERT/spaCy for pragmatic relevance/tense matching, Q-learning for session adaptation, and LIME for interpretable feedback. Linking to Broca/Wernicke areas of brain and emotional influences, the system outperforms baselines in transcription, grammatical error classification (F1=0.82), and personalization, enabling scalable teacher/parent monitoring. This bridges the gap between clinical linguistics and classroom monitoring.**

Keywords—Automatic Speech Recognition, Grammar Error Correction, Explainable AI, Reinforcement Learning, Early Childhood Development

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CYBERSECURITY RESILIENCE OF HEALTHCARE CRITICAL INFRASTRUCTURE: A CASE STUDY OF THE HIPOCRATE/RSC RANSOMWARE INCIDENT (FEBRUARY 2024)

Adelaida Stanciulescu

***Abstract*—Critical infrastructures, particularly in the healthcare sector, are increasingly vulnerable due to their dependence on third-party software providers. The Hipocrate incident stands as one of the most severe cyberattacks in the history of the Romanian healthcare system. The compromise of the servers belonging to the Hipocrate Health Information System provider paralyzed the operations of 26 medical units and forced the preventive disconnection of 79 others, affecting approximately 19% of Romania's operational hospitals. The ransom demand of 3.5 BTC (~€157,000) was refused. This paper reconstructs the attack chain using attack trees and the MITRE ATT&CK v14 framework, evaluates post-incident resilience through MTTD, MTTR, and a proposed Longitudinal Resilience Index (LRI), and quantitatively validates — through Agent-Based Modeling simulation (AnyLogic 8.9.8) — the impact of NIS2 compliance: the LRI at 72 hours increases from 0.539 in the real scenario to 0.674 in the post-NIS2 scenario, while the infection peak drops from 94% to 57% of network nodes. The decisive vulnerability: the absence of multi-factor authentication for remote vendor access. The factor that limited the disaster: the institutional transparency of DNSC, with IoCs published within 72 hours.**

Keywords—Software supply chain attack, cybersecurity resilience, Hipocrate incident, attack trees

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THRESHOLD MECHANICAL STRESS FOR REORIENTATION OF LOCALISED HYDRIDES IN ZR-2.5%NB ALLOY

Denisa Toma, Nicu Bizon, Viorel Ionescu, Vasile Radu, Alexandru Nitu, Alexandra Jinga, Alexandru Toma, Sebastian Dragusin and Robert Bostinaru

***Abstract*—The absorption of deuterium in CANDU (CANadian Deuterium Uranium) pressure tubes from the heavy water coolant during normal reactor operation leads to an increase in the concentration of hydrogen equivalent in the material volume. This, combined with the existence or occurrence of defects on the inner surface of the CANDU pressure tube, Zr-2.5%Nb (Zirconium 2,5% Niobium) alloy, results in the migration of hydrogen to locations of high mechanical stress. Under specific thermal cycling conditions, determined by the loading-unloading regimes of the nuclear fuel, localised hydrides may form at mechanical stress spots on the top of the volumetric flaw, thereby developing a fragile zone in these locations. Determining the threshold mechanical stress, from which the reorientation phenomenon of zirconium hydrides can occur, plays an important role in the structural integrity analyses, which are carried out on Fitness-for-Service criteria in the periods between two periodic inspections of CANDU 600 fuel channels. In this paper, a method is developed to obtain the threshold stress value from which the reorientation of localized hydrides occurs based on metallographic analyses and stress field analysis at volumetric flaws by using the finite element method (ANSYS).**

Keywords—reorientation hydrides, threshold stress, hydrogen embrittlement, hydride cracking

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POSE ESTIMATION DRIVEN KINEMATIC ANALYSIS OF SHOULDER EXERCISES CAPTURED FROM MONOCULAR VIDEOS IN NATURAL AND REALISTIC CONDITIONS

Jorge Felix Martínez Pazos, Hans-Peter Köhler, Silvano Merced Len and Jorge Gulìn-Gonzàlez

***Abstract*—The human shoulder's biomechanical complexity and wide range of motion make it prone to maladaptive movement patterns during exercise. Laboratory-based motion capture systems provide precise kinematic data but are costly and restrictive, limiting the study of naturalistic movement. This research explores shoulder kinematics and associated upper-body movements during gym exercises using a non-invasive and practical video-based approach. Monocular RGB videos at 60 fps were recorded in a gym environment. MediaPipe BlazePose 3D was employed to track upper-limb key points, while cervical alignment was indirectly estimated from the geometric relationship between the nose landmark and the midpoint of the bilateral heel landmarks, providing a measure of head-neck deviation relative to the vertical axis. Upper-limb kinematics and cervical posture were analyzed to evaluate movement coordination and postural control during loaded exercises. During shoulder exercises, cervical deviations were observed that, in some cases, reflected natural postural adjustments or reflexive responses. Involuntary movements, such as brief shifts in head position or gaze, occasionally amplified these deviations, particularly during sustained loaded tasks. The importance of postural control during resistance exercises is emphasized by these findings, which demonstrate how subtle, involuntary behaviors can influence cervical-shoulder stability and upper-limb coordination. Monocular pose estimation combined with geometric inference successfully captured meaningful kinematic patterns without the necessity of a specialized laboratory. The proposed framework provides a practical, non-invasive, and economical method to study shoulder and associated upper-body kinematics outside the laboratory. It enables assessment of movement patterns, detection of maladaptive behaviors, and evaluation of exercise technique in real-world settings.**

Keywords—Kinematic Analysis, Motion Capture, Monocular Pose Estimation

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FAULT DETECTION IN CAR ENGINES USING ACOUSTIC ANALYSIS FOR PREDICTIVE MAINTENANCE AND DIAGNOSTICS

Garwaz Akilan, Moises Javier, Moh. Ahadhin Tati and Odon Maravillas

***Abstract*—Conventional vehicle diagnostic tools, such as On-Board Diagnostics (OBD), may not recognize small mechanical problems with the engine's mechanical parts. In this paper, the authors propose the use of an artificial intelligence-based engine fault diagnosis system based on acoustic signals as a predictive vehicle maintenance approach. The engine states that the proposed system can recognize include Normal, Clicking, Knocking, Rod Knock, and Timing Belt. Audio signals were obtained from online sources such as TikTok, YouTube, Facebook, and Hugging Face. Three deep learning models were tested: MobileNetV2, ResNet50, and YAMNet. The results were obtained in terms of accuracy, precision, recall, and F1 score. The best model among all was MobileNetV2, with a high accuracy of 94.38% for training, 84.38% for validation, and 67.86% for real-world applications. The model correctly identified 19 out of 28 vehicles. The ResNet50 model had a high accuracy of 78.12%, while the YAMNet model had an accuracy of 43.75%. It was also observed that the fuel type had an impact on the classification results. The system achieved an accuracy of 75% in gasoline engines, whereas the system achieved an accuracy of 50% in diesel engines.This is because there were more gasoline engine recordings in the dataset. A web-based diagnostic tool was also implemented to record, analyze, and report engine sound in real-time to enable non-technical users to utilize it. The results indicate that deep learning with acoustic analysis is a non-invasive method for early fault detection in engines.**

Keywords—Acoustic analysis, Deep learning, Engine fault detection, Predictive maintenance, Spectrograms

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SIAMESE MASK R CNN: AN EXPLAINABLE DUAL-BRANCH FRAMEWORK FOR THE DETECTION AND LOCALISATION OF IMAGE SPLICING

Shahad Amjed Hamed, Khawla Hussein Ali, Zaid Ameen Abduljabbar and Vincent Nyangaresi

