Keynote Speakers

Dr. Haitham Abu-Rub

Title: Inverse Model Predictive Control for Power Electronic Converters

Abstract: Advanced power electronic converters are increasingly required to perform multiple functions, such as renewable energy conversion, grid support, and electric drives. These capabilities necessitate adaptive and multi-objective control techniques that can accommodate fast dynamics, multiple control goals, and system uncertainties.

Model Predictive Control (MPC) has been widely explored for such applications due to its ability to predict system behavior and enforce constraints. However, its practical implementation is often limited by its high computational complexity. To address this challenge, Inverse Model Predictive Control (IMPC) is introduced as an alternative approach that maintains the advantages of MPC while significantly reducing computational load.

This talk provides an overview of IMPC and its implementation in power electronics convertersTo demonstrate the applicability of IMPC, several case studies will be presented, including grid-following and grid-forming inverters, as well as converter-fed drives. These examples highlight the potential of IMPC for various converter topologies.

Biography: Haitham Abu-Rub is a professor at Hamad Bin Khalifa University and an adjunct professor at Texas A&M University, Qatar. He received two PhDs, one in electrical engineering from the Gdansk University of Technology, Poland, in 1995, and the second Ph.D. degree in humanities from Gdansk University, Poland, in 2004.

Abu-Rub has research and teaching experiences at many universities in many countries including Qatar, Palestine, Poland, USA, and Germany. His areas of expertise include power electronics converters and electric drives.

Abu-Rub has served for five years as the chair of Electrical and Computer Engineering Program at Texas A&M University at Qatar and for ten years as the managing director of the Smart Grid Center at the same university.

He is the recipient of many national and international awards and recognitions. He has contributed to publishing over 600 journal and conference papers, eight books, and eight book chapters.

Abu-Rub is a Fellow of IEEE and the Vice President for Publication at IEEE IES.

Dr. Kuan-Wei Lee

Title: Trends and Development of the Semiconductor Industry: Insights from Taiwan

Abstract: The semiconductor industry has become a cornerstone of modern technology, underpinning advancements in information technology, artificial intelligence, communications, transportation, and energy systems. This talk presents an overview of current trends and development in the semiconductor industry, using Taiwan as a representative and influential case. The presentation begins with an introduction to semiconductor materials and their classifications, including elemental semiconductors such as silicon, compound semiconductors, and emerging materials for advanced electronic and optoelectronic applications. Their respective roles in logic, memory, power electronics, and sensing applications are briefly discussed to provide a common technical foundation for a multidisciplinary audience.

Taiwan’s strategic importance in the global semiconductor ecosystem is then examined from both technological and geopolitical perspectives. Owing to its highly concentrated manufacturing capacity, mature supply-chain clusters, and strong integration between academia, industry, and government, Taiwan occupies a pivotal position in global semiconductor production. This unique role has also placed Taiwan at the center of international discussions on supply-chain resilience, economic security, and geopolitical stability. Special attention is given to Taiwan Semiconductor Manufacturing Company (TSMC), which has played a decisive role in shaping the global foundry model. TSMC’s emphasis on pure-play manufacturing, large-scale capital investment, and advanced process integration has enabled rapid technology scaling while allowing fabless companies worldwide to focus on design innovation.

By combining advanced manufacturing capabilities, flexible industrial collaboration, and long-term strategic planning, Taiwan has established a competitive advantage that is difficult to replicate. The presentation concludes by discussing future challenges and opportunities facing the semiconductor industry, highlighting the implications for technology development, global collaboration, and multidisciplinary research.

Biography: Dr. Kuan-Wei Lee received the PhD degree from the Department of Electrical Engineering, National Cheng-Kung University, Tainan, Taiwan, in 2006. He joined the Department of Electronic Engineering at I-Shou University as an assistant professor in 2006, was promoted to associate professor in August 2009, and was promoted to professor in February 2013. Professor Lee’s main research focuses on metal-oxidesemiconductor (MOS) technology and its application in GaAs-based electronic devices. He was elected a Distinguished Teaching Instructor by the College of Electrical and Information Engineering at I-Shou University in 2010. He also received the Outstanding Electrical Engineer Award from The Chinese Institute of Electrical Engineering (CIEE) in 2011 and was listed in Marquis 2011-2012, 2016-2017 Who’s Who in Science and Engineering. Dr. Lee has published 47 SCI journal papers and 126 conference articles. He has also delivered 8 invited talks and 8 keynote speeches at international conferences, and 6 keynote speeches at the universities. Meanwhile, Prof. Lee was a guest editor respectively for “Micromachines”, “Crystals”, “Molecules”, “Microelectronics Reliability”, and “Active and Passive Electronic Components”.

IEEE IMCET 2026

5th IEEE International Multidisciplinary Conference on Engineering Technology (IMCET 2026)

April 15-17, 2026

2026 IEEE 5th International Multidisciplinary Conference on Engineering Technology (IMCET) Program

Time (Beirut)	Virtual Room-1	Virtual Room-2	Virtual Room-3
Wednesday, April 15			
09:00 am-09:30 am	**OPcer: Virtual Room-1**: *Opening Ceremony*		
09:30 am-10:15 am	**KeyNote#1: Virtual Room-1**: *Inverse Model Predictive Control for Power Electronic Converters*		
10:15 am-10:30 am	**CB#1**: *Coffee Break*		
10:30 am-12:30 pm	**S11(A)**: *Biomedical and Bioinformatics-I*	**S11(B)**: *Computer Systems and Applications-I*	**S11(C)**: *Power, Power Electronics, Industrial Electronics and Energy-I*
12:30 pm-01:00 pm	**Lunch#1**: *Lunch Break*		
01:00 pm-03:00 pm	**S12(A)**: *Biomedical and Bioinformatics-II*	**S12(B)**: *Computer Systems and Applications-II*	**S12(C)**: *Power, Power Electronics, Industrial Electronics and Energy-II*
03:00 pm-03:15 pm	**CB#2**: *Coffee Break*		
03:15 pm-05:30 pm	**S13(A)**: *Biomedical and Bioinformatics-III*	**S13(B)**: *Computer Systems and Applications-III*	**S13(C)**: *Power, Power Electronics, Industrial Electronics and Energy-III*
Thursday, April 16			
09:30 am-10:15 am	**KeyNote#2: Virtual Room-1**: *Trends and Development of the Semiconductor Industry: Insights from Taiwan*		
10:15 am-10:30 am	**CB#3**: *Coffee Break*		
10:30 am-12:15 pm	**S21(A)**: *Antennas, Microwave, Magnetics and RF circuits & Power*	**S21(B)**: *Control Systems, Instrumentation and Robotics*	**S21(C)**: *Communications and Information Systems*
12:15 pm-12:45 pm	**CC-Room1**: *Closing Ceremony*		

Wednesday, April 15

Wednesday, April 15 9:00 - 9:30

OPcer: Virtual Room-1 Opening Ceremony
Virtual Room-1

Wednesday, April 15 9:30 - 10:15

KeyNote#1: Virtual Room-1 Inverse Model Predictive Control for Power Electronic Converters
Dr. Haitham Abu-Rub, Professor at Hamad Bin Khalifa University
Virtual Room-1, Virtual Room-2, Virtual Room-3
Chair: Hadi Y. Kanaan

Wednesday, April 15 10:15 - 10:30

CB#1: Coffee Break
Virtual Room-1, Virtual Room-2, Virtual Room-3

Wednesday, April 15 10:30 - 12:30

S11(A): Biomedical and Bioinformatics-I
Virtual Room-1
Chairs: Mohamad Abou Ali, Amira J. Zaylaa

Design and Evaluation of a Real Time IOT Health Monitoring System
John Harb, Fady Saffo, Rita Eid, Abdallah Kassem, Mustapha Hamad and Chady El Moucary
Remote health supervision benefits from continuous sensing and timely alerts, especially when physiological changes and environmental hazards may occur simultaneously. This paper presents a low cost, ESP32-based IoT monitoring platform that integrates multiple sensors to collect vital, environmental and context signals in real time. The proposed system measures heart rate and oxygen saturation using a MAX30100 module, acquires single-lead ECG using an AD8232 front-end, monitors ambient temperature via a DHT11 sensor, detects carbon monoxide exposure trends using an MQ-7 sensor, includes a pressure sensor for additional status/context sensing, and provides GPS based location reporting using a NEO-6M module for emergency scenarios. An LCD provides local visualization of key readings. Measurements are streamed over WiFi to a mobile/cloud dashboard and threshold based event detection generates real-time notifications for abnormal conditions. The prototype demonstrates end to end data acquisition, local display, live mobile visualization, and alert generation in a compact and cost effective implementation suitable for educational and rapid prototyping deployments.

PharmaBot: A Multimodal AI System for Drug Interaction Detection
Fatima Nasser, Hadi Hasan, Safaa Salman, Ammar Mohanna and Ali Chehab
Adverse drug-drug interactions (DDIs) constitute a persistent and preventable threat to patient safety, increasingly driven by widespread polypharmacy and the growing complexity of modern pharmacotherapy. However, current DDI checking tools largely rely on structured inputs and manual database lookups, rendering them ill-suited for real-world pharmacy workflows where medication data are often unstructured or image-based and decisions must be made rapidly under time pressure. We present PharmaBot, an end-to-end, microservices-based system for automated DDI screening from medication images or free-text input. PharmaBot integrates computer vision for medication detection, optical character recognition (OCR), large language model (LLM) based drug extraction, and retrieval-augmented generation (RAG) grounded in DrugBank to identify and explain clinically relevant interactions. PharmaBot is evaluated on a template-generated, pharmacist-realistic dataset

where the drug extraction service achieves near-perfect performance (F1-score 0.9968), while end-to-end interaction detection attains high accuracy (F1-score 0.9913). Medicine image detection achieves a mean Intersection over Union (IoU) of 97%, enabling reliable localization for downstream processing. These results demonstrate that integrating computer vision and knowledge-grounded LLM reasoning within a modular architecture enables accurate and practical DDI screening from unstructured real-world inputs, supporting safer and more efficient pharmacist-facing decision support.

Intelligent Framework for Skin Cancer Detection and Classification Using Deep Learning

Mohammed Abdullah Salim Al Husaini, Yousuf Nasser Al Husaini, Mohamed Hadi Habaebi, Yasir Abdallah Khalifa Al Masqari, Moza Atiyaq Obaid Al-Yaqoubi and Wasin AlKishri

Skin cancer is one of the most common types of cancer worldwide, and catching it early can make a big difference in treatment success. In this paper, we're excited to share a deep learning-based framework that uses convolutional neural networks (CNNs) to help distinguish between cancerous and non-cancerous skin lesions. Our approach involves carefully preprocessing images, augmenting data to improve the model, and then training CNN models through transfer learning. We tested our method on a dataset of 2,300 labeled skin lesion images, categorized into cancer and non-cancer groups. To see how well it works, we looked at various metrics like accuracy, sensitivity, specificity, precision, F1-score, and the area under the ROC curve (AUC). The results are promising: ResNet 18 achieved an impressive average accuracy of 96.8%, with sensitivity at 96.4%, specificity at 96.5%, precision at 96.7%, and an F1-score of 96.3% across different validation tests. It also scored an average AUC of 0.99, showing its strong ability to tell these two classes apart. These encouraging findings suggest that deep learning image classification can be a helpful tool for automated skin cancer analysis and could support doctors in making more informed diagnoses.

Dosimetry of Hypofractionation Versus Conventional Radiotherapy in Prostate Cancer: A Comparative Study

Zainab Mazeh, Wassila El kanawati and Bilal H. Shahine

This study represents a retrospective dosimetric comparison between hypofractionated with a dose of 60 Gy in 20 fractions (3Gy per fraction) and conventional fractionation with a dose of 78 Gy in 39 fractions (2 Gy per fraction) radiation therapy in localized prostate cancer treatment. Thirty patients with mean age of 76.75 years with prostate cancer were involved in this study. For each patient two different treatment plans were created, hypofractionated and conventional; rectum, bladder and penile bulb Dose Volume Histograms were estimated based on the 2 Gy per fraction using the linear-quadratic model. Statistical analysis were done using SPSS. Dosimetric parameter values for the studied Organs at risk were within tolerance for both groups. The mean dose of rectum, bladder and penile bulb in Hypofractionated group was less than conventional RT with significant difference ($p<0.001$). Regarding DVH parameters V30, V40, V50, V60, V70, and V74 of rectum, the mean values of Hypofractionated were significantly lower than conventional values ($p< 0.001$). Similar results were obtained for the bladder and penile bulb the Hypofractionated values were significantly less. This study presents a quantitative retrospective analysis of organs at risk dose of a group of patients. Our conclusion is hypofractionation regimen shows superior results over conventional treatment in prostate cancer radiation therapy.

Enhanced Fall Detection Using Machine Learning Models on Acceleration Data from the SisFall Dataset

Hadi Noureddine, Ahmad Kobeissi, Marwa Ollaik and Mohammad Rammal

Falls are a leading cause of injury among elderly individuals, making accurate and timely fall detection a critical health concern. This paper presents an enhanced two-step fall detection framework using accelerometer data from the publicly available SisFall dataset. In the first step, a threshold-based pre-screening detects potential falls, followed by a window-based classification using machine learning models. We investigate the effects of using acceleration magnitude versus full tri-axial acceleration vectors, varying sampling frequencies, and data

augmentation through random rotations to simulate device orientation changes. Results show that incorporating 3D acceleration vectors significantly improves classification performance, achieving high accuracy. This approach offers a low-cost, energy-efficient solution for wearable devices, contributing to more robust and reliable fall detection in real-world scenarios.

AutoML vs Classical Machine Learning: A Comprehensive Comparative Analysis Using Diabetes Prediction as a Case Study

Mohamad Abou Ali, Fadi Dornaika, Ignacio Arganda-Carreras, Hussein Ali and Abdallah Kassem

The rapid proliferation of automated machine learning (AutoML) platforms presents a paradigm shift in data science workflows, yet comprehensive empirical comparisons with classical machine learning (ML) pipelines remain limited. This study presents a dual-experiment framework evaluating AutoGluon AutoML against expert-engineered classical ML pipelines using diabetes prediction as a representative clinical case study. Experiment 1 examines binary classification using the Kaggle diabetes prediction dataset, while Experiment 2 extends the analysis to a novel 3-class formulation based on American Diabetes Association (ADA) 2025 guidelines. Our systematic evaluation across four scenarios demonstrates that AutoML achieves competitive predictive performance (AUC: 0.9790 vs 0.9791) with significantly reduced development effort (93% code reduction) and expertise requirements. More strikingly, AutoML facilitates a crucial transition toward \textbf{Agentic AI Systems}---autonomous learning architectures that minimize human-in-the-loop interventions while optimizing model selection, feature engineering, and hyperparameter tuning. This research establishes AutoML not merely as a productivity tool but as an essential engine for next-generation autonomous AI systems, with profound implications for clinical decision support, personalized medicine, and democratized data science.

From Binary to Multi-Class: Benchmarking AutoGluon Against Classical Machine Learning for Diabetes Prediction and the Rise of Agentic Clinical AI

Mohamad Abou Ali, Fadi Dornaika, Ignacio Arganda-Carreras, Hussein Ali and Abdallah Kassem

The integration of automated machine learning (AutoML) into clinical workflows promises to democratize advanced predictive analytics, yet rigorous benchmarks against state-of-the-art (SOTA) classical machine learning pipelines remain limited. This study presents a comprehensive evaluation of AutoGluon against meticulously engineered classical ML approaches for diabetes risk prediction, a global health priority affecting over 537 million adults worldwide. We conduct two complementary experiments: (1) binary diabetes classification on a 100,000-sample dataset, and (2) a novel three-class risk stratification framework (Normal, Pre-Diabetes, Diabetes) aligned with American Diabetes Association (ADA) 2025 guidelines, establishing a new benchmark for pre-diabetes detection. Results demonstrate that AutoML achieves performance parity with SOTA classical models (AUC: 0.9790 vs. 0.9791) while reducing development effort by 93% and substantially lowering expert intervention requirements. A discordance analysis reveals that rare model disagreements are concentrated in clinically ambiguous borderline cases, reflecting areas of inherent diagnostic uncertainty rather than model failure. Beyond benchmarking, we conceptualize AutoML as the computational core of Agentic Clinical AI Systems-autonomous, adaptive architectures capable of continuous learning, explainability, and real-world clinical deployment. Collectively, these findings support AutoML-powered agentic systems as a scalable and practical pathway for high-quality diabetes prediction across diverse healthcare settings.

Load Transfer in a Pediatric Transfemoral Prosthetic Socket Revealed Through Embedded Strain Sensing

Claritta Miguel Khoury, Rita Abou Karam, Giorgio Haddad, Samir Mustapha and Massoud Khraiche

Pediatric prosthetic sockets present significant biomechanical challenges, particularly in conflict-affected and resource-limited regions where access to long-term prosthetic care is constrained. Rapid skeletal growth, evolving gait patterns, and residual-limb volume fluctuations complicate socket fit and load distribution, yet internal load transfer within pediatric sockets remains poorly quantified. This study presents a pediatric transfemoral prosthetic socket with embedded low-power strain gauge sensors designed to enable quantitative characterization of internal strain distribution under pediatric-scale loading. A 3D-printed femur-socket assembly incorporating a silicone soft-tissue simulant was instrumented with five strain gauges and subjected to controlled axial loads representative of single-limb support during gait. Strain measurements exhibited clear load-dependent behavior, with peak femoral strains reaching approximately 112 με while socket strains remained near baseline (~5 με), indicating a dominant load pathway through the femoral structure. This asymmetric load-sharing behavior suggests a stiffness mismatch between structural components that limits effective load transfer to the socket wall. These findings provide quantitative insight into the mechanical behavior of sensor-integrated pediatric prosthetic sockets and establish a foundation for optimizing load distribution to enhance comfort, structural performance, and long-term usability in pediatric populations.

S11(B): Computer Systems and Applications-I

Virtual Room-2

Chairs: Roy Abi Zeid Daou, Gaby H Abou Haidar

AI-Driven Intrusion Detection System for Internet of Things Devices using Network Simulator

Asmaa Akram Hindawi, Be, Omar Al Halabi, Suaad Alsabouh, Amal El Arid and Foad Tarek Naffah

The development of Internet of things has completely changed modern systems in various fields through the introduction of consistent monitoring, remote diagnosis, and at-this-time data capturing systems. Nevertheless, the increased connectivity has also put all the above-mentioned systems at the risk of an increasing number of cyber-threats. Traditional, signature-based, or rule-centric intrusion detection systems have a hard time identifying zero-day intrusion methods and keeping up with the ever-changing characteristics of network traffic. In this paper, an AI-enabled IDS tailored specifically to IoT environments is described to resolve this problem. The proposed solution incorporates a lightweight and adaptable machine learning pipeline, which consists of robust data preprocessing, extra trees feature extraction, and an optimized extremely gradient boost multi-classifier. The system is trained and tested using the CICIoT2023 dataset, which contains 2.6 million samples of network flow data comprising 33 types of attacks, for accurate detection of malicious behavior within limited computation time and simple deployment, with practical roll-out being possible on constrained devices, including smart infusion pumps and wireless diagnostic platforms. The findings in this paper proved a significant accuracy of 99.25%, showing advancement over previous models applied on the same dataset. A holistic Internet of Things network where the system is deployed and tested in a simulated environment. This stage validates the model performance and responsiveness under dynamic situations.

Designing a Secure Architecture for Web-Based 3D Shape Modelling

Ali Abdallah and Farah Yasine

The rapid advancement of web technologies has significantly transformed collaborative 3D modelling, enabling multiple users to create, modify, and share models in real time through online platforms. With the emerging Internet infrastructure, this shift has improved accessibility; however, sharing 3D models online exposes both system components and digital assets to unauthorized access, code tampering, and digital piracy; thus, security has become a critical concern. To address these challenges, a secure and flexible web-based 3D shape modelling architecture is introduced, integrating multiple layers of protection to ensure confidentiality, integrity, and controlled accessibility of these assets. This work reflects a client-server design and combines advanced rendering techniques with essential security mechanisms including code obfuscation to protect source code, user authentication and authorization to regulate access, and encrypted 3D models to mitigate data theft. Experimental results demonstrate that this proposed architecture improves security in online 3D modelling environments while maintaining high interactivity and performance, establishing a strong foundation for secure, scalable, and efficient collaborative 3D modelling applications. Keywords-adaptive architecture,

Defending Against Adaptive Adversarial Attacks: A Reinforcement Learning-Based Approach to Deep Neural Network Robustness

Hadi Hasan, Ali Chehab and Razane Tajeddine

Adversarial attacks generated through reinforcement learning present a significant challenge to the robustness of deep neural networks due to their adaptive and non-deterministic nature. Traditional defense strategies often rely on the consistency of known attacks, which limits their effectiveness against more dynamic threats. In this work, we propose the Adaptive Reinforcement-Based Defense (ARBD), a novel defense framework designed to mitigate the impact of reinforcement learning-based adversarial attacks. ARBD integrates adversarial training with a pre-processing technique known as feature squeezing, to reduce the influence of small perturbations by applying Bit Depth Reduction and Spatial Smoothing (Median Filtering). This combination enables the model to learn robust representations while minimizing the effect of subtle input manipulations. Experimental results show that ARBD reduces the reinforcement attack success rate to 0.31% on MNIST and as low as 2% on CIFAR-10. Furthermore, it maintains or improves clean accuracy across all tested models, achieving up to 99% on MNIST and 98% on CIFAR-10.

BlockSafe: A Hybrid Architecture Combining AI-Driven Security and Blockchain Integrity

Georges El Hajal, Gaby H Abou Haidar and Roy Abi Zeid Daou

Due to the rapid increase in digital services, relying on passwords as a primary method of authenticating the identity is increasing. This shift has resulted in the continual increase in data breaches, credential thefts, and phishing attacks on users by the digital-service providers they use. Traditional password-management systems depend upon centralized architecture for their operation, which creates a single point of failure and exposes the system to exploitation by Distributed Denial-of-Service (DDoS) attacks. Current implementations of blockchain technology do offer a decentralized approach, with secure and immutable credentials; however, such implementations tend to be costly from both a hardware and an operational standpoint. BlockSafe is a lightweight, artificial intelligence-based password management system that combines machine-learning-driven security analytics with simple blockchain architecture. The application leverages the Gemini Large Language Model (LLM) to perform intelligent, real-time password strength classification and provide contextual security feedback. In addition, BlockSafe utilizes client-side asymmetric encryption through MetaMask and Ethereum-based smart contracts to ensure the immutability and verifiable integrity of credential data.

Dempster-Shafer evidence combination in AND/OR trees: insights, heuristics and applications

Costas Koutras, Christos Nomikos, Christos Moyzes and Christos Rantsoudis

Evidence combination is a fundamental problem in the Dempster-Shafer theory of evidence (DST), still 50 years after the start of the field. Several rules have been proposed and investigated in a vivid scientific debate on how to combine pieces of evidence coming from multiple, possibly conflicting, sources. Here, we introduce the problem of bottom-up evidence combination in AND/OR trees, motivated by problems in Computational Social Science. The problem has not been addressed hitherto; it implies a shift of perspective on evidence combination and it seems to require new insights on the meaning and the role of ‘evidence', along with novel combination techniques. We provide some insights on the problem by experimenting with an ad hoc heuristic that employs different combinations of some known rules in AND/OR trees with ternary AND-nodes (branching degree at most three). The problem is worth considering given the widespread use of AND/OR trees in AI and CS problems. Our results contribute to a better understanding of the problem towards providing a dedicated evidence combination algorithm; we outline motivating applications and relevant algorithmic problems that emerge.

Deep Learning-Automatic Honey Variety Identification

Al Yaqeen Salim Mohammed Al Wardi, Mohammed Abdullah Salim Al Husaini, Yousuf Nasser Al Husaini, Yasir Abdallah Khalifa Al Masqari, Mohamed Hadi Habaebi and Rawad Abdulghafor

Honey authentication plays a vital role in ensuring food quality and helping consumers know more about their products. Traditional methods like chemical analysis and melissopalynology are trusted but can be slow, expensive, and require expert skills. To make things easier and faster, this study introduces a deep learning approach that automatically identifies honey varieties using hyperspectral and RGB images. We gathered a diverse set of 5000 honey samples from five different floral origins-Sidr, Clover, Acacia, Citrus, and Wildflower-and carefully processed the data through normalization, resizing, and data augmentation. Using a ResNet-50 neural network trained with the Adam optimizer and categorical cross-entropy, we split our dataset into 70% for training, 15% for validation, and 15% for testing, ensuring reliable evaluation with 10-fold cross-validation. The results are quite promising: our model achieved an impressive average accuracy of 99.80%, along with high sensitivity,

specificity, precision, F1-score, and AUC values, all indicating excellent classification performance. The confusion matrix shows that different honey types are well distinguished, with only a few misclassifications among visually similar samples. When tested on new, unseen samples, the model provided confidence scores ranging from 86.5% to perfect 100%. These encouraging findings suggest that deep learning image analysis can offer a powerful, non-invasive method for identifying honey varieties. Moving forward, we plan to expand our dataset and explore combining multiple data types for even better results.