***Abstract*—Image splicing is a common attack vector in the digital world which is quite often deployed for malicious activities such as the dissemination of fake news. In order to preserve trust in visual evidence, these image manipulation technique need to be detected. Unfortunately, conventional image slicing detection cascades are primarily designed based on hand-crafted features, which is inefficient. In addition, conventional detection mechanisms experience some trade-offs between accuracy and localisation error. As such, many deep learning approaches have been developed for this task. However, these deep learning techniques are black-box models, which are characterized with low explainability and poor generalisation to other types of transformations. To address these problems, this paper presents a deep learning approach based on a Siamese Mask R-CNN for the detection of image splicing. The deployed Siamese architecture includes two symmetric networks with shared weights, which can be trained to compare pairs of inputs. As such, it results in better detection of image-splicing forgeries. Moreover, the deployed Mask R-CNN can detect splicing regions and their boundaries via pixel-level segmentation. The proposed method is evaluated on the CASIA v2 and Columbia datasets, achieving accuracy and precision values of 98.52% and 100% respectively. In addition, the proposed Siamese network with Mask R-CNN yields a significant boost in manipulation detection, particularly for image splicing. This technique renders the proposed model more attentive to image content, in addition to being much sensitive to changes. As such, it is capable of recognising splicing operations more efficiently and effectively.**

Keywords—Siamese Network, R-CNN, Image Splicing, Mask R-CNN, Localisation

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COMPARATIVE BPM-BASED ANALYSIS OF GRATING-ASSISTED COUPLING IN MICRORING RESONATORS FOR INTEGRATED PHOTONIC APPLICATIONS

Lipsa Subhadarshini and Pallabi Mishra

***Abstract*—Microring resonators are key building blocks in integrated photonic circuits, where device performance is strongly governed by the efficiency of optical coupling between the bus waveguide and the resonant cavity. This paper presents a systematic beam propagation method (BPM)–based comparative analysis of three microring resonator configurations: without grating, with non-uniform grating, and with uniform subwavelength grating in the coupling region. Optical field evolution, confinement characteristics, and resonant circulation behavior are investigated at an operating wavelength of 1550 nm using OptiBPM. Two-dimensional and three-dimensional field intensity distributions are analyzed to examine coupling dynamics and power leakage mechanisms. Quantitative evaluation is performed using normalized peak field intensity and coupling efficiency as performance metrics. The results demonstrate that uniform subwavelength grating-assisted coupling provides smoother effective refractive index transitions, enhanced mode matching, and significantly improved optical field confinement compared to both no-grating and non-uniform grating configurations. Furthermore, the extracted simulation-based field metrics form a structured and physically meaningful dataset that is well suited for data-driven surrogate modeling and AI-assisted optimization of grating-assisted photonic devices. The proposed framework offers practical design insights for integrated photonic applications and supports emerging trends in computational intelligence–enabled photonic system design.**

Keywords—Microring resonator, integrated photonics, beam propagation method, subwavelength grating, optical coupling

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ADVANCED WATER QUALITY MANAGEMENT BY UAV BASED IN-SITU MEASUREMENT, WATER SAMPLING AND REMOTE SENSING

Pham Duc Dai, La Phu Hien and Khoa Nguyen Dang

***Abstract*—Water quality monitoring is a crucial task in ensuring water security. With global climate change and the emergence of new pollutants, surface water contamination is becoming increasingly serious. These factors pose challenges in improving monitoring efficiency and developing methods for early pollution detection to alleviate the spread of pollution. This paper proposes an effective solution for monitoring and early detection of water pollution over large areas using unmanned aerial vehicles (UAVs) based in-situ measurement, water sampling and remote sensing. The system operates on the principle of data collection, modeling to estimate water quality parameters, and early pollution detection methods. UAVs can carry direct sensors and sampling devices to survey large areas and provide data for constructing water quality estimation models using remote sensing imagy. The estimation models and multispectral imagery help to create water quality maps and trends of water quality change within the managed area. Areas with unusual changes in water quality over a large area could be sources of pollution. Managers can identify these locations, and UAVs can fly there to directly measure and collect samples, aiding in the verification of pollution sources. A system for monitoring and early pollution detection has been practically implemented in one lake in Hanoi, and the results demonstrate its effectiveness**

Keywords—Multispectral, Unmanned Aerial Vehicle, Remote sensing

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SMART INVERTER DESIGN FOR ZERO EMISSION MARINE POWER SYSTEM

Balaji V, Harshini P, Jeeva Dharshini T and Megaa S

***Abstract*—The decarbonization of marine auxiliary power systems requires efficient renewable-integrated electrical architectures. This work presents the design and hardware implementation of a DC-coupled marine power system based on a regulated common DC bus. Solar photovoltaic and wind energy outputs are conditioned through power electronic interfaces before integration into the DC link. To improve system dynamics, a hybrid storage unit consisting of a 12 V battery and a supercapacitor is connected across the DC bus. The battery provides sustained energy support, while the supercapacitor compensates for short-duration power fluctuations, maintaining DC link voltage stability. A microcontroller-based control scheme generates PWM signals to drive MOSFET switching devices through opto-isolated drivers. Voltage and current sensing provide feedback for duty-cycle control and protection. Experimental evaluation demonstrates stable DC bus regulation, effective renewable integration, and reliable DC load operation under varying input conditions. The proposed DC-coupled configuration simplifies power coordination and is suitable for renewable-assisted marine auxiliary power systems.**

Keywords—DC Microgrid, Marine Renewable Energy System, Common DC Bus Architecture, Multi-Port Interleaved High-Gain SEPIC Converter, Hybrid Energy Storage System, Battery–Supercapacitor Integration

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PILLAR-BASED TAXONOMY OF ENABLING TECHNOLOGIES FOR INDUSTRY 5.0 TRADE-OFFS AND FUTURE RESEARCH DIRECTIONS

Marius Constantin Marica, Nicu Bizon and Ionel Bostan

***Abstract*—Industry 5.0 represents a paradigm shift from Industry 4.0, repositioning the human factor, sustainability and resilience as central values of industrial processes. Although recent literature extensively covers the individual technologies associated with this transition, a systematic approach is lacking that simultaneously maps the enabling technologies onto the three official pillars of Industry 5.0, assesses their maturity level and identifies tensions between the pillars. This paper proposes a pillar-based taxonomy, namely Human-Centricity, Sustainability and Resilience, as an original framework for classifying key technologies for Industry 5.0. The taxonomy integrates three dimensions of analysis: pillar membership, technological maturity level and inter-pillar conflict relationships, providing a structured framework for analyzing Industry 5.0 technologies. Based on the proposed taxonomy, cross-cutting technologies that simultaneously serve multiple pillars are identified, together with four key inter-pillar trade-offs. The paper concludes with a structured agenda of open research directions, derived directly from the taxonomy analysis. The results provide a useful framework for both researchers positioning their contributions in the context of Industry 5.0 and industrial practitioners assessing the technological maturity of available solutions.**

Keywords—Industry 5.0, Industry 4.0, enabling technologies, pillar-based taxonomy, human-centricity, sustainability, resilience, technology maturity, trade-off analysis

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NON-INTRUSIVE LOAD MONITORING: IDENTIFICATION BASED ON GENETIC ALGORITHMS OPTIMIZATION

Alexandra Buzducea, Florin Enache, Emil Cazacu and Georgiana Subașu

***Abstract*—With the increasing electricity demand experienced at global level, it has become mandatory for all the parties involved in its production and distribution to adopt efficient and responsible methods of energy management. In the past few decades, research in the field of electrical engineering focused on non-intrusive load monitoring (NILM) methods, aiming to simplify the characterization of local grids. The proposed paper approaches the load identification phenomena as a problem of optimization and uses genetic algorithms (GA) to correctly identify the combination of connected electrical consumers from an aggregated current signal.**