Translation and Prioritization of Lebanese Road Policies for Context-Aware Autonomous Driving in Developing Countries

Claritta Miguel Khoury, Raghad Tarek Al Agha and Naseem Daher

Although autonomous ground vehicles (AGVs) perform reliably in structured and controlled environments, their deployment in unstructured settings and poorly-maintained infrastructures, such as those in Lebanon, exposes limitations in current planning and learning-based methods. This paper introduces a policy-aware, physics-based local planning framework. It combines deontic logic with prioritized safety policies to help AGVs navigate such contexts. Various dynamic traffic scenarios were examined, including lane changes, overtaking, and mixed road users. Results show that the ego vehicle adheres to the highest-priority safety constraints while relaxing lower-priority constraints within the hierarchy. The proposed framework enables transparent and deterministic decision-making by explicitly resolving policy conflicts according to their safety priority.

Adaptive Neuro-Fuzzy Inference System with Hybrid Learning for Next-Day pH Prediction in Water Quality Monitoring

Anthony Ayli, Karim Daou and Hadi Y. Kanaan

Accurate prediction of water quality parameters is essential for ensuring safe drinking water and protecting aquatic ecosystems. This paper presents an Adaptive Neuro-Fuzzy Inference System (ANFIS) based on Takagi-Sugeno-Kang inference for next-day pH prediction in water treatment systems. The proposed model utilizes four key input parameters: current pH, dissolved oxygen, electrical conductivity, and temperature. Unlike traditional black-box neural networks, our ANFIS implementation incorporates complete hybrid learning with forward-pass least squares estimation for consequent parameters and backwardpass gradient descent for premise parameters, coupled with adaptive learning rate adjustment. We systematically compare three membership function types across multiple configurations to identify optimal model architecture. Performance evaluation on the UCI Water Quality dataset demonstrates that the best ANFIS configuration with Generalized Bell membership functions achieves an R-squared value of 0.90 with RMSE of 0.058, significantly outperforming traditional approaches. The results indicate that ANFIS provides superior interpretability through fuzzy rules while maintaining excellent prediction accuracy, making it particularly suitable for operational decision support in water treatment facilities.

S11(C): Power, Power Electronics, Industrial Electronics and Energy-I

Virtual Room-3

Chair: Hiba Al Sheikh

Design and Simulation of Inverter for Smart Grid Using DSP-Based Model Predictive Control

Youness Hakam and Mohamed Tabaa

This paper explores the advantages of incorporating electric vehicle (EV) chargers into the smart grid, particularly highlighting how Vehicle-to-Grid (V2G) technology can reduce electricity costs for smart homes. By using Model Predictive Control (MPC), our approach enhances system performance and boosts energy efficiency. The MPC predicts changes in voltage output across different inverter switching states through a discrete-time model, identifying the best switching state for upcoming intervals. This method reduces Total Harmonic Distortion (THD) and speeds up system response, leading to a more dependable and efficient setup.Our findings are supported by MATLAB/Simulink simulations under pump motor load conditions, where we saw THD decrease from 2.56% to 1.56%, an improvement of roughly 1.00%. Further tests using Hardware-in the-Loop (HIL) simulations affirm the durability and practicality of the MPC approach. The paper also discusses the design needs for high-performing boost converters and inverters, highlighting the importance of digital signal processing in improving system efficiency. We used Texas Instruments' TMS320F28379D digital signal processor, which features dual CPUs and a 16-bit resolution ADC, to develop and test specific MPC controllers and electronic circuits. This setup significantly enhances the performance of high-efficiency charger boards and offers a costeffective solution for smart homes, optimizing energy utilization through the smart grid

Hysteresis-Driven Thermal Behavior and Geometry Optimization of Multi-Tube PCM Tanks: A 2D Enthalpy Model with Tank-Scale Correlations

Noureddine Badie Itani, Nazih Moubayed, Chantal Maatouk and Rabih Dib

This research introduces an innovative and substantially improved numerical framework for simulating latent thermal energy storage (LTES) utilizing paraffin-based phase-change materials (PCMs). Earlier studies that used single-tube PCM domains had very long melting times because the heat-transfer area was small and the phase-transition formulas were too simple. In contrast, this work presents a multi-tube cylindrical tank architecture integrated with an innovative hysteresis-aware phase change material (PCM) model, resulting in a significant acceleration in complete melting compared to traditional designs. An enthalpy-based representation of phase change is used to create a two-dimensional axisymmetric finite-difference formulation. The main new thing is that it combines direction-dependent melting and solidification kinetics using logistic S-curve hysteresis correlations. This makes it possible to accurately predict how asymmetric phase transitions will behave. Other new features include tank-scale averaging correlations for liquid fraction, enthalpy, and effective heat capacity. These make it possible to see hysteresis at the system level instead of just at the material point level. The results show that the multi-tube design greatly improves thermal charging performance, cutting the time it takes to melt to levels that work with daily solar availability. The hysteresis analysis additionally elucidates unique melting and solidification pathways that conventional models do not adequately represent. The suggested framework sets up a new way of doing things and a new way of looking at things for high-efficiency PCM storage in solar-assisted cooling, industrial heat recovery, and next-generation thermal battery systems.

Optimization of Energy Management System with Different Operating Strategies for Greenhouse Heating: A Case Study in Lebanon

Loubna Khaled, Raymond Ghaleb, Rabih Dib, Bakri Abdulhay and Nazih Moubayed

Sustainability in agriculture involves protected cultivation systems to create a controlled environment for crop growth, particularly in the face of climate change. Year-round production in Lebanon requires an effective energy

management system to sustain essential operations. This study examines combinations of electric generation methods to meet the analytically modeled heating load to maintain an 18 °C internal temperature, during winter, for 20 standard Quonset greenhouses on a 10,000 m2 area of land. Operating strategies include a single diesel generator, with and without heat recovery, dual diesel generators, photovoltaic panels with different layouts (South and East/West), and battery storage. Each strategy is modeled and examined under various operating conditions in 2023. The multi-objective Pareto optimization, with a weighted average approach, is based on the normalized factors: the Levelized Cost of Energy, Renewable Fraction, and payback period, providing an adequate choice given the available land area. Each strategy offers specific economic, environmental, or spatial benefits. The results indicate that fully removing the diesel generator is currently unfeasible for heating applications. The strategy with the highest rank, with equal weights, is the dual diesel generators, followed by the hybrid with south-facing panels, which is the highest with 60% and more importance to the environment. This study provides an optimization tool for an energy management system for a greenhouse farm according to desired economic, environmental, or spatial parameters.

Inverse Diagnostics for Energy Efficiency: Optimizing Heat Pump Placement in Greenhouses via Gradient-Flux Mapping

Loubna Khaled, Rabih Dib, Bakri Abdulhay and Nazih Moubayed

The energy footprint of controlled environment agriculture is related to the power demands of microclimate control systems, particularly heat pumps, which are often oversized and inefficiently deployed due to a lack of precise diagnostic tools. This paper discusses the critical challenge of reducing electrical and fuel consumption by introducing a simple, low-computational-demand inverse method for optimizing the placement of system components. The methodology evaluates available multi-point experimental data on temperature and relative humidity stratification in a 332 m2, 3m high, thermal-polyethylene-covered Quonset greenhouse in Lebanon. The simple gradient inverse method is employed to compute the inferred heat flux, the moisture flux, and the density gradient, qualitatively describing the air movement. The results show the accumulation of heat and moisture at the top-far end of the studied structure, and the inferred air movement from low (bottom inlet) to high (top outlet) density areas. This convergence locates the dominant source of thermal stratification and buoyant flow, which is the primary driver of microclimate non-uniformity and energy waste. The derived technical decision is to strategically place the heat pump and vent openings to actively break the buoyant flow, rather than simply treating the average air volume. Also, the use of a variable perforation duct system for homogeneity at the ground (heating) and plant (cooling) levels for optimum uniformity. This work provides a practical, data-driven framework for power system engineers to optimize the deployment of thermal management equipment in agricultural and industrial settings.

Electrical Energy Demand, Specific Energy Consumption, and Emissions Implications of the Karak Wastewater Pumping System

Renalda El-Samra

Wastewater pumping stations are critical yet often overlooked components of urban electricity demand, particularly in regions with complex topography and fossil-fuel-dominated power generation. This study presents a novel assessment of the electrical energy demand and indirect greenhouse gas emissions of the wastewater pumping system serving Karak, Jordan. Unlike most previous studies that focus primarily on wastewater treatment processes, the proposed approach explicitly links hydraulic constraints, operational variability, and duty-cycle behavior to electricity consumption at the pumping-station level. Using operational records and system design data, specific energy consumption (SEC) and electricity-related emissions (scope 2) are evaluated across multiple pumping stations, enabling internal benchmarking of energy and emissions performance. The results reveal pronounced variability in SEC and emissions, demonstrating that cumulative electricity demand and carbon

footprint are governed more by hydraulic and operational conditions than by installed pump power alone. By accounting for differences in load utilization and operating duration, the study provides actionable insights for energy efficiency improvement, emissions mitigation, and integration of wastewater conveyance systems into urban energy and power-system planning, particularly in water-scarce and energy-constrained regions.

Ultra-Efficient ZVS DC-DC Converter Topology for Modern Low-Power Systems

Najmehossadat Nourieh, Syed Mudassir Hussain, Yichuang Sun and Oluyomi Simpson

This paper presents a compact resonant DC-DC converter that operates entirely under soft-switching conditions. The proposed topology employs a simple LC resonant network that enables zero-voltage switching (ZVS) for the main switch while simultaneously facilitating energy transfer from the source to the load. A diode-connected MOSFET is incorporated to achieve ultra-low conduction losses, making the converter well suited for low-power and energy-constrained applications. The prototype delivers an output of 5 V at 14.2 µA from an input of 0.35 V at 286 µA, achieving a measured power-conversion efficiency of 71%. The simulations obtained are used to validate the steady-state operation, soft-switching performance, and overall functionality of the proposed design. Owing to its resonant behavior, the converter maintains a narrow variation in switching frequency (approximately 10%), enabling optimal component selection and stable performance.

Augmentation Environment]: A Template-Mask Based Data Generation for SystemVerilog Assertion Translation

Abdelaziz Mohammad, Abdallah Taha, Abdelrahman Sabry, Abdelrahman Kamel, Aya Reda, Omar Nasr, Mahmoud Abd El Mawgoed, Sohila Akram, Samer El Saadany, Waleed Aly and Eman M. ElMandouh

The semiconductor industry faces a significant challenge in obtaining enough structured datasets to train machine learning models for hardware design and verification tasks. This limitation slows down the development of AI-driven tools that could automate complex verification processes. This paper presents the Augmentation Environment-a novel data generation framework that uses template-based randomization combined with semantic masks to address this gap. Our approach specifically tackles the challenge of generating diverse SystemVerilog Assertion (SVA) structures from natural language templates, which is essential for training effective AI models. The framework allows users to control the complexity and variety of generated assertions through configurable probability distributions and mask types. We discuss the environment's modular design, the taxonomy of masks used for different assertion patterns, and user experience enhancements that make the tool practical for real-world applications. These improvements streamline the entire training pipeline for AI-powered SVA generation systems, making it easier to produce high-quality datasets at scale. Our results demonstrate the framework's ability to generate over 500,000 unique assertion samples, significantly advancing the state of automated hardware verification.

Impacts of On-Grid PV on Voltage and Power Factor in Zahle, Lebanon, with Mitigation Strategy

Jessica Joseph Korkmaz and Raymond Ghajar

The penetration of solar photovoltaic-based distributed generation (PV DG) has increased significantly in regions with high solar potential, such as Lebanon, raising concerns regarding the reliable performance of distribution networks. This paper analyzes the impacts of grid-connected PV DGs on voltage profiles and power factor of real-world distribution feeders, located in Zahle, a region of Eastern Lebanon. After modeling the distribution feeders, optimal siting and sizing of capacitor banks (CBs) are carried out using the CAPADD function in OpenDSS, to mitigate the quantified impacts. The impact assessment identifies the feeder that is most critically affected by the integration of PV DGs. Although the optimal CB allocation effectively reduces power losses, it introduces adverse impacts on the voltage and power factor at the Slack Bus.

Wednesday, April 15 12:30 - 1:00

Lunch#1: Lunch Break

Virtual Room-1, Virtual Room-2, Virtual Room-3

Wednesday, April 15 1:00 - 3:00

S12(A): Biomedical and Bioinformatics-II

Virtual Room-1

Chairs: Mohammad Ayache, Ali El-Zaart

Low-Cost, Open Personal Health Wearable for Sports Performance and Rehabilitation

Srihari Yamanoor and Narasimha Sai Yamanoor

Participation and success in sports used to be an exclusive domain, with only a few nations of certain wealth and resource levels able to succeed and dominate international events, including quadrennial events such as Olympics, World Cups in various sports and others with interim frequencies. As economies develop, sports enthusiasts have emerged and found growing success in various sports endeavors. A fundamental requirement of competitiveness in the world of sports is the ability to measure and understand one's health metrics to benchmark and set goals for improvement and readying oneself for participation and ultimately success. Citizens of developing nations continue to be stymied by the expense of measuring and managing metrics, as well as locating appropriate healthcare consultants. The current work presents an effort at tackling metrics at a minimal expense to the user. The configuration presented will have a variety of sensors useful for the determination of health including IMU, Temperature Sensor, Heart Rate & Pulse Oximetry Sensor, and Blood Glucose Sensor. The design is open and therefore can be appropriately modified or expand sensory metrics as desired. A costed BOM for the prototype is presented to guide the understanding and development of such open products on a scale. The open design also provides opportunities for success in regional entrepreneurship and manufacturing initiatives such as Make in India and may be adopted elsewhere worldwide.

Comparative Dosimetry of VMAT Left Breast Radiotherapy Using Free Breathing and Deep Inspiration Breath Hold Techniques

Nourhane Ali Moussawi and Wassila El kanawati

This research investigates the differences between free breathing and deep inspiration breath-hold volumetric modulated arc therapy in the context of left breast radiotherapy, focusing on dosimetric metrics for the clinical target volume (CTV) and organs at risk (OAR). The study enrolled twenty-six patients after breast conserving-surgery. An independent t-test was used to assess these differences in quality metrics between the two groups based on clinical target volume D98 and D95, homogeneity index, conformity index, and monitor units, in addition to dose volume measures for the heart and lungs. The deep inspiration breath hold technique enhanced target coverage and dose distribution uniformity. For the organs at risk, this technique lessened heart exposure to low doses, evidenced by a reduced heart V5 percentage, and lowered the mean dose and V20 to the ipsilateral lung. No significant differences were noted for the mean doses of the contralateral lung or contralateral breast. In general, deep inspiration breath-hold combined with volumetric modulated arc therapy enhanced the dose quality of the clinical target volume, while also offering greater protection for the heart and ipsilateral lung in comparison to free breathing.

An Interpretable AI Framework to Predict Post-ICU Mental Health Risks employing EHR Data and Vitamin D Biomarkers

Mohamed Tabaa, Salma Chebbawi and Hassan Badir

This research paper is an evidence-based artificial intelligence pipeline that will enhance predictions related to mental health outcomes related to Post-Intensive Care Syndrome (PICS). The given approach will help to harness the power of structured clinical data and vitamin D levels, a modifiable and clinically actionable biomarker, by attempting to find a solution to the issue of sparse mental health coding in regular electronic health records (EHRs). The findings indicate that the combination of biological, clinical, and demographic variables increases predictive accuracy and allows assessing risks more personally and fairly. In addition to predictive accuracy, the pipeline will also add to the emerging discipline of critical care AI by highlighting clinically meaningful features which can be used to inform preventive and therapeutic interventions. In general, the article demonstrates the possibilities of integrating machine learning and adjustable biomarkers to aid in the earlier detection of patients who will develop post-ICU mental health issues and facilitate a hybrid AI-clinical decision-support in a critical care setting.

Glaucoma Screening on Retinal Fundus Images with Deep Learning

Anday Duru

Glaucoma is a leading cause of irreversible vision loss, and effective screening relies on accurate identification of glaucomatous optic neuropathy from routine ocular imaging. Fundus photography is widely used as a supportive modality in clinical practice because it provides a direct view of the optic nerve head and adjacent retinal structures. In this study, a public retinal fundus dataset was used to evaluate the extent to which deep learning models can support glaucoma screening, while quantifying the effect of different backbone choices and hyperparameter configurations on performance. Training and evaluation pipeline was implemented considering a fair comparison across models. Under a matched experimental protocol, four convolutional neural networks were fine-tuned, including ResNet-50, DenseNet-121, EfficientNet-B0, and ConvNeXt-Tiny. The best-performing configuration achieved ROC-AUC = 0.971, accuracy = 0.940 on the subject-level test folds, with sensitivity = 0.957 and specificity = 0.923. Model interpretability was further examined using Grad-CAM, and the resulting maps generally highlighted clinically relevant regions around the optic disc, providing qualitative support for the decision process. Overall, these findings suggest that automated glaucoma screening from retinal fundus images can serve as a useful component of clinical decision support systems for triage and prioritization.

Enhanced Liver Tumor Segmentation via Optimized Preprocessing and Attention-Based U-Net Model

Carine Shqeir, Mohamad O. Diab and Racha Soubra

Liver cancer is a leading cause of cancer-related deaths worldwide. Accurate liver tumor segmentation from Computed Tomography (CT) images is a critical step for diagnosis, treatment planning, and disease monitoring. However, it is challenging due to heterogeneous tumor appearance, low contrast boundaries, and large variability in lesion size and shape. In this work, we adopt an Attention U-Net model integrated with Atrous Spatial Pyramid Pooling (ASPP) and Convolutional Block Attention Modules (CBAM) and we focus on optimizing preprocessing techniques to enhance liver tumor segmentation performance. The preprocessing pipeline includes liver-focused cropping, normalization, gamma correction, and contrast-limited adaptive histogram equalization to improve tumor visibility and boundary definition. The model is trained and evaluated on liver-focused CT slices derived from the LiTS dataset. Segmentation performance is assessed using Dice Similarity Coefficient and Intersection over Union metrics. Experimental results achieve a tumor Dice score of 0.9166 and an IoU of 0.8586, demonstrating a substantial improvement over baseline approaches and highlighting the critical role of preprocessing combined with attention-enhanced architectures. The proposed framework provides a robust and accurate approach for automated liver tumor segmentation while maintaining computational efficiency, supporting its potential for automated clinical image analysis.

A Comparative Evaluation of Linear and Non-Linear Combat Variants for Multisite EEG Harmonization

Milana Kasab, Mirna Mahmoud El Shamaa, Fréderic Bonnardot, Nils Laurent, Mohamed ElBadaoui, Mohamad O. Diab and Mahmoud Hassan

Aggregating multisite electroencephalography (EEG) data is essential for overcoming the limitations of single-site studies and achieving robust statistical power, particularly for the identification of reliable biomarkers of brain development. However, site-specific variability arising from differences in acquisition hardware and protocols often obscures genuine biological signals. This study evaluates the efficacy of three ComBat-based harmonization frameworks-NeuroComBat, NeuroHarmonize, and OPNested-ComBat-GMM-in mitigating these batch effects. Resting-state EEG data from 558 healthy participants aged between 5 and 18 years were aggregated across four independent cohorts. Following standardized preprocessing, over 2000 feature-channel combinations were extracted per participant. Harmonization performance was assessed using t-SNE visualization, Z-score variance analysis, residual site mean and variance dispersion analysis, and correlation-based preservation of age-related effects. All methods substantially reduced site-related variability; however, NeuroHarmonize consistently demonstrated superior performance. By modeling nonlinear age effects through Generalized Additive Models (GAMs), NeuroHarmonize achieved the lowest residual between-site dispersion while preserving biologically meaningful age-feature relationships. These findings highlight the importance of accounting for nonlinear developmental trajectories in multisite EEG harmonization and establish NeuroHarmonize as a robust strategy for large-scale developmental neurophysiological studies

A Power-Efficient Analog Hardware Type-2 Fuzzy Classifier Architecture for Parkinson's Disease

Evangelos Asitzoglou, Daniela Papa, Vassilis Alimisis, Andreas Papathanasiou, Vasileios Moustakas, Evangelos Georgakilas and Paul P Sotiriadis

This work presents an ultra-low-power fully analog hardware fuzzy classifier comprising Gaussian membership function circuits, a MIN/MAX-based rule evaluation stage, and an analog operational transcoductance amplifier as defuzzification block. A high-dimensional Parkinson's disease dataset with strong feature correlations is used to demonstrate the performance of the circuit. To reduce hardware complexity and data overlap, the five most classification-relevant features are selected, enabling efficient hardware implementation while preserving classification performance. The proposed classifier is implemented in a TSMC 65 nm CMOS process. Post-layout simulation results demonstrate proper operation with a classification accuracy of 83.82% (vs 85.26% of the software equivalent) and a total power consumption of 138 nW, confirming its suitability for ultra-low-power biomedical edge applications.

Why are EEG Signals Heavy-Tailed?

Tamara Sadek, Jihad Fahs and Ibrahim Abou-Faycal

Electroencephalographic (EEG) signals are commonly assumed to follow Gaussian statistics, yet growing evidence suggests their amplitude distributions are heavy-tailed. In this work, we provide the first analytical justification for this phenomenon by modeling the spatial distribution of active neuronal clusters as a Poisson Point Process and adapting interference-aggregation techniques from wireless communications. Under physiologically motivated assumptions such as inverse-square voltage attenuation, we prove that the aggregate EEG voltage follows a symmetric alpha-stable distribution, specifically a Cauchy distribution in the canonical case. Empirical validation on the University of Bonn and Zenodo EEG datasets confirms that heavy-tailed models, particularly the Student's-t and alpha-stable families, consistently outperform Gaussian and lighter-tailed alternatives across multiple goodness-of-fit criteria. These findings bridge a gap between empirical observations of non-Gaussianity in EEG and a mathematical explanation, offering a foundation for rethinking statistical assumptions in EEG signal processing and analysis.

S12(B): Computer Systems and Applications-II

Virtual Room-2

Chairs: Elio Aoun, Tejas Pravinbhai Patel

Goal-Based Multi-Agent AI Systems for Academic Advising: A Survey of Policies, Risk Detection, and Intervention Frameworks

Mohamad Klot, Milan Dordevic, George Tsaramirsis and Mohamad Nassereddine

Artificial intelligence (AI) is increasingly embedded in computer-based academic advising and decision-support systems to improve student retention, progression, and timely intervention at scale. However, most current platforms remain largely reactive, focusing on question answering or risk prediction, and lack the ability to explicitly model student goals, curriculum constraints, and adaptive intervention policies. This survey reviews goal-oriented, multi-agent, and agentic AI architectures for advising systems, with emphasis on software frameworks enabling policy-driven early-warning and intervention for at-risk students in higher education. It traces the evolution from rule-based degree audits and early-warning analytics to advanced architectures integrating learning analytics pipelines, explainable AI (XAI), affect-aware modelling, reinforcement learning, and LLM-based agents. A unified taxonomy classifies systems by goal representation, planning horizon, risk awareness, intervention autonomy, and governance. The survey highlights gaps between accurate risk detection and actionable intervention logic, examines closed-loop agentic architectures with human-in-the-loop controls, and outlines research challenges in causal validation, equity, scalability, and deployment

Enhancing Medical Risk Prediction via Hybrid Quantum Relevance Network

Rayane Moustapha ElRaba'a, Soha Rawas and Ali El-Zaart

As medical datasets grow in both dimensionality and complexity, traditional attention, based neural architectures have their limitations especially concerning their mechanisms for determining the relevance score, which, in most cases, are limited to linear or shallow non, linear similarity functions. This article introduces a hybrid quantum, classical neural architecture model that swaps the typical method for calculating relevance scores with a Variational Quantum Circuit (VQC) while keeping the rest of the classical learning pipeline unchanged. Through superposition, entanglement, and interference, the proposed method allows the model to carry out more complex feature interactions at the time of relevance estimation, thus not affecting the subsequent aggregation and prediction stages. The method is realized through the PennyLane quantum simulator integrated into a PyTorch training pipeline and tested on a synthetically generated medical dataset holding key physiological indicators. The results of the experiments show that relevance scoring enhanced by quantum still keeps the predictive performance at a competitive level while providing a more expressive and theoretically justified similarity modeling mechanism. Hence, quantum relevance kernels may be considered a component of clinical decision support systems of the future.