Keywords—non-intrusive load monitoring, source identification, genetic algorithm

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OPTIMAL PRESSURE MANAGEMENT FOR WATER DISTRIBUTION SYSTEMS USING ACCURATE QUADRATIC PIPE FRICTION MODEL

Pham Duc Dai and Trung-Dung Le

***Abstract*—Optimal pressure management in water distribution systems (WDSs) is one of the most efficient approaches to regulate water leakage for water utilities worldwide. The pressure control aiming to minimize excessive pressure can be accomplished through regulating operations of pressure reducing valves (PRVs) placed in the WDSs, and this engineering problem can be formulated as a nonlinear program optimization problem (NLP). Using the Hazen-Williams formula in the formulated NLP will lead to the problems of singular jacobian when solving it by standard nonlinear program solvers. To deal with this problem, the Hazen-Williams formula (H-W) will be approximated by a quadratic function, which can be readily used for formulating and solving the NLP. However, the proper choice of the flow range for taking the approximation, which results in feasible solution when applying to the WDS using H-W model, has not been discussed yet in the literature. In this paper, we propose an approach to improve the NLP solution by determining an effective velocity for taking approximation of quadratic pipe model. With such the velocity value, the solution of the formulated NLP will guarantee minimum pressure satisfaction as applying to the WDSs with H-W model and, at the same time, it results in low excessive pressure. A benchmark case study is taken to demonstrate the efficiency of our proposed approach. The results have revealed that, for each WDS, it is possible to find an effective velocity providing feasibility and high quality of NLP.**

Keywords—Quadratic pipe friction model, Water distribution system, Optimal pressure management

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DIGITAL-INTELLIGENCE DEEP-LEARNING FOR CONFIDENTIAL-COMPUTING UNDER ZERO-TRUST TOKENIZATION AGAINST CYBER ATTACKS

Hossein Shayeghi, Babak Mohamadi, Peyman Zare, Salar Rezaei Moghadam and Nicu Bizon

***Abstract*—Cyber-physical energy systems increasingly depend on digital measurement, state estimation, and learning-assisted monitoring layers. This dependence improves situational awareness, but it also exposes the energy infrastructure to stealthy data-manipulation attacks that can alter the operator's view of the system without producing a clear residual alarm. This paper presents a digital-intelligence deep-learning framework for analyzing false data injection attacks in energy-system state estimation under a confidential-computing and zero-trust tokenization perspective. Three physics-constrained generative models are developed and compared: a conditional generative adversarial network, an autoencoder, and a variational autoencoder. The proposed framework does not generate attack samples as unconstrained noise. Instead, it embeds the nonlinear measurement function, local state-estimation sensitivity, residual-preservation behavior, and reconstruction consistency into the learning process. This structure allows the generated samples to remain close to the feasible measurement manifold while retaining statistical similarity to real operating data. The models are evaluated on IEEE 14-bus, IEEE 57-bus, and IEEE 118-bus systems using convergence behavior, bad data detection bypass rate, and Jensen-Shannon divergence. The results show that the variational autoencoder and autoencoder provide stronger residual evasion, whereas the conditional generative adversarial network produces more realistic measurement distributions. These findings indicate that residual stealth and distributional stealth are different security properties and should be jointly considered in zero-trust energy-monitoring architectures.**

Keywords—Deep Learning, Energy System Security, State Estimation.

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A SCALABLE FRAMEWORK FOR STRUCTURED DATA CLEANING IN STREAMING ENVIRONMENTS: AN ML-BASED PREDICTION APPROACH WITH HUMAN-IN-THE-LOOP GOVERNANCE

Lavindi Thihansa

***Abstract*—Ensuring high data quality in streaming environments is a critical challenge due to the continuous, high-volume, and heterogeneous nature of incoming data. This paper presents a novel A scalable framework for structured data cleaning that advances beyond rule-based and statistical approaches through dependency informed machine learning prediction. The core novelty is a per column Random Forest prediction engine, in which each target The attribute is corrected using a model trained exclusively on statistically dependent columns, identified through chi-square testing, mutual information, and Spearman correlation. This dependency-aware architecture prevents spurious cross-attribute contamination and produces contextually coherent corrections. The framework integrates LLM-based rule extraction (LLaMA 3.3-70B), multi-dimensional issue detection, SHAP and LIME explainability, and a Human-in-the-Loop governance layer in which human review is the primary correction pathway and ML auto-correction activates only on inactivity timeout with mandatory approval confirmation. A composite quality scoring mechanism (Completeness 40%, Validity 40%, Consistency 20%) quantifies dataset reliability on a 0–95 normalized scale with grade mapping. Evaluation design considerations demonstrate that the proposed approach achieves robust, explainable, and accountable data cleaning for real-time streaming applications.**

Keywords—structured data cleaning, streaming data, machine learning prediction, dependency analysis, Human-in the-Loop, data quality, LLM rule extraction, SHAP, LIME, Apache Kafka

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FINTECH ADOPTION, GREEN FINANCE, AND FINANCIAL LITERACY: A UNIFIED FRAMEWORK FOR SUSTAINABLE CONSUMER BEHAVIOUR

T Deva Prasad and B Raghava Reddy

***Abstract*—Purpose: This investigation aims to investigate the conjoint impact of FinTech adoption (FA), green finance (GF) and financial literacy (FL) on the development of the sustainable consumer behaviour (SCB) in Indian digital financial landscape. It further scrutinises the mediating role of financial literacy in the transformation of the digital financial engagement and green financial awareness into sustainability-oriented behavioural outcomes. Design/methodology/approach: A quantitative cross-sectional design was adopted whose results were based on the survey data collected from 430 active users of financial digital services in both urban and semi-urban areas in India. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used through the software SmartPLS 4.0 to measure construct reliability, convergent and discriminant validity, structural relationships and indirect mediation relationships. Findings: The analysis supports strong psychometric properties on all constructs and find that both FA and GF significantly improve on FL as well as on SCB. Green finance has a large predictive relevance of FA, FL, and SCB. Financial literacy was a powerful mediator in the relationships of the FA - SCB and the GF - SCB, which evidenced meaningful indirect and sequential mediation effects. The structural model has a high explanatory power (R2-SCB = 0.692), thus shedding light on the important role of literacy and awareness to promote sustainable financial behaviour. Originality/value: This research adds an integrated model linking the financial technology utilisation, green financial orientation and financial capability towards sustainability driven consumer behaviour which is an underexplored area in emerging economies. The findings provide valuable information for immediate action, for policymakers, educators, and FinTech providers looking to enhance sustainability outcomes using digital financial ecosystems.**

Keywords—Fintech Adoption, Green finance, Financial literacy, and sustainable consumer behaviour

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AN INTERPRETABLE FP-GROWTH-BASED ASSOCIATION RULE MINING FRAMEWORK FOR MULTI-SOURCE OBESITY RISK ANALYSIS USING NHANES DATA

Saja B. Attallah, Abusnina M. Mukhtar, Rafif Aman Mahammed, Ruslan S. Naseef, Ali S. Abdulmohsin, Muntadher Alsabah, Zaid Ameen Abduljabbar, Ali Hasan Ali and Vincent Nyangaresi