A Production Framework for Adaptive GPU Resource Management in Deep Learning Inference

Tejas Pravinbhai Patel, Rohit Nimmala and Milan Parikh

Deploying AI models in production requires balancing throughput, latency, and infrastructure cost. Existing inference systems often rely on static GPU allocation and fixed batching strategies, leading to underutilized resources during low traffic and degraded performance during demand spikes. This paper presents a practical framework for adaptive AI inference that dynamically adjusts batching and GPU allocation based on real-time workload patterns. We implement the system using commodity GPU instances and evaluate it with vision and language models under varying traffic conditions. Results from experiments on NVIDIA A4000 and A5000 GPUs show throughput improvements of 1.4× to 2.1× compared to baseline configurations, with latency reductions of 18-32% during steady-state operation and 25-38% better GPU utilization. The framework is designed for

straightforward deployment in existing cloud environments without requiring specialized hardware or extensive reconfiguration.

Fast Warm-Start Techniques for Large Language Model Inference

Tejas Pravinbhai Patel

Large language model (LLM) inference servers experience significant latency during cold starts-the period from process initialization to serving the first request. We measure cold-start time-to-first-token (TTFT) exceeding 45 seconds for 7B-class models and 80 seconds for 13B-class models on com- modity GPUs. This latency creates SLA violations during scaling events, deployments, and fault recovery. We present a system of engineering techniques that reduce cold-start overhead without modifying model weights or architecture: artifact pre-staging, CUDA context pre-initialization, memory allocator priming, and kernel warm-up. Our evaluation on Paperspace GPU instances shows TTFT reductions of 42-68% (7B models) and 31-54% (13B models) compared to na¨ıve cold starts, while maintaining steady-state throughput within 3% of baseline. We characterize the breakdown of cold-start phases and demonstrate that system- atic warm-start optimization is practical for production serving systems.

FALLMAS: An LLM-Based Multi-Agent System for Automated Financial Analysis and Strategic Reporting

Hicham Bouchtib, Mohamed Tabaa, Kaouter Karboub and Mohammed Hamlich

Large language model-based Multi-Agent systems (LLM-MAS) latest success has proven remarkable versatility across several applications including domain-specific knowledge such as customs compliance and law. However, applying LLM-MAS to high-stakes domains like finance in particular, to financial analysis, which is a highly competitive task that requires a combination of effective strategy, sufficient knowledge and precise decision-making, is still rare and not fully proven. It is appealing to apply the emerging power of these Artificial Intelligence (AI) Agents in a competitive arena of financial advising in order to understand if they can outperform professional financial advisors. In this study, we introduce our Financial Advisor based on Large Language Models and multi-agent Systems (FALLMAS) as a fully operational LLM-MA system that integrates data extraction (e.g., from tax filings and web sources), financial ratio computation (e.g., Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA), Return on Equity (ROE), gearing ratio), strategic SWOT analysis, and narrative report generation. Each autonomous agent specializes in a distinct task, such as financial metric mining, web exploration, news retrieval and strategic reasoning enabling effective analysis. This paper intends to provide interpretations into the current state of the art of LLM-based Multi-Agent Systems used in financial analysis. Furthermore, our LLM-based MA system for financial analysis is open-source, we invite researchers to make use of our results. FALLMAS is publicly available on Github.

A Lightweight and Interpretable HSV-Based Semantic Routing Framework for Content-Based Image Retrieval

Reda Shbib and Haneen Kodamy

Efficient content-based image retrieval (CBIR) remains challenging in scenarios where computational budget, latency, and interpretability are critical constraints. While deep embedding models achieve high retrieval accuracy, their parameter count, hardware dependence, and opaque representations limit their suitability for lightweight or edge-oriented applications. This paper presents HSV+SAF+NN, a modular and fully interpretable CBIR framework that augments global Hue-Saturation-Value (HSV) color histograms with a Semantic Activation Filter (SAF) and a compact semantic routing classifier. The proposed design enhances the discriminative capacity of handcrafted features while preserving their transparency and computational efficiency. We evaluate the framework on three benchmark datasets of increasing difficulty-Corel-1K, Wang/Corel-1000, and Oxford Flowers-17-covering easy, moderate, and fine-grained retrieval settings. Across datasets, semantic activation and class-guided routing consistently improve early-rank precision and mean Average Precision compared to raw HSV descriptors. On the challenging Flowers-17 dataset, the complete pipeline achieves a clear and consistent improvement in mAP over the HSV baseline, despite the inherent limitations of global color features in fine-grained scenarios. The entire system uses fewer than 2K trainable parameters and achieves sub-microsecond query latency, making it suitable for real-time and resource-constrained deployment. These results demonstrate that classical color statistics, when combined with lightweight semantic gating and routing, provide a transparent and efficient alternative for CBIR applications where interpretability and efficiency are primary requirements

Seeing The Physical World Using WiFi Channel State Information and Artificial Intelligence

Mohamad Abou Ali, Malek Srouji, Mohamad Al Hajj and Abdallah Kassem

WiFi Channel State Information (CSI) enables fine-grained perception of the physical environment beyond traditional communication. This paper presents a leakage-safe and physics-aware framework for material recognition distinguishing empty scenes, organic, and metallic objects by eliminating shortcut learning from positional and temporal metadata. Through physics-guided feature engineering, we capture statistical dispersion, phase variability, and channel instability inherent to RF propagation. Evaluated on a large-scale real-world dataset, our approach demonstrates robust generalization, with TabNet achieving 96.0% test accuracy and a macro-AUC of 0.993. Interpretability analyses confirm that classification is driven by physically meaningful CSI characteristics, supporting trustworthy and transparent environment sensing using commodity WiFi.

RISCNet: A Novel Deep Learning Model for RealTime Radiation induced sickness Classification

Raja Kafi Rahmatullah, Humayra Akhter, Kawshik Das, Md Shamim Ahmed and Ramit Kumar Sadhukhan

Exposure to ionizing radiation poses significant health risks, leading to a wide spectrum of radiation-induced toxicities, ranging from localized effects like cataracts to systemic acute reactions such as extensive vomiting. The accurate and early classification of these symptoms are critical for effective clinical intervention and patient management. However, hybridity of data and scarcity of balanced exposure datasets presents a significant challenge for traditional diagnostic method. This research introduces the Radiation Induced Sickness Classification Network (RISCNET), an adaptation of the XDNet hybrid machine learning framework, specifically tailored to classify radiation-induced sickness based on dosimetric and clinical features. Unlike generic AI systems, RISCNet is tailored to the unique characteristics of improved accuracy and handling complex data sets originated from radiation induced sickness. The framework combines the Deep Neural Network (DNN) to extract patterns from high dimensional numerical data, such as absorbed dose and exposure duration, while incorporating CatBoost to handle categorical clinical symptoms and demographic variables. To overcome the inherent limitations of small medical datasets, a Synthetic Data Augmentation Network (SDAN) was utilized to generate a robust training environment. The process starts with gathering input data from cesium-137 isotope around from nuclear weapons testing and from the accidents at Chernobyl and Fukushima. Based on calibration tests of multiple device designs using the same detector), including radiation levels and environmental parameters, followed by preprocessing to clean and normalize the data. The RISCNet model is then trained on a portion of the dataset and tested on 30% to evaluate its performance. The trained model provides accurate radiation based sickness classification, including real-time data processing. Our suggested model achieved 99.79% accuracy, with same amount of precision and recall, as demonstrated by the confusion matrix for six-class radiation induced sickness classification. These results validate its effectiveness for real time applications which also outperforms significantly baseline single-architecture models. By providing real-time, interpretable classification of toxicities like ocular damage and gastrointestinal distress, this framework offers a powerful tool for clinicians in radiotherapy. It also enhances safety, reduces costs, and minimizes human error, offering scalable solutions for radiation sickness and other domains. Future developments can include advanced unsupervised techniques, integrating multi-modal 3D radiomic imaging and real-time wearable sensor data to enhance personalized diagnostic precision and clinical

explainability in radiological emergencies and multimodal data handling for broader applicability and real-world deployment.

S12(C): Power, Power Electronics, Industrial Electronics and Energy-II

Virtual Room-3

Chairs: Atef Harb, Jean Sawma

Resistorless DVCCTA-Based Memristor Emulator for Analog/Digital/Neuromorphic Applications

Prerna Rana, Alak Majumder, Vassilis Alimisis and Paul P Sotiriadis

Memristor devices have gained considerable attention for applications in neuromorphic computing, adaptive learning systems, and analog signal processing. However, practical hardware realization is limited by the complexity of fabrication and device variability. This paper proposes a minimal, resistorless memristor emulator based on a Differential Voltage Current Conveyor Transconductance Amplifier (DVCCTA) and a single grounded capacitor. The proposed configuration eliminates the need for passive resistors by exploiting the inherent current-mode processing and voltage-controlled transconductance of the DVCCTA. The grounded capacitor serves as the state-variable element, enabling dynamic modulation of memductance in response to the input signal. Simulation results for TSMC 180nm on Cadence confirm that the emulator reproduces the characteristic pinched hysteresis loop in the current-voltage plane, with hysteresis area shrinking at higher frequencies, consistent with memristive behavior. Owing to its minimal component count, resistorless structure, and CMOS compatibility, the proposed design is well suited for low-power and area-efficient implementations. The versatility of the design is demonstrated through its use in analog, digital and neuromorphic applications.

Electrochemical-Thermal Coupled Modeling of Lithium-Ion Batteries for Cooling Performance Evaluation at Different Charge-Discharge Rates

Abdurahman Mohamed and Mian Hammad Nazir

Effective thermal management is essential for ensuring the safety, performance, and longevity of lithium-ion batteries (LIBs), particularly under high C-rate operation. This study develops a coupled 1D electrochemical-3D thermal-fluid model in COMSOL Multiphysics 6.2 to evaluate the thermal behavior and air-cooling performance of a cylindrical 18 650 LIB across multiple charge-discharge rates. Simulations quantify internal heat generation, temperature rise, thermal gradients, and cell potential variation, as well as cooling effectiveness at different inlet air velocities. Results show that increasing C-rate significantly intensifies heat generation and thermal non-uniformity, whereas higher airflow velocities markedly reduce peak temperature and improve uniformity. The integrated framework provides a reliable basis for analysing cooling strategies and guiding the design of thermally robust LIB systems.

Synergistic Optimization of Solar Photovoltaic Generation and Energy Storage Deployment for Smart Grid Performance Enhancement

Duy C Huynh, Viet D. Q. Nguyen, Ho Dac Loc, Phat Tien Nguyen, Corina Barbalata and Matthew Dunnigan

The increasing integration of renewable energy sources in smart grids requires effective planning strategies to reduce power losses and maintain voltage stability. This paper proposes a synergistic optimization framework for coordinated deployment of solar photovoltaic (PV) generation and battery energy storage systems (BESS) to enhance smart grid performance. The optimization problem is formulated to minimize total active power losses under operational and voltage constraints and is solved using an advanced artificial bee colony (ABC) algorithm with chaotic initialization. Numerical simulations on the IEEE 33-bus smart grid demonstrate that coordinated solar PV-BESS integration significantly outperforms solar PV-only deployment, achieving a maximum loss reduction of 65.84% while satisfying all voltage limits. Comparative results with GA, PSO, and the conventional ABC algorithm confirm the effectiveness and robustness of the proposed approach for smart grid planning applications.

Multi-Objective Optimization of Electric Vehicle Charging and Discharging in Smart Grid-based Vehicle-to-Grid Systems

Duy C Huynh, Viet D. Q. Nguyen, Ho Dac Loc, Phat Tien Nguyen, Corina Barbalata and Matthew Dunnigan

This paper proposes a multi-objective optimization framework for electric vehicle (EV) charging and discharging scheduling in a smart grid-based vehicle-to-grid (V2G) system. The scheduling problem is formulated to simultaneously minimize electricity cost and battery degradation while satisfying all operational and state-of-charge constraints. A modified Artificial Bee Colony (mABC) algorithm is proposed to address the problem, enhancing both convergence speed and solution quality. The performance of the proposed method is evaluated over a one-year assessment horizon using a representative 24-hour daily profile. It is compared with Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and standard ABC algorithms. Numerical results demonstrate that the mABC algorithm achieves lower annual electricity costs, smoother battery state-of-charge profiles, and faster convergence than the benchmark algorithms. These findings confirm the effectiveness and robustness of the proposed approach for practical EV energy management in smart grid-based V2G systems.