***Abstract*—Obesity is a complex problem involving interactions of dietary, metabolic and behavioral factors that present a significant public health challenge. Machine learning techniques have been widely employed for obesity prediction; however, many existing approaches have limited interpretability, which prohibits their usage in future healthcare strategies. This study provides a novel data-mining framework that uses an ensemble of the interpretable association-rule mining algorithm FP-Growth to identify obesity-risk patterns from multiple-source data based on the National Health and Nutrition Examination Survey (NHANES). The framework collates demographic, dietary, laboratory, examination and questionnaire data into a single cohesive platform, yielding 9,813 records for complete participants. Continuous health variables were converted into binary risk indicators to facilitate efficient extraction of frequent patterns. Association rules were established with obesity as the target outcome and rated by support, confidence and lift. Fourteen major obesity-related association rules were identified from experimental results. The most significant predictors of obesity were dietary factors, especially high caloric intake, which produced a ceiling effect value of 2.83 and high sugar consumption. On the other hand, increased blood sugar had the greatest predictive accuracy at a confidence of 51.54%. Behaviors such as short sleep duration and a sedentary lifestyle contributed heavily to obesity risk as well. The transparent and clinically interpretable insights provided by the proposed framework may support healthcare analytics, obesity-risk assessment and public health decision-making.**

Keywords—Obesity Prediction, Data Mining, FP-Growth, Association Rule Mining, NHANES, Explainable AI, Health Analytics, Lifestyle Risk Factors

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MATLAB/SIMULINK® SEPIC DC/DC CONVERTERS OPERATING IN BOTH CCM AND DCM AVERAGE MODELS IMPLEMENTATIONS

Eduard-Dimitrie-Alexandru Vulpe and Claudius Dan

***Abstract*—In this paper we present our implementation of the behavioral models for the SEPIC converter in MATLAB/Simulink® and we compare the response with the results in LTSpice® in order to check if this setup is suitable to design such a DC/DC converter. Additionally, we make use of MATLAB/Simulink® numerical capabilities to analyze the changes that take place in the poles and zeros positions due to operating conditions. Based on the state-space analysis, we derived the transfer functions of the SEPIC and simulated it in MATLAB/Simulink®. Transfer function parameter comparison vs behavioral model results confirm method validity.**

Keywords—DC/DC, SEPIC converter, behavioral models, state-space modelling, transfer function, MATLAB/Simulink®, LTSpice®

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AUTOMATIC SPEECH RECOGNITION: A COMPREHENSIVE REVIEW FROM HMM-GMM TO SELF-SUPERVISED FOUNDATION MODELS

Dhiaa M. Abed, Saja B. Attallah, Awab Qasim Karamanji, Ruslan S. Naseef, Hussein M. Hasan, Abusnina M. Mukhtar, Ali S. Abdulmohsin, Zaid Ameen Abduljabbar and Vincent Omollo Nyangaresi

Abstract*—Automatic Speech Recognition (ASR) has emerged as one of the most transformative technologies in modern artificial intelligence, underpinning critical applications in healthcare, education, smart devices, robotics and human-computer interaction. Despite remarkable progress driven by deep learning, transformer architectures and self-supervised learning, a unified analytical framework covering the full trajectory from classical statistical models to contemporary foundation-model approaches remains absent from the literature. This paper addresses that gap by presenting a comprehensive review of ASR systems, tracing the evolution from traditional Hidden Markov Model (HMM) and Gaussian Mixture Model (GMM) pipelines to modern end-to-end, transformer-based and self-supervised architectures. The review synthesizes major ASR techniques, including MFCC feature extraction, DNN-HMM hybrids, CNN and LSTM acoustic models, attention-based encoder-decoders, Transformers, Conformers and self-supervised frameworks such as wav2vec 2.0, HuBERT and Whisper and critically evaluates their relative strengths and limitations. Benchmark corpora and evaluation metrics, including WER, CER, PER and RTF, are systematically examined. Beyond accuracy, the paper provides a multi-dimensional comparative analysis of computational complexity, robustness, multilingual scalability, latency and deployment feasibility across edge and cloud environments. Key challenges, including noise robustness, low-resource and multilingual ASR, accent variability, computational cost, algorithmic bias and data privacy, are thoroughly discussed. Emerging research directions encompassing foundation models, multimodal audio-visual ASR, edge AI and scalable self-supervised pretraining are also identified. By integrating architectural analysis, empirical benchmarking and open-challenge synthesis within a single structured framework, this review provides actionable insights for researchers and practitioners designing the next generation of efficient, equitable and deployable speech recognition systems.

Keywords—Automatic Speech Recognition (ASR), Deep Learning, Transformer Networks, Self-Supervised Learning, wav2vec 2.0, Whisper, Conformer, Speech Processing, End-to-End ASR, Multilingual ASR, Edge AI, Real-Time Speech Recognition, Acoustic Modeling, Speech Recog

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FREQUENCY-SCALABLE DESIGN AND EXPERIMENTAL VALIDATION OF SOLR MICROSTRIP BANDPASS FILTERS AT 2.4, 3.5, AND 5.8 GHZ

Andreica Sergiu

***Abstract*—This paper presents the design and experimental validation of frequency-scalable square open-loop resonator (SOLR) microstrip bandpass filters operating at 2.4 GHz, 3.5 GHz, and 5.8 GHz. The study extends previous single-frequency investigations by demonstrating the applicability of the proposed design approach to multiple frequency bands of interest in modern wireless systems. The filters are designed using different dielectric substrates and analyzed through three-dimensional electromagnetic simulations. Fabricated prototypes are experimentally validated by frequency-domain measurements to evaluate the filter performance as a function of operating frequency and substrate properties. The experimental results show good agreement with the simulated responses and highlight the multi-band behavior of the SOLR filters. The comparative analysis confirms that the proposed structures enable effective frequency scalability while maintaining suitable performance for wireless and electromagnetic compatibility applications in the sub-6 GHz frequency range.**

Keywords—microstrip bandpass filters, square open loop resonator, dielectric substrates, experimental validation, sub-6 GHz

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SMART MONITORING OF AN AGRICULTURAL GREENHOUSE: PREDICTIVE ANALYSIS FOR TOMATO CULTIVATION

Ouahbi Younesse, Maarouf Asmae, Khalifi Manal, Saadaoui Benlkahlaafrae, Driar Raid, Kasraoui Mehdi and Ziti Soumia

***Abstract*—Intelligent monitoring technologies are being increasingly incorporated into smart agricultural practices to improve crop yields and resource utilization efficiency. In this paper, we propose an intelligent monitoring framework for smart greenhouses using multimodal monitoring approaches, including Internet of Things-based environmental monitoring, camera-based visual monitoring, and machine learning-based decision support systems. The system continuously monitors vital microclimatic factors, including temperature, humidity, and luminosity, using an IoT-based distributed sensor network. The environmental monitoring module employs an unsupervised anomaly detection algorithm, known as the Isolation Forest algorithm, to analyze the environmental data, allowing the system to identify abnormal climate patterns without requiring prior knowledge of normal patterns. At the same time, an intelligent camera-based monitoring module performs visual monitoring of the plant conditions using an image classification algorithm, providing additional information about the plant conditions beyond the environmental monitoring module. The results of both monitoring approaches are fused using a multimodal fusion algorithm to improve the accuracy of anomaly detection and reduce false alarms. The decision support system uses rules to provide recommendations based on the detected anomalies, displayed using an interactive dashboard interface. The proposed system design is efficient, scalable, and interpretable, making it appropriate for deployment in resource-constrained agricultural environments. The system's integration of IoT, artificial intelligence, and machine learning technologies makes it an innovative solution for advancing precision agriculture, thereby promoting sustainable food production globally.**

Keywords—Smart Agriculture, Greenhouse Monitoring, Internet of Things (IoT), Anomaly Detection, Machine Learning, in Agriculture, Environmental Monitoring, Isolation Forest, Computer Vision, Multimodal Data Fusion, Decision Support, Systems, Precision Agriculture

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SOFTWARE SUPPLY CHAIN ATTACKS IN 2025–2026: COMPARATIVE ANALYSIS OF ATTACK VECTORS, OSINT SOURCES AND DESIGN OF A MACHINE LEARNING ARCHITECTURE FOR EARLY WARNING

Adelaida Stanciulescu

***Abstract*—This work analyzes major Software Supply Chain Attack (SSCA) incidents from the period January 2025 – May 2026. The 10 new incidents in the first five months of 2026 were examined along three dimensions: attack vectors, the effectiveness of OSINT (Open Source Intelligence) sources in early detection, and the implications for cyber resilience. The comparison with the 2025 landscape reveals a paradigm shift: self-replicating worm campaigns have given way to coordinated multi-vector operations targeting npm and PyPI simultaneously, with new extensions to DevSecOps tooling and AI/ML (Artificial Intelligence / Machine Learning) ecosystems. OSINT has proven effective for public package registries — with response times in the order of hours — and systematically ineffective for the vendor/installer vector, where the non-detection interval has reached 30 days. Based on these findings, we developed an ML framework that uses NLP (Natural Language Processing) to extract entities from unstructured OSINT sources and LSTM (Long Short-Term Memory) to classify packet behavior - with the aim of detecting attacks before a CVE (Common Vulnerabilities and Exposures) is issued.**

Keywords—Software Supply Chain Attack, OSINT, Cyber Resilience, Anomaly Detection, LM

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INVESTMENT PORTFOLIO OPTIMIZATION USING MACHINE LEARNING AND REINFORCEMENT LEARNING METHODS

Ion Bostan, Sebastian-Alexandru Dragusin and Nicu Bizon

***Abstract*—This paper proposes an integrated framework for investment portfolio optimization that combines gradient boosting prediction models (LightGBM), market regime detection via Hidden Markov Models (HMM), and a reinforcement learning agent trained using the Proximal Policy Optimization (PPO) algorithm. The system was implemented as an interactive web application (Streamlit) and evaluated on a portfolio of 20 assets (equities and sector ETFs) from the NASDAQ/NYSE technology sector, automatically selected via multi-criteria ranking from a universe of 530 tickers available to users in the interface (experimental configuration with max_assets=20), using daily OHLCV data from Yahoo Finance. LightGBM models were trained on the 2015-2020 period, while the RL-PPO agent used an extended training window (2015-2022) encompassing both the 2021 tech bull market and the severe 2022 correction, providing broader market regime coverage. Out-of-sample evaluation of the RL agent targeted the interval July 2022 - December 2024. Approximately 88 technical and regime features were constructed per asset, including moving averages, RSI, MACD, Bollinger Bands, and log-returns over multiple horizons. The LightGBM return direction prediction model achieved a directional accuracy of 64.8% on walk-forward out-of-fold (WF-OOF) validation and 67.03% on the IS validation set, with an F1 score of 0.740. The RL-PPO agent, trained for 500,000 timesteps with a parsimonious reward function (excess return minus transaction cost), achieved an annualized Sharpe ratio of 1.157 over the full 2015-2024 period - outperforming all baseline strategies and the SPY benchmark (Sharpe 0.477) - with a CAGR of 20.15% and a Maximum Drawdown of -16.02%, substantially lower than SPY's -33.92%. On the out-of-sample period (July 2022 - December 2024), the RL-PPO Sharpe ratio (0.887) exceeded both HRP (0.845) and SPY (0.581). Stress tests across historical scenarios (COVID crash 2020, inflation bear market 2022, AI bull run 2024) consistently confirm the strategy's robustness, with drawdowns lower than all evaluated alternatives.**

Keywords—portfolio optimization, reinforcement learning, Proximal Policy Optimization, LightGBM, Hierarchical Risk Parity, Hidden Markov Model, SHAP, financial markets

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MEDAI-SVM: A HYBRID AI FRAMEWORKS FOR MULTI-DISEASE EARLY DETECTION

Shubham Kumar Jha, Ch Naavya and C Viswanathan

***Abstract*—Artificial Intelligence (AI) and Machine Learning(ML) are transforming healthcare by enabling doctors to diagnose diseases earlier and develop more effective treatments. The main goal of this paper is to build a prediction system using a Support Vector Machine (SVM) model that can estimate the chances of heart disease and diabetes using basic patient information. Features such as age, gender, blood pressure, cholesterol, and blood sugar levels were used to train the model. The model was able to predict risk with high accuracy and was able to identify important health factors using the preprocessed dataset. This represents how Machine Learning based tools can help physicians identify trustworthy insights which can result in prompt treatment and improved patient outcomes.**

Keywords—Machine Learning, Support Vector Machine, Heart Disease Prediction, Diabetes Prediction, Healthcare Analytics

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EQUIVALENT ELECTRICAL CIRCUIT DESIGN OF ELECTROMAGNETIC DIAPHRAGM PUMP

Grazia Lo Sciuto, Szymon Skupien, Pawel Kowol, Giacomo Capizzi and Salvo Coco

***Abstract*—The electromagnetic diaphragm pump system is developed to transfer liquid media at low pressures and flow rates using the electromagnetic forces acting between the permanent magnet positioned on rubber membrane and the electromagnets. The fluid flow rate and temperature are control and monitor by a digital cabinet. This study proposes an equivalent electrical circuit model of electromagnetic diaphragm pump system obtained starting from temperature and pumped fluid measured within the laboratory. The estimation of the transfer functions was calculated by means of orthonormal rational basis functions based on frequency response measurements. Finally, the circuit synthesis based on input temperature and output pumped liquid was performed using the Cauer's method for the representation of analogue circuit combining branch of resistor, inductor and capacitor.**

Keywords—Electromagnetic Diaphragm Pump, Electromagnets, Circuit synthesis

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KISANBANDHU: AI-BASED CROP RECOMMENDATION AND DECISION SUPPORT SYSTEM FOR FARMERS

Jasir Ahmad Khan, Robin Kumar, Avik Masanta, Chestdhari Kumar, Pawan Rohan and Ayush Pandey

***Abstract*—The KisanBandhu Project introduces a decision support system based on artificial intelligence to help smallholder farmers make informed choices about the best crops for their soil and the climate around them. The system uses 7 machine learning algorithms, specifically Random Forest, CatBoost, XGBoost, Gradient Boosted, Decision Trees, KNearest Neighbors, and Support Vector Machine). These algorithms were trained using a total of 2,200 observations of 22 types of crops and with 7 input features while attempting to compensate for class imbalance through use of synthetic samples. For the models that were evaluated, CatBoost outperformed all the others to provide the best classification accuracy at 80.0%, and was also able to provide fairly equal precision, recall and F1-scores, all of which are close to 0.80**

Keywords—Crop Recommendation, Machine Learning, CatBoost, Precision Agriculture, SMOTE, Decision Support System, Neural Networks, Sustainable Farming

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A SMART GEOGRAPHIC ROUTING ALGORITHM BASED ON TOPSIS FOR CONGESTION MITIGATION AND VOID AREAS BYPASSING IN WIRELESS SENSOR NETWORKS

Ghaihab Hassan Adday, Hikmat Z. Neima, Maha Salih Abdulridha, Ans Ibrahim Mahameed and Rana M. Ghadbanline