Urban Heat Island as a Thermal Stressor on Egyptian Energy Systems

Samar Morkos, Renalda El-Samra, Keer Zhang and Elie Bou-Zeid

The Urban Heat Island (UHI) effect creates a persistent source of elevated ambient temperatures in urban environments. In hot-arid, cooling-dominated regions such as Egypt, these thermal anomalies pose a significant and sustained stress on urban energy systems, driving up cooling degree days (CDD), peak electricity demands, and infrastructure load during summer months. This study investigates the spatiotemporal characteristics of UHI intensity in Cairo over the period 2011-2020 using a combined observational and physically based modeling framework (CLM/CLMU). We quantify the UHI signal using near-surface air temperature observations and simulated surface temperature fields. Results reveal a consistently positive UHI signal with pronounced seasonal amplification, confirming a substantial urban thermal loading. By reframing UHI as a persistent thermal forcing rather than solely a climatic phenomenon, this work provides a physical basis for incorporating long-term urban thermal effects into energy-system planning, load forecasting, and resilience strategies in rapidly urbanizing, cooling-dominated environments.

Enhancing Battery Aging in a Dual-DC-Source-Fed Open-End Winding Induction Motor Drive

Khaled Abdul Nasser Safsouf, Jean Sawma and Hadi Y. Kanaan

This study investigates a Hybrid Energy Storage System (HESS) composed of a battery and a supercapacitor supplying an Open-End Winding Induction Motor (OEWIM) for electric vehicle applications. The two energy sources are interfaced with the OEWIM through two conventional three-phase, two-level inverters connected to each end of the motor windings. The battery acts as the primary energy source, providing power required for normal vehicle operation and charging the supercapacitor. In contrast, the supercapacitor serves as a secondary energy source, responsible for delivering peak power demands during transient conditions such as acceleration and regenerative braking operation. Basically, batteries are sensitive to peak currents, which accelerate degradation and reduce lifespan. Therefore, they should preferably operate at low frequencies and supply nearly constant power. This paper presents two methods to keep the battery power close to constant by dynamically adjusting the power-sharing ratio between the two energy sources. The two proposed methods are extensively evaluated under a selected load profile, and conclusions are drawn based on the obtained results.

A Comparative Review and Simulation-Based Analysis of Static and Rotating Excitation Systems for Off-Grid Synchronous Generators

Cynthia Moussa, Gabriel Khoury, Jean Sawma, Flavia Khatounian and Ragi Ghosn

Synchronous generators remain a dominant technology in global power generation and require dedicated excitation systems to energize their rotor winding, particularly in off-grid applications. This paper presents a

comprehensive review of excitation system configurations for off-grid synchronous generators. Various excitation source types used in stand-alone generation systems are classified, and their electrical characteristics are systematically analyzed. Both static and rotating excitation systems are examined, including their structural design, operating principles, control and implementation constraints. Four excitation system configurations are studied, and their performance is evaluated through MATLAB/Simulink simulations. The comparative analysis is conducted based on multiple evaluation criteria related to voltage regulation, system performance and control. The review is conducted in accordance with IEEE excitation system standards and aims to provide guidance for the selection and design of excitation systems in off grid synchronous generation applications.

Economic Analysis and Performance Comparison of Solar Tracking vs. Fixed-Axis Systems in Solar Power Plants: A Case Study in Iraq

Husam Ali Hadi, Safwan Nadweh, Abdallah Kassem, Hassan Amoud, Nazih Moubayed and Chady El Moucary

A comparison on the performance and economic analysis of a solar tracking system and a fixed-axis photovoltaic (PV) system is done. The increased need of clean energy in the world today makes solar power a significant alternative source of fossil fuels. Specifically, this paper focuses on the techno- economic feasibility of these two system configurations of a solar power plant in Babylon, Iraq. The nature of previous research is usually constrained by the generic comparisons that fail to capture the circumstances of site and lifecycle cost evaluation. The main contribution of this study is the in depth and location specific model, which is a combination of the performance simulation and the financial analysis. The project-specific data used in the methodology is solar resource and load profiles to derive the main measures and indicators of energy efficiency, annual energy production (AEP), initial capital cost and the levelized cost of energy (LCOE). It is discovered that the tracking-axis system has a better efficiency range of 18% - 20% percent than 15% - 18 % in the case of the fixed-axis system. Even though the initial cost of the tracking system is higher $\mathbf{1200 - 1500}$ $\$/\boldsymbol{kWp}$ compared to 1 $\mathbf{000 - 1200}$ $\$/\boldsymbol{kWp}$ of the fixed one), the AEP of the tracking system is much greater ($\mathbf{1800 - 2100}\ \boldsymbol{kWh/kWp\ per\ year}$) as compared to that of the fixed one ($\mathbf{1500 - 1800}\ \boldsymbol{kWh/kWp\ per\ year}$). The tracking system therefore shows a possibility of a better LCOE throughout the project period.

Wednesday, April 15 3:00 - 3:15

CB#2: Coffee Break

Virtual Room-1, Virtual Room-2, Virtual Room-3

Wednesday, April 15 3:15 - 5:30

S13(A): Biomedical and Bioinformatics-III

Virtual Room-1

Chair: Mohamad O. Diab

Integrating Biomarkers from Correlation Analysis and Metric Learning for Hair Loss Classification

Noor Kamal Al-Qazzaz and Iyden Kamil Mohammed

The loss of hair is a multifactorial condition that is caused by nutritional deficiency, hormonal disequilibrium and inflammation. The two major objectives of this case-control study were: first, to provide a comparative statistical study on the correlation patterns of eight major biomarkers, namely Vitamin D3 (D3), Ferritin (Ferr.), C-reactive Protein (CRP), Thyroid-Stimulating Hormone (TSH), Zinc (Zn), Hemoglobin (Hb), Cortisol (Cort.), and General Urine (GUE) in 35 patients with hair loss and 35 healthy controls; second, to assess the feas Group-specific factors were identified by correlation analysis with a stronger positive Ferr.-Hb relationship with patients, a strong positive CRP-GUE relationship (r=0.858, p$<$0.01), a strong positive D3-Ferr. relationship (r=0.638, p=0.032), positive Ferr.-Hb association (r=0.582, p=0.001), and negative associations between Ferr.-Zn (r= -0.353, p=0.032). Standard k-Nearest Neighbors (kNN) with Euclidean distance provided accuracies of around 65% cross-validated and LMNN, which learns an optimal Mahalanobis distance to maximize the separation between classes, provided a better score of 95%. Such an improvement indicates the capability of the LMNN to learn nonlinear interactions between biomarkers and outperform other measures and offer robust, data-driven diagnostics. The combination of correlation-based information and metric learning can expose the possible pathophysiological connections and allow the detection of alopecia in the future, more sophisticated, and profoundly automated.

Uncovering Alzheimer's Disease Patterns in Patient Health Records through Artificial Intelligence and Principal Component Analysis

Agung Muliawan, Lama Yassine, Achmad Rizal and Amira J. Zaylaa

Alzheimer's disease is a form of progressive dementia that is often detected at an advanced stage, making early intervention and effective management difficult. This study explores the integration of artificial neural networks (ANN) with ensemble models for early classification of Alzheimer's disease by utilizing an open dataset of patient health parameters. This study explores the integration of deep learning and neural network approach with ensemble classifier to analyze health data, including indicators of hypertension, cholesterol, diabetes, heart disease, weight, and family history. A deep neural network (DNN) model is employed on a dataset covering patients with various stages of the disease, allowing the network to learn complex patterns and important features associated with Alzheimer's progression. In addition, Principal Component Analysis (PCA) was. used for dimension reduction without reducing information, and the ensemble classifier, specifically the Bagging and Boosting models, were integrated for increasing optimization of Alzheimer's disease classification accuracy. The results applied on real patient's records showed that the use of feedforward neural network (FNN) with PCA was advantageous as compared to the use of the same network without PCA, with 0.87% increase in the accuracy of detection of the disease. Integrating FNN with Boosting model using PCA showed the utmost and optimal early detection accuracy (83.95%) and was approximately 2% higher than that obtained using the deep learning without PCA (81.24%). However, the difference in the accuracy of detection while integrating the deep learning with the ensemble models was in the range of 1 to 1.5% higher than the difference in the accuracy using FNN with ensemble models. This study suggests that applying artificial intelligence techniques can be valuable in early diagnosis efforts, facilitating faster intervention and better care strategies for Alzheimer's patients.

A Leakage-Safe Multi-Task Learning Framework for Joint Brain Tumor Classification and Segmentation with External Validation

Ahmad O. Al Hassan, Marwan AlHawat, Ahmad Diab, Mohamad Kanaan and Lyn Abdelkader

Multi-task learning approaches that jointly perform brain tumor segmentation and classification have gained increasing attention due to their potential to exploit shared anatomical representations. However, many existing studies report near-saturated performance without sufficiently addressing data leakage, task coupling, or limited evaluation protocols, raising concerns about generalizability. In this work, we present a robust and leakage-safe multi-task deep learning framework for joint brain tumor segmentation and classification from MRI. This framework is designed to operate on heterogeneous datasets with partial annotations and enforces strict separation between training, validation, and external testing data. During inference, the segmentation and classification tasks are explicitly decoupled to ensure unbiased evaluation. We conduct comprehensive experiments across two independently curated public datasets with differing characteristics. Classification performance achieves 94.2% accuracy on the internal test set (Dataset A) and 99.1% accuracy on the external test set (Dataset B). Segmentation performance on the external test set (Dataset B) achieves a mean Dice coefficient of 0.866 and an IoU of 0.795. These results demonstrate strong and consistent performance across both tasks, with stable generalization to unseen external data. Our study highlights the importance of rigorous experimental design and evaluation practices when assessing multi-task learning models in medical imaging.

A New Multi-Class Framework for Electrocardiogram (ECG) Arrhythmia Classification Using Artificial Intelligence

Mohamad Zuhair Abo Hadba, Mohammad Ayache and Amira J. Zaylaa

Cardiovascular diseases remain the leading global cause of death, and large-scale epidemiological estimates report 18.6 million cardiovascular deaths in 2019, reinforcing the need for reliable, scalable signal-analysis pipelines that can support clinical workflows without increasing expert workload. Electrocardiography (ECG) is a ubiquitous, non-invasive modality for characterizing heart rhythm disturbances, yet automated interpretation remains error-prone and often requires human oversight for safety-critical decisions. This paper presents an arrhythmia signal classification framework (not disease prediction) evaluated exclusively on the MIT-BIH Arrhythmia Database using the widely adopted inter-patient DS1/DS2 protocol and AAMI-style class grouping. The proposed method combines (i) beat-centered segmentation (90 samples pre-R and 110 post-R; 200 samples total) with z-score normalization, (ii) a lightweight 1D CNN-GRU backbone trained with focal loss to mitigate severe class imbalance, and (iii) a neuro-symbolic post-processing agent that applies explicit temporal-morphological rules to correct systematic CNN confusions on unseen patients. Using the provided result figures as the primary reporting source, the baseline model achieves one-vs-rest ROC AUC values of 0.886 (N), 0.599 (S), and 0.973 (V), while the normalized confusion matrix indicates recalls of 87.2% (N), 8.2% (S), and 92.0% (V) for the N/S/V evaluation subset. Building on this baseline, the neuro-symbolic agent corrected 715 CNN errors, improved overall accuracy by 1.4% (relative), and increased S-class recall from approximately 8% to 21% while retaining high V-class sensitivity in inter-patient testing. The framework also integrates Grad-CAM-based explainability to support interpretability and auditing for human-in-the-loop use

Obesity Risk Prediction Using a Clustering-Informed Risk Labeling Framework

Layla Mohammad Dakdouk, Mahmoud Skafi, Julie Bu Daher and Mohammad Ayache

Obesity represents a major public-health challenge, and timely identification of individuals at elevated risk can support earlier and more targeted lifestyle intervention. This study proposes a clustering-informed framework for

obesity risk prediction that integrates unsupervised lifestyle profiling with supervised learning. Individuals are first grouped into lifestyle profiles, and each profile is assigned one of three risk labels (Low, Moderate, High) based on the distribution of weight-status categories within the group. To ensure reliable evaluation and avoid information overlap between training and testing phases, clustering and risk-label generation are embedded within a nested validation framework. Experimental results demonstrate strong and consistent predictive performance, with ensemble methods, particularly Gradient Boosting, achieving the best results, with identical accuracy and F1-score (0.9716) followed by Random Forest and XGBoost. In addition, feature analysis is used to highlight influential predictors and support the interpretation of the learned decision patterns.

How Many Omics Are Enough? A Comprehensive Ablation Study for Breast Cancer Survival

Yassmine Haggag, Shereen Afifi and Mohamed Hamed Fahmy

Accurate cancer survival prediction through multi-omics data integration remains a critical challenge in precision medicine. While recent deep learning approaches have demonstrated promising results, the contribution of individual genomic and proteomic modalities and their combinations remains poorly understood. We present a systematic ablation study evaluating all 63 possible combinations of six key omics modalities: copy number variations (CNV), DNA methylation, microRNA (miRNA), messenger RNA (mRNA), somatic mutations, and protein expression (RPPA). Using a prototypical contrastive learning framework on the TCGA breast cancer cohort, we demonstrate that the complete six-modality integration achieves optimal performance (C-index: 0.8771), while strategic four-modality combinations can retain over 94% of this performance (C-index: 0.8252). Our analysis reveals that miRNA expression alone provides the strongest single-modality signal (C-index: 0.7862), and that protein expression contributes the smallest marginal improvement when added to five-modality models. These findings provide practical guidance for cost-effective clinical implementation and highlight the potential for reduced data collection burden without substantial performance loss.

EEG-to-ECoG: Cross-Modal Transfer Learning for Enhanced Seizure Detection

Khouloud Issa, Sarry Wehbi, Hussein Mazeh, Abed El Hadi Nhayli, Sahera Saleh and Massoud Khraiche

The conversion from Electroencephalography (EEG) to Electrocorticography (ECoG), two key modalities for measuring neural activity, poses challenges due to differences in signal characteristics, spatial resolution, and noise profiles. In this work, we propose a cross-modal transfer learning framework that leverages EEG pretraining to enhance ECoG-based seizure detection. Three deep learning models were evaluated, including a one dimensional convolution neural network with long short-term memory and two transformer-based architectures (iTransformer and PatchTST). Each model is initially trained on raw EEG data from the publicly available GAERS dataset and then fine-tuned on in-house experimental ECoG data from a seizure animal model. The iTransformer model performed the best on EEG data, achieving a mean accuracy of 99.75%, sensitivity of 99.5%, precision of 95.46%, and F1-score of 97.44%. After fine-tuning with ECoG data, PatchTST transformer showed superior results with mean accuracy reaching 91.41%, sensitivity of 84.47%, precision of 87.25%, and F1-score of 85.84%. These results mainly highlight the potential advantage of EEG-trained pretraining for enhancing seizure detection when ECoG data are limited and demonstrate its applicability in experimental neurophysiology.

Fully Inkjet-Printed Organic Electrochemical Transistors for Portable Nicotine Sensing

Hadi Dayeh, Jad Daorah, Alan Shihadeh and Massoud Khraiche

Rapid, point-of-care quantification of nicotine can enable timely screening of tobacco exposure and support cessation and epidemiological workflows, yet standard laboratory methods such as HPLC remain instrument-intensive and slow for on-site use. Here, we present a fully inkjet-printed organic electrochemical transistor (OECT) platform fabricated on glass using gold nanoparticle ink, an inkjet-printed polyimide insulator, and a multilayer PEDOT PSS channel. Our control over the PEDOT PSS thickness through Drop-on-Demand inkjet-printing unlocks

high transconductances of 10.59 ± 1.94 mS, benefiting from volumetric ionic coupling. For proof-of-concept nicotine sensing, gold gate electrodes were functionalized using a biotin-streptavidin method to immobilize biotinylated anti-nicotine antibodies. Nicotine exposure in PBS produced concentration-dependent transfer-curve shifts, with an approximately linear trend over 1-10 ng/mL (n=1). To support point-of-care deployment, we also designed a compact, portable readout PCB DAQ with ongoing hardware benchmarking. These results highlight inkjet-printed OECTs as a potential scalable route toward portable screening to distinguish smokers from non-smokers and motivate further batch studies.

Ultrasound-mediated Neuronal Membrane Deflection: A Model for Hypoglossal Motoneuron Modulation

Kareem Abu and Massoud Khraiche

Hypoglossal nucleus modulation can enhance hypoglossal nerve activity and tongue motor output, although current methods require direct access to the nucleus or genetic modification of the motoneurons. However, ultrasound can offer a non-invasive alternative for modulating the hypoglossal nucleus activity. Hypoglossal nucleus neuromodulation is explored by combining ultrasound-induced displacement current flexoelectricity in the Hodgkin and Huxley model of the hypoglossal motoneuron. High-frequency and low-pressure ultrasound effectively excited the hypoglossal motoneuron. The effectiveness is further reflected in the significant attenuation of baseline noise in the evoked action potential, more so in large-sized soma, compared to lower-frequency and high-pressure ultrasound. As pressure increased the latency to response decreased but response is evoked at an elevated threshold membrane voltage. Consequent upon threshold elevation, peak-to-peak membrane voltage decreases at higher pressures, leading to reduction of excitability of a neuron from rest or inhibition of a firing neuron. This computational model demonstrates the importance of ultrasound parameters optimization and prospects of low-pressure and high-frequency ultrasound stimulation of the hypoglossal nucleus, which can further be explored towards the improvement of tongue muscle activity and treatment of obstructive sleep apnea.

S13(B): Computer Systems and Applications-III

Virtual Room-2

Chairs: Vassilis Alimisis, Ramzi A. Jaber

From Waste to Value: The Dust Pool Mechanism in Blockchain Transactions

Haneen Kodamy and Reda Shbib

Blockchain transaction fees fluctuate significantly under varying network congestion, often resulting in residual token balances ("dust") that remain economically unspendable at the individual level. While dust accumulation is commonly discussed in the context of wallet management and privacy, limited work has quantitatively evaluated the economic feasibility of cooperative dust consolidation under realistic fee conditions.

This paper proposes and empirically evaluates a Dust Pool Mechanism for aggregating fragmented token balances and consolidating them when economically viable. Using real Ethereum on-chain transaction data, we identify dust magnitudes across multiple tokens and model consolidation outcomes under varying base fee scenarios. A threshold-based economic feasibility condition is formalized to determine when pooled dust exceeds consolidation and operational costs.

Our results show that while individual dust balances are negligible in isolation, aggregation enables meaningful recovery of otherwise stranded value under realistic transaction cost constraints. Sensitivity analysis demonstrates that consolidation viability is strongly dependent on network fee conditions, highlighting the importance of adaptive triggering policies. Additionally, participation analysis indicates that dust accumulation is widely distributed rather than concentrated, supporting the cooperative nature of the proposed mechanism.

The findings contribute a data-driven assessment of dust recovery feasibility and provide a systems-level framework for evaluating economically constrained resource consolidation in blockchain networks.

A Decoder-Based CNTFET Ternary Half-Adder Design

Ramzi A. Jaber, Bilal Owaidat and Abdallah Kassem

Multi-valued logic (MVL) has been widely investigated as an alternative to conventional binary logic due to its ability to represent information more efficiently and reduce interconnection complexity. The design choices adopted in this work were guided primarily by circuit simplicity and practical implementability rather than theoretical optimality. This work proposes a ternary half-adder (THA) circuit which implements a previous proposed energy efficient ternary decoder (TDecoder) using carbon nanotube field-effect transistors (CNTFETs). The proposed THA reuses the outputs of the decoder as intermediate signals to generate the SUM and CARRY. Simulations results via HSPICE show that the proposed THA achieves up to 76.8% compared to a traditional THA.

Comparative Analysis of Classical Machine Learning Models for Multi-Label Emotion Detection in Student Feedback in Higher Education

Aaron Paul M Dela Rosa, Charlyn V. Rosales, Gabriel M. Galang and Edwin S. Garcia

Emotion detection in text has been an influential domain of natural language processing (NLP) with informative applications in education to reveal subtleties in affective patterns in student feedback. This study gave a comparative evaluation between three classical machine learning algorithms, Logistic Regression, Support Vector Machine (SVM), and Naïve Bayes, for multi-label emotion detection in student comments collected over a span of three academic years (2021-2024). Following rigorous preprocessing and TF-IDF vectorization, a dataset of 3,126 comments labeled in 16 emotion categories was analyzed. Precision, Recall, F1-score, Hamming Loss, and computational time were employed to check performance. It was found that SVM performed optimally, having maximum precision (92.4%), recall (84.7%), and F1-score (87.3%), while exhibiting minimum Hamming Loss (0.028). Logistic Regression exhibited moderate performance, having maximum precision (87.9%) but low recall (58.1%) regarding minoritarian classes. Naïve Bayes, exhibiting maximum computational efficiency (runtime:

0.051s) but low recall (50.3%) and F1-score (57.9%), failed to capture delicate and low-frequency emotions adequately. Per-class analysis gave evidence regarding SVM's superiority across frequent and rare categories, while Logistic Regression was prone to mostly majority categories. Naïve Bayes gave consistent weaknesses in context-based emotions. This work concludes that SVM was the most effective classical algorithm for multi-label emotion detection in educational feedback, while offering a trade-off between predictive strength and computational tractability. This study provides empirical benchmarks against classical algorithms and serves as informative guidance for educational establishments and future research in affective computing applications.

Context-Aware Query Decomposition for Polyglot Database Systems: A Hallucination-Resistant Approach

Khadija Ahaidous, L'houssaine Aarif, Mohamed Tabaa and Hanaa Hachimi

Converting natural language queries into executable database operations across heterogenous data stores remains a significant challenge in learning analytics and data integration. Large Language Models show promise for query decomposition, but suffer from hallucinations, which limits their practical applicability in production systems. This paper proposes a two-stage system that uses LLMs to decompose queries, taking into account the specific context of the databases involved. The architecture consists of three components: a feasibility checker that validates query feasibility and generates domain-specific warnings, a context propagation module that transfers these warnings to guide downstream processing and a query decomposer that generates structured execution plans. The feasibility checker uses semantic analysis with explicit schema constraints, while the decomposer receives injected warning context to eliminate hallucinations. Evaluation on 150 natural language queries from the OULAD dataset demonstrates that our approach achieves 93.3% feasibility detection accuracy, outperforming both rulebased (90%) and LLM-only (85.3%) baselines. Our method reduces false positives by 68% compared to LLM-only approaches, which failed to detect any adversarial queries. For database selection, our solution achieves 87.8% exact match accuracy, an 11.2 percentage point improvement over LLM-only methods. The system successfully decomposes complex queries involving joins between PostgreSQL, MongoDB, Neo4j, and Weaviate databases while respecting domain-specific constraints. These results demonstrate that context propagation between LLM stages effectively mitigates hallucinations in multi database query decomposition without degrading overall performance.

A Benchmarking Framework for Accuracy-Energy Trade-offs in Machine Learning

Hassan Diab, Karl Ghanem, Tala Hachem and Nadine Abbas

Machine learning models have been widely used as the default choice for many real-world analytics pipelines. Yet, their energy use and carbon footprint are rarely reported, making model selection largely driven by accuracy. Green AI appeared to design and deploy AI solutions that are not only accurate and scalable, but also energy-efficient and environmentally sustainable. Towards this goal, we present in our work a controlled benchmark framework that jointly evaluates predictive performance and computational efficiency for widely used classifiers across multiple datasets. Our framework standardizes pre-processing, data splits, hyperparameter budgets, and cross-validation protocols to ensure transparent and fair comparisons. We conduct experimental measurements with integrated process-level energy tracking, and report both energy and carbon-equivalent emissions along with accuracy and macro-F1. Our results demonstrate the accuracy-efficiency trade-offs in choosing the acceptable performance loss for a lower energy/carbon footprint for different dataset scales.

Enhancing Gold Price Forecast Accuracy through Feature Engineering and Financial News Sentiment Integration

Rosalinda Abou Mrad, Khalil Chtaiwy, Yaacoub Khalil, Michel Owayjan and Ali Abdallah

This research explores an enhanced approach to predicting gold prices by combining machine learning algorithms with real-world news sentiment. The project focuses on generating daily Buy, Sell, or Hold signals and predicting short-term gold price trends using models like LSTM, Prophet, and Linear Regression. To evaluate their performance, the models were trained on gold price data from January 2023 to March 2025 and tested on April 2025. Alongside price-based features, additional indicators such as moving averages, momentum, volatility, and trend signals were used. One of the key contributions of this work is the use of news sentiment-headlines and summaries were analyzed using GPT-4o to assess whether they had a likely positive, negative, or neutral impact on gold. These daily sentiment scores and event flags (e.g., mentions of inflation or geopolitical conflict) were merged with the price data to improve accuracy. Results show that adding sentiment features significantly reduced prediction error. The best-performing model, a linear regression with sentiment input, achieved a very low root mean squared error of $2.35 when forecasting April 2025 prices, showing strong potential for practical use in financial forecasting.