***Abstract*—Wireless Sensor Networks (WSNs) are well-established, smart systems whose significance is rapidly escalating. Geographic routing offers many advantages in terms of network reliability and performance. However, they tend to fail in high congestion and the presence of energy holes. To address these challenges, a new geographic routing technique has been introduced to enhance network performance. The proposed routing algorithm is built upon the Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS). TOPSIS will use four criteria to forward data reports to the best-neighbor node without causing excessive congestion. In addition, the proposed algorithm will be embedded with a technique that retard the energy hole formation and can bypass them effectively without expanding them. The Path Deviation (PD) technique will prevent repetitive sending along the same paths. PD technique removes the previous forwarding node from the routing table. The proposed routing algorithm outperforms the benchmark algorithms, delivering notable improvements in packet error rate, reaching 29.3% and 16.4% compared to the FTR and EEGR algorithms, respectively. Moreover, the proposed routing algorithm demonstrates enhanced performance over the benchmark algorithms, achieving gains in packet delivery ratio of 2.6% and 1.16%, respectively. At the same time, it outperforms the network lifetime of the FTR algorithm by 28.4% and the EEGR algorithm by 11.7%. Lastly, it reduces latency by 12.2% compared with FTR and 18.2% compared with EEGR.**

Keywords—geographic routing, multi-criteria decision making, path deviatio, TOPSIS, wireless sensor networks

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EFFECTS OF OPERATING TEMPERATURE ON EFFICIENCY IN HIGH-PRESSURE PROTON EXCHANGE MEMBRANE (PEM) WATER ELECTROLYZERS

Ioan Cristian Hoarca, Florin-Alexandru Lungu, Mihai Serbanescu and Florentina Magda Enescu

***Abstract*—Proton exchange membrane (PEM) water electrolysis is a premier technology for green hydrogen production, but achieving high energy efficiency and stack durability requires careful optimization of operating conditions. This paper investigates the coupled effects of elevated operating temperatures and pressures on PEM water electrolyzers. By integrating theoretical thermodynamic models, electrochemical overpotential analyses, and multi-physics representations of gas crossover, we analyze the performance of both balanced and differential pressure configurations. Our analysis reveals that while increasing temperatures up to 80-85°C enhances reaction kinetics, reduces thermodynamic onset potentials, and minimizes ohmic losses, operating above 90°C causes rapid membrane degradation, passivation of titanium components, and localized dry-out. Furthermore, we evaluate how gas crossover (diffusion and convection) limits low-load operations and Faradaic efficiency. Finally, we propose a hybrid sequential compression strategy (40-80 bar electrochemical compression followed by non-mechanical cyclic adsorption-desorption) combined with dynamic temperature control to maximize system efficiency and operating lifetime.**

Keywords—hydrogen, electrolyzer, high-pressure, PEM, green energy, efficiency

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OPTICODE: AN AI-POWERED INTELLIGENT CODE ANALYSIS PLATFORM FOR ENHANCING COMPUTER SCIENCE EDUCATION

Haritha Himansha, Navinda Viraj, Thilina Sandamal, Ashani Hettiarachchi, Sanjeevi Chandrasiri and Lokesha Weerasinghe

***Abstract*—The increasing reliance of computer science students on AI-generated code without adequate understanding of underlying concepts presents a significant pedagogical challenge. Students often submit functionally correct code while remaining unable to explain the algorithms, data structures, or design patterns involved, leaving them underprepared for industry-level technical assessments. This paper presents OptiCode, a multi-component intelligent code analysis platform that integrates four AI-powered modules: (1) a Code Concept Extractor using a hybrid Abstract Syntax Tree (AST) and Large Language Model (LLM) pipeline; (2) an Adaptive Weakness Detector that classifies recurring conceptual gaps through machine learning; (3) a Code Refactoring and Risk Analyser employing deterministic ASTbased transformations; and (4) an AI Interview Simulator combining real-time facial emotion recognition with NLP scoring. Experimental evaluation demonstrates that the hybrid AST-LLM approach achieves a macro F1-score of 0.83, outperforming the LLM-only baseline by 16.9%, confirming that static structural analysis substantially improves concept recall. The integrated platform provides educators and learners with actionable, real-time feedback on code comprehension and technical readiness.**

Keywords—OptiCode, Artificial Intelligent, Code, Concept extract

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A MULTI-STAGE EXPLAINABLE AI ARCHITECTURE FOR STOCK FORECASTING AND PORTFOLIO DECISION SUPPORT

Dushan Warnakulasuriya, Madhawa Awishka, Danuka Ariyarathne, Banuka Wahalathanthri, Kalpani Manathunga and Suriyaa Kumari

***Abstract*—Investment decision-making in emerging markets such as the Colombo Stock Exchange is constrained by fragmented analytics, limited interpretability, and delayed incorporation of market-relevant information. Investors commonly rely on isolated financial indicators and short horizon price models that lack an integrated decision-support structure. This study proposes InvestWise, an artificial intelligence driven portfolio planning platform tailored to the Colombo Stock Exchange. The framework integrates four components: a two-stage XGBoost model for detecting and classifying market-moving financial news; a forward-looking financial risk module using Support Vector Regression to forecast Altman Z Score trajectories; a dividend cut prediction model based on Elastic Net logistic regression; and an ensemble price forecasting model combining XGBoost, LightGBM, and CatBoost for five-day-ahead predictions. Empirical evaluation using Colombo Stock Exchange data from 2012 to 2025 demonstrates consistent predictive stability and improved directional accuracy. By embedding explainable artificial intelligence mechanisms across modules, the proposed system provides a scalable, transparent, and context-aware decision support platform for portfolio management in emerging markets.**

Keywords—Artificial intelligence, Stock forecasting, Financial risk modeling, Dividend prediction, Ensemble learning, Explainable AI

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PIXEL-WISE SEMANTIC SEGMENTATION OF WOOD SURFACE DEFECTS USING DEEP LEARNING FOR AUTOMATED INDUSTRIAL INSPECTION

Thierry Mubang Nuh and Yacine Yaddaden

***Abstract*—Precise delineation of wood surface defects is essential for automated grading and industrial quality assessment, yet most existing deep-learning approaches focus on image-level classification or bounding-box detection rather than pixel-level localization. This paper presents a semantic segmentation framework for wood defect analysis and, to the best of our knowledge, the first reproducible pixel-wise benchmark on the large-scale public VSB-TUO sawn timber dataset. The proposed pipeline relies on defect-centered Region of Interest (ROI) extraction to reduce foreground-background imbalance while maintaining consistency between training and inference distributions. Five segmentation architectures, including U-Net, attention-gated Fully Convolutional Networks (FCN-AG), and DeepLabV3+, are evaluated under a unified protocol using Dice score, Intersection over Union (IoU), Precision, Recall, and computational cost metrics. Experimental results show that all evaluated models achieve Dice scores above 92.9\%, with FCN-AG-VGG16 obtaining the best performance at 93.46\% Dice and 88.37\% IoU. Despite substantial architectural differences, all models converge within a narrow performance range, revealing a dataset-level performance ceiling where data characteristics dominate segmentation quality more than model complexity. The results suggest that future improvements are more likely to arise from higher-quality annotations, higher-resolution inputs, and downstream defect-severity analysis than from increasingly complex segmentation architectures.**

Keywords—wood defect segmentation, semantic segmentation, industrial inspection, deep learning, computer vision, automated grading, transfer learning, defect localization, pixel-wise segmentation, wood surface analysis

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COMPARATIVE ANALYSIS OF DEEP LEARNING-BASED SEGMENTATION MODELS FOR ROOT CANAL FILLING DETECTION WITH EFFICIENCY AND PRUNING EVALUATION