Reflective Surface Detection: A Comparative Study

Hadi Harb, Salam A. Tabet, Ayman Kayssi and Imad H Elhajj

Reflective surfaces such as mirrors and glass can cause serious privacy risks when they inadvertently reflect sensitive information. In smart city camera streams, this can lead to compromising the privacy of citizens, especially when people and license plates are exposed. While stringent privacy regulations, such as the GDPR, necessitate the blurring or masking of private information in feeds, reflective leaks are often overlooked in privacy frameworks. Previous surveys of reflective surface detection often provide comprehensive overviews of models and datasets without evaluating their robustness for practical deployment. This paper presents the first comparative evaluation of reflective surface detection models. We evaluate three public pretrained segmentation models for reflective surface understanding: MirrorNet for mirror segmentation, GDNet for glass detection, and a rich context glass surface detection model with reflection priors (GSD), at the task of pixel-wise reflective surface detection. We also include GPT-4.1 as an LLM-based model in the comparison. We adopt a cross-dataset protocol where each model is tested on each dataset test set, and also on combined pools. To ensure fairness, all models are evaluated as released, without any training or fine-tuning, using the official inference pipelines and pretrained checkpoints. On public benchmarks, each model performs best on its original dataset, but transfer behavior differs strongly. GSD generalizes more consistently and achieves the highest accuracy on the combined public pool (0.9016) while also being the fastest at 0.106 seconds per image. On a new dataset designed to better reflect smart city scene characteristics, accuracies are close (around 0.80), but Intersection-over-Union (IoU) exposes clearer separation, with GDNet obtaining the highest IoU (0.4386). When the new dataset is added to the combined evaluation, GSD achieves the best overall performance (accuracy 0.8734 and IoU 0.6383).

Bridging the Governance-Operation Gap: A Staged ITIL 4 Implementation Roadmap for Local Government

Balqis Aisyah Farahdiba, Rudy Hartanto and Ahmad Nasikun

The implementation of the Electronic-Based Government System (SPBE) in Indonesia has accelerated the development of digital public services. However, ensuring post-implementation sustainability remains a significant challenge for local governments. This is often characterized by inconsistent service quality, reactive operational responses, and a high reliance on individual heroism. While ITIL 4 presents a comprehensive framework for service management, full-scale adoption is frequently impractical for resource-constrained and low-maturity organizations. To address this issue, this study employs a Design Science Research (DSR) approach to develop a practical, context-aware adoption roadmap. The primary contribution of this research is a Staged-Evolutionary Roadmap that organizes seven foundational ITIL4 practices into three capability clusters: Responsive Services, Service Stability, and Adaptive Governance. This roadmap outlines a two-phase evolution for each

cluster, advancing from Initial Adoption, which emphasizes manual discipline and centralization, to Mature Adoption, which prioritizes automation and integration. This roadmap provides a feasible pathway for resource-constrained local governments to shift from ad-hoc operations to standardized and reliable IT service management, without exceeding their organizational capacity.

A Two-Stage Deep Learning Pipeline for Medical Image Restoration Using DRUNet and Real-ESRGAN

Shereen Afifi, Mohamed Nabil, Sara Mohamed Naguib Hassan Gheita, Yassmine Haggag and Omar Fahmy

High-resolution, noise-free medical images are critical for accurate diagnostics. However, limitations in imaging hardware, scan time, and cost often result in degraded outputs. This paper proposes a two-stage deep learning pipeline that combines DRUNet for blind denoising and Real-ESRGAN for super-resolution to enhance brain MRI and CT images. Initial testing was conducted on retinal fundus images to validate the feasibility of using super-resolution in medical imagery. A custom dataset of 1000 noisy brain MRI/CT images was curated and used to fine-tune the models. The final pipeline achieves strong quantitative performance on both real and synthetically noised datasets, reaching PSNR of 43.19 dB and SSIM of 0.9861. Clinical validation with a practicing radiologist confirmed its utility, while future work will target broader generalization and diagnostic integration.

S13(C): Power, Power Electronics, Industrial Electronics and Energy-III

Virtual Room-3

Chairs: Vassilis Alimisis, Mohamad Nassereddine

Surrogate-Assisted Physics-informed Reinforcement Learning for Analog IC Design Automation

Rayan Mina and Maroun Ayli

Transistor sizing in analog integrated circuit (IC) design is a time-consuming task that relies heavily on iterative SPICE-class simulations and expert knowledge. Recent approaches based on reinforcement learning (RL) have shown promise in automating this process, but typically require expensive circuit simulations at every optimization step. This paper presents a hybrid machine learning approach that completely eliminates SPICE simulations from the RL loop leading to reduced IC design cycle times. We train an artificial neural network (ANN) surrogate to predict transistor small-signal parameters (transconductance and output resistance) from design parameters, then use analytical circuit equations to compute performance metrics. A physics-informed reward function guides a Proximal Policy Optimization (PPO) agent to find optimal design parameters for target specifications. Our approach is validated on a single-stage CMOS amplifier, targeting differential voltage gain and common-mode rejection ratio. Results demonstrate that with only 9560 training samples for the surrogate model, the system achieves a symmetric mean absolute percentage error (SMAPE) of 7.5% for gain and 15% for CMRR. The method achieves 200× speedup per optimization step compared to simulation-in-the-loop approaches

High-Pressure PEM Electrolyzer Simulation Model Validation Based on Experimental Data

Bilal A Izzo, Gabriel Khoury and Jihane Rahbani El-Mounsef

The proposed article explores the development and validation of two steady-state proton exchange membrane electrolyzer (PEMEL) models using the Aspen Plus V15 software. Based on the experimental data reported in the literature, a geometry-sensitive model and a simplified model based on the current-polarization curve are developed and validated against experimental polarization curves over a temperature range of 20-80°C. Both models successfully predict hydrogen production rates and cell voltage variations, achieving a Mean Absolute Error (MAE) of less than 0.052 V. A pressure sensitivity analysis verifies the slight sensitivity of the overall hydrogen production to the operational pressure up to a pressure of 100 bars at a constant current source, thereby confirming the operational integrity of the design at pressurized conditions. The proposed approach confirms the capability of Aspen Plus as a reliable platform for the performance prediction and parametric studies of proton exchange membrane electrolyzers.

Optimal Coordination of Overcurrent and Distance Relays using Gazelle Optimization Algorithm

Ayham Al-Asafreh and Eyad A. Feilat

In modern power systems, reliable and selective relay operation is vital for system stability and equipment protection. This paper presents an optimal coordination scheme for distance and overcurrent relays using a metaheuristic Gazelle optimization algorithm (GOA) inspired by gazelle behavior. The coordination problem is formulated as a constrained nonlinear optimization problem aiming to minimize the total relay operating time while maintaining selectivity. The proposed method determines optimal relay parameters, including time dial settings, pickup currents, and zone reaches. Simulation studies on an IEEE 8-bus system demonstrate that the GOA achieves faster convergence, reduced operating times, and improved reliability compared to the Genetic algorithm (GA).

A Generative AI-Enhanced Framework for Smart Sustainable Electrical Networks

Mohamed Shaaban, Abdulrahman Al-Shanoon and Mohamad Nassereddine

High penetration of solar and wind generation introduces significant uncertainty that challenges conventional deterministic power system operation. This paper proposes a unified five-layer Generative-AI-Enhanced Machine Learning framework for managing smart electrical networks under renewable variability. The framework integrates deterministic forecasting, probabilistic scenario generation, physics-informed AC power flow propagation, and voltage feasibility restoration within a single end-to-end workflow. Short-term renewable prediction is performed using an LSTM model for solar power and an XGBoost model for wind generation. A conditional neural scenario generator then expands limited historical data into realistic future trajectories, enabling systematic assessment of uncertainty and rare operating conditions. Monte Carlo scenarios are propagated through a differentiable AC power flow model to identify potential voltage risks, while a physics-aware optimization layer restores feasibility using minimal reactive power support. Case studies based on UAE climate and load data demonstrate that deterministic forecasts alone underestimate network risk, whereas scenario-based analysis reveals up to 18% undervoltage violations before control. After applying the proposed restoration layer, violations are reduced to near-zero levels with reactive adjustments on the order of 0.0001 per unit. The results confirm that the framework enhances risk awareness, improves voltage security, and provides a practical AI-enabled pathway for resilient and interpretable smart grid operation.

Short-Term Residential Load and Solar Power Forecasting Using Machine Learning

Nayab Sohail Nadeem, Habiba Ahmed and Mohamad Nassereddine

The increasing penetration of rooftop photovoltaic systems and battery storage in residential buildings has created a growing need for accurate short-term forecasting of both electricity consumption and solar power generation. Reliable forecasts at short time horizons are essential for reducing grid dependence, improving battery operation, and enabling intelligent residential energy management systems. This paper presents a machine-learning-based framework for short-term forecasting of residential load demand and rooftop photovoltaic generation using high-resolution five-minute real residential time-series data collected from a hybrid grid-connected system. Forecasts are generated for horizons ranging from fifteen to sixty minutes ahead and are evaluated against a classical persistence-based baseline model. Three supervised learning approaches including Ridge Regression, Random Forest Regression, and Gradient Boosting Regression, are developed and systematically compared across multiple forecasting horizons using standard error metrics. Experimental results show that machine-learning models consistently outperform the persistence baseline for both targets. For residential load forecasting, Root Mean Square Error (RMSE) reductions of approximately 19% at a 60-minute horizon are achieved, corresponding to an average normalized forecasting error of approximately 28 W per minute of look-ahead time. For photovoltaic generation forecasting, larger improvements are observed, with RMSE reductions exceeding 25% at longer horizons and normalized errors as low as approximately 15 W per minute at a 60-minute horizon. These results demonstrate the effectiveness of machine-learning techniques for short-term residential energy forecasting and support their integration into real-time smart home energy management systems for improved battery scheduling, demand management, and utilization of locally generated solar energy.

Optimal Operation of Smart Cities Integrated with Data Centers and Workload Dispatch

Takuma Ishibashi, Akie Uehara, Masahiro Furukakoi, Ahmed Rashwan, Hiroshi Takahashi, Paras Mandal and Tomonobu Senjyu

To advance green transformation (GX), the transition to smart cities (SC) is being promoted. For this purpose, an energy management system (EMS) utilizing IoT devices in SCs is a promising approach. In recent years, the proliferation of artificial intelligence and digitalization has led to an increase in data centers (DC). Along the decarbonization pathway, SCs require the introduction of renewable energy and combined cooling, heating and power (CCHP), and integration with DCs is also essential. Therefore, this study proposes a model that integrates

DCs and SCs, comprehensively addressing DC workloads, power, and cooling demands. It incorporates indirect power demand response through the dispatch of delay-tolerant workloads. To validate the proposed model, numerical simulations are conducted, comparing costs and carbon emissions.

PV/BESS Interfaced Fault Tolerant Dual-Input LLC Resonant Converter with VSG Inverter for Land-Based Aquaculture System

Lin Myat, Masahiro Furukakoi, Akie Uehara, Hideito Matayoshi, Hiroshi Takahashi and Tomonobu Senjyu

This paper proposes PV/BESS interfaced fault-tolerant dual-input LLC resonant converter to realize a cost-effective, stable, and reliable power supply system for standalone aquaculture facilities. Furthermore, duty-ratio coupled coordinated control between two input sides is employed to ensure autonomous power balancing between PV and BESS, allowing the battery to compensate for PV shortages during irradiance fluctuations, thereby maintaining a stable dc-link. On the AC side, a virtual synchronous generator (VSG) inverter control is integrated to achieve stable AC voltage and frequency during irradiance changes and input disturbances. The proposed system offers four key contributions: (1) cost reduction by removing the extra bidirectional converter, (2) inherent fault tolerance for both PV and BESS input side semiconductor switches, (3) stable dc power delivery via effective energy-sharing control, and (4) AC-side stability with VSG control. The effectiveness of the proposed topology and control strategy is validated through MATLAB/Simulink with 9-kW standalone aquaculture system under (1) solar irradiance variation and (2) primary-side switch fault scenarios.

Harmonic Index-Driven Power Quality Detection and Forecasting for Distribution Grid Monitoring: Eliminating the Need for High-Resolution Waveforms

Albashir Bashir and Mohamad Nassereddine

Modern distribution grid monitoring demands scalable analytics to convert power-quality (PQ) data into actionable insights for real-time decision-making. However, utilities commonly store exported harmonic indices and total harmonic distortion (THD) from power-quality meters instead of continuous high-rate waveforms. This practice limits the applicability of existing analytics methods that depend on waveform access, time-frequency transforms, and computationally intensive feature extraction. This paper proposes a novel telemetry-first signal processing (SP) and machine learning (ML) framework that enables harmonic detection and short-horizon forecasting directly from time-synchronized harmonic telemetry recorded