Mehmet Zahid Genç, Berrin Çelik and Mahmut Emin Çelik

***Abstract*—Accurate automated segmentation of root canal fillings in periapical radiographs represents a critical bottleneck in scaling endodontic quality assessment, yet most existing deep learning approaches prioritize accuracy while neglecting deployment feasibility in resource-constrained clinical settings. This study evaluates deep learning-based segmentation models for automated segmentation of root canal fillings in periapical dental radiographs. Five widely used architectures—U-Net, U-Net++, Feature Pyramid Network (FPN), LinkNet, and SegFormer—were compared in terms of both segmentation performance and computational efficiency using a dataset of 597 annotated periapical radiograph images. Experimental results demonstrated that U-Net achieved the highest segmentation accuracy with a mean Intersection over Union (IoU) of 74.57 ± 1.34% and a Dice score of 85.42 ± 0.90% across five independent training cycles. Lightweight models such as FPN and LinkNet provided a favorable balance between performance and efficiency for resource-constrained clinical environments, with LinkNet achieving a GPU latency of 7.52 ms and throughput of 132.9 images/s. Additionally, pruning experiments on the best-performing U-Net model revealed that moderate unstructured pruning (10–30%) led to limited performance degradation recoverable through fine-tuning, whereas aggressive pruning and structured pruning at higher ratios resulted in substantial accuracy loss. These results highlight the trade-off between segmentation accuracy and computational efficiency and provide practical insights for the deployment of deep learning models in clinical dental imaging workflows.**

Keywords—dentistry, deep learning, pruning, computational cost

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AI-BASED EARLY CHILDHOOD EMOTION MONITORING USING ARTWORKS AND EMOTION REGULATION CHECKLIST

Eshanie Rathnasinghe, Thiyara Gunawardena, Binuki Mihara, Chathuni Abesinghe, Dr Lakmini Abeywardhana, Lokesha Weerasinghe and Dr. Naren Selvaratnam

Abstract*—Early identification of emotional dysregulation in children aged 4–6 is critical to preventing long-term behavioral and cognitive impairments. However, traditional diagnostic methods often rely on invasive digital technologies, such as facial recognition, which raise significant privacy concerns and lack contextual depth. This paper proposes a privacy preserving, multimodal framework designed to identify emotional states and dysregulation levels in Sri Lankan preschool children through a combination of artistic expression and use of emotion regulation checklist. The methodology integrates two distinct data streams. The first utilizes a Deep Learning pipeline where a Vision Transformer (ViT-L/16) extracts high-dimensional features from a custom dataset of 600 child-generated artworks. These features are optimized via Principal Component Analysis (PCA) and classified using a Support Vector Machine (SVM) with a Radial Basis Function (RBF) kernel to identify emotions such as happiness, sadness, and anger. To address the "black-box" nature of AI, the system incorporates Explainable AI (XAI) features, including confidence rates and feature heatmaps, providing transparency for educators. The second stream processes the Emotion Regulation Checklist (ERC) via a Linear SVM to categorize dysregulation into low, medium, and high levels. Correlation analysis confirms that the ERC Lability/Negativity subscale serves as a robust ground-truth validator, showing strong correlations ($r > 0.50$) with total dysregulation scores. Implemented as a web-based diagnostic tool using React.js and Python, the system provides longitudinal time-series visualizations for parents and teachers. By bypassing invasive biometric monitoring in favor of culturally appropriate, non digital inputs, this research offers a scalable and ethically sound solution for early emotional intervention in urban educational settings

Keywords—Emotional dysregulation, Vision Transformer, Emotion Regulation Checklist, Explainable AI, Child Psychology, Privacy Preserving Technology

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INTERNET OF THINGS BASED LOW CONCENTRATION PHOTOVOLTAIC SILICON SOLAR CELL PROTECTION USING ACTIVE COOLING SYSTEM

Mallela Abhishek, Dr.N Sudhakar Reddy, Koosetty Amulya Royal, Penugonda Dugra Prasad, Pentiboina Uma Mahesh and Balamanikandan A

***Abstract*—As a renewable and sustainable energy source, solar panels have seen a big increase in new customers. Adoption of PV (Photovoltaic) technology is at an all time high. Silicon cells are the majority of the PV cell market because they are both financially viable and reliable. There are problems associated with PV cells that can affect efficiency, such as high operating temperature. For the majority of manufacturers and installers, the potential efficiency losses are substantial and occur at a rate of approximately 0.4 - 0.5% per 1°C increase in operating temperature. This issue becomes even more problematic with low-concentration photovoltaic (LCPV) systems due to the concentrated solar energy producing excessive heat on the solar cells. The aim of this project is to develop a system to actively cool an LCPV solar cell with the help of the Internet of Things (IoT). An IoT-based cooling system is being developed that will monitor the solar cell and other environmental conditions such as the surrounding air temperature and solar irradiance to help protect the solar cell from the effects of heat. Sensors connected to microcontrollers will collect data on the variables listed above and transmit that information, via the Internet of Things, to a cloud service. Using the temperature data collected, an active cooling method, i.e. air or liquid, will be initiated to ensure the optimal operating conditions of the solar cell. Compared to conventional cooling methods, the proposed system provides enhanced temperature control, real-time monitoring and automated control, resulting in higher efficiency and power output from the solar cell and an extended operational life of the solar cell.**

Keywords—LCPV silicon solar cells, Internet of Things (IoT), active cooling system

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ANOMALY DETECTION IN CRIME REPORTS USING ISOLATION FOREST WITH EXPLAINABLE AI

Aayushi Thakur, Anannya Gupta and Kuldeep Das

***Abstract*—In this paper, an approach is presented for anomaly detection in crime data utilizing machine learning methods along with explainable AI. As the quantity of data concerning crime reports rises, recognizing anomalies within them becomes imperative in order to make appropriate decisions for public safety purposes. For this purpose, the Isolation Forest method is used to efficiently identify anomalies within crime datasets by separating rare and irregular patterns among data instances. Furthermore, by applying methods related to explainable AI, the model can be improved and made more interpretable for better understanding. In this study, the purpose is to create an intelligent and efficient solution for police departments to recognize anomalies within crime datasets. Experimentally, it is shown that the proposed model achieves good performance levels while being interpretable.**

Keywords—Anomaly Detection, Crime Data, Isolation Forest, Explainable Artificial Intelligence, Machine Learning

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ADAPTIVE FUZZY-TUNED CONTINUOUS CONTROL SET MODEL PREDICTIVE CONTROL FOR A NON-INVERTING BUCK-BOOST CONVERTER

Mohammad Ahmed, Harith Al-Badrani and Sahar L. Qaddoori

***Abstract*—This DC-DC non-inverting buck-boost converters are widely used in modern power electronic applications due to their capability to operate in both buck and boost modes while maintaining positive output polarity. Also, fast voltage regulation with low switching losses is still difficult in low-cost embedded systems, particularly for low-cost embedded platforms. This paper presents an adaptive fuzzy tuned Continuous Control Set Model Predictive Control (CCS-MPC) strategy for a non-inverting buck–boost converter with real-time implementation using an ESP32 microcontroller. The proposed controller updates the weighting factors of the predictive cost function according to the voltage tracking error and duty cycle variation using a fuzzy inference mechanism. In addition, a simplified absolute value-based cost function is adopted to reduce computational complexity and reduce execution time for real-time operation on low-cost embedded hardware. To reduce switching activity and switching losses, the converter operating region is divided into buck, boost, and buck-boost modes according to the relationship between the input voltage and the reference voltage. The buck-boost operating mode is restricted to a narrow region around the reference voltage (±0.5 V), allowing the converter to operate with a single active switching device whenever possible. This operating strategy reduces switching activity by approximately 50% while maintaining smooth transitions and stable output voltage regulation. The proposed controller was validated using both MATLAB/Simulink simulations and practical hardware implementation. The experimental setup includes an ESP32-based control platform with practical voltage sensing, low-pass noise filtering, and ADC protection circuits. Comparative results demonstrate that the proposed adaptive fuzzy CCS-MPC improves transient response, reduces overshoot, and achieves faster settling time compared with conventional fixed-parameter MPC and PID controllers under reference voltage and load variations.**

Keywords—Non-Inverting Buck–Boost Converter, Fuzzy Control, Predictive Control, DC–DC Converter, Adaptive Control.

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A MULTI-SOURCE INTEGRATION ARCHITECTURE FOR INTELLIGENT ENTERPRISE RESOURCE PLANNING AND CUSTOMER RELATIONSHIP MANAGEMENT SYSTEMS IN ELECTRONIC COMMERCE

Cynthia Andreea Delea, Eugen Pop, Mihnea-Alexandru Moisescu and Miruna Elena Iliuta

***Abstract*—Conventional e-commerce architectures maintain Enterprise Resource Planning and Customer Relationship Management systems as isolated data environments, synchronizing them through scheduled batch processes that introduce decisional latency and limit the scope of predictive analytics. This paper presents the operational instantiation of a multi-layer intelligent Enterprise Resource Planning and Customer Relationship Management architecture within an electronics retail environment, extending it through the incorporation of the e-commerce platform as a third data source at the ingestion level. Behavioral signals generated at the platform layer, session activity, browsing patterns and cart abandonment events, are absent from both ERP transaction records and CRM interaction logs, yet directly condition demand patterns and customer disengagement. Three operational scenarios are examined: seasonal demand forecasting through Long Short-Term Memory based multivariate modeling, silent churn detection through ensemble classification on a unified cross-source feature set and multi-channel overselling prevention through Robotic Process Automation driven event-level stock synchronization. In each scenario, the failure mode of the baseline configuration is shown to be structurally unavoidable without the proposed integration layer. The results establish the Semantic Integration Layer as the architectural precondition for the capabilities demonstrated and identify empirical validation in a live deployment as the primary direction for future research.**

Keywords—E-Commerce, Intelligent Enterprise Resource Planning, Customer Relationship Management, Demand Forecasting, Customer Churn Prediction, Semantic Integration

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HAND TRACKING FOR GESTURE-BASED CONTROL IN SURGICAL ROBOTICS: A SECURITY AND ETHICS PERSPECTIVE

Marius Petreanu, Laura Patrasc-Luta and Ioana Corina Bogdan

***Abstract*—In this paper we present a robotic control system based on hand gestures, inspired by the master–slave surgical teleoperation principle. The system is implemented on a Raspberry Pi 5 platform, equipped with a Hailo-8 neural accelerator, and enables real-time hand tracking as well as the extraction of relevant gesture features. For interpreting hand movements, we use a geometry-based method that extracts positional and angular features directly from hand landmarks detected in real time, associating them with continuous servo targets for each robot joint. These commands are transmitted via USB serial to a robotic arm (TinkerKit Braccio++), which reproduces the operator's movements. The developed system demonstrates the feasibility of using edge-AI technologies for gesture control in surgical robotics and provides a low-cost, fully open-source platform, useful both for educational purposes and for research in the field of human–robot interaction.**

Keywords—Hand Tracking, Surgical Robotics, Teleoperation, Gesture Recognition, Clustering, Security, Ethics, Human–Robot Interaction

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SWEET CORN MATURITY CLASSIFICATION USING YOLOV7 AND RESNET-50

Rence Joseph Cadsawan, Patrick John Figarola and Meo Vincent Caya

***Abstract*—This study introduced an automated edge-computing system to evaluate sweet corn maturity, addressing a vital need for precise harvest timing to maximize crop value in the Philippines. Operating on a Raspberry Pi 4 with an external camera, the standalone device utilized a robust two-stage deep learning pipeline. It employed YOLOv7 for real-time object detection alongside a ResNet-50 convolutional neural network to accurately classify the corn as mature, immature, or over-mature. Trained on a custom dataset of 2,400 locally sourced images, the system demonstrated exceptional reliability in a controlled environment. It achieved a flawless 100% detection rate and an 88.89% multi class classification accuracy, surpassing the 85% target. Ultimately, this framework provided farmers a highly practical solution to standardize crop quality and optimize their harvest schedules.**

Keywords—Sweet Corn, YOLOv7, ResNet-50, Raspberry Pi, Classification

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QoE-Driven Video Streaming Optimization in NDN-Based MANETs using E-Draft Protocol and Hybrid HHGWO Algorithm

Hamid Al-Asad, Hawraa Al-Asadi, Zaid Abduljabbar, Ali Al-Asadi and Vincent Nyangaresi

***Abstract*—Mobile Ad hoc NETworks (MANETS) are emerging as a favored approach for facilitating multimedia communications, especially in more infrastructure-less and highly dynamic settings. Nevertheless, reliable multimedia delivery in such environments is a real challenge, and the rapid topological changes in MANETs along with the unreliability of wireless links lead to packet loss that degrades the perceived quality of video at the user end. The proposed work formulates an improved routing protocol based on the Enhanced Dynamic Adaptive Forwarding Table (EDRAFT) technique, and the innovative approach of Hybrid Harris Hawks–Grey Wolf Optimization (HHGWO) is integrated to perform even better decision-making for choosing forward paths in MANETs. This optimization technique will help derive a multi-criteria routing metric based on multiple indicators of network reliability, such as packet loss and delay. Simulation results were obtained to analyze the proposed EDRAFT-HHGWO-based routing approach. The simulations presented consisted of 45 mobile nodes distributed over a square area of 120m x 120m, with overall simulation duration of 60 seconds. During each simulation, 1,534 video packets were generated and transmitted across the network. To obtain statistically reliable results, the average values of five independent simulation runs were computed. Simulation obtains deterministically higher multimedia communication performance compared to other works in the literature for the proposed EDRAFT-HHGWO-based routing method. The simulation trials showed that in the best trial, 1,302 video packets were successfully delivered, with stable and reactive routing behavior across varying network scenarios. Moreover, simulation trials results showed that the advocated method positively affects some Quality of Service (QoS), Quality of Experience (QoE) indicators; packet delivery ratio, packet loss ratio and video quality parameters (Peak Signal-to-Noise Ratio [PSNR], Structural Similarity Index [SSIM] and Mean Opinion Score). In conclusion, optimization algorithms combined with the EDRAFT routing protocol yield optimal paths by selecting fewer hops, achieving lower costs and higher performance for multimedia problems than traditional methods.**

Keywords—Mobile Ad Hoc Networks, EDRAFT Protocol, Hybrid Harris Hawks Grey Wolf Optimization Algorithm, Multimedia Transmission, Quality of Service, Quality of Experience, Video Streaming

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ZERO-SHOT DETECTION OF DENTAL PATHOLOGIES WITH MULTIMODAL LARGE LANGUAGE MODELS ON PANORAMIC RADIOGRAPHS

Meryem Paşaoğlu

***Abstract*—Panoramic dental radiography is a screening tool for detecting caries, periapical lesions, and impacted teeth. However, manual annotation of these images is not feasible for large-scale screening programs. Multimodal large language models (MLLMs) can process images via prompts to detect dental pathologies without task-specific fine-tuning. This study evaluates seven MLLMs—three from Anthropic (Claude), three from Google (Gemini), and one from OpenAI (GPT)—using 200 panoramic radiographs sampled from the DENTEX dataset. Performance is assessed at three levels: binary presence per pathology class, instance count matching, and identification of the most clinically severe pathology per image. Gemini 2.5 Pro demonstrates the highest image-level F1 score and the highest severity-detection accuracy. However, Gemini 2.5 Pro did not identify any of the 20 healthy images as normal, whereas Gemini 3.1 Pro, despite lower overall performance, correctly identified 12 of 20 healthy images.**

Keywords—dental radiology, multimodal large language models, zero-shot evaluation, pathology detection, DENTEX

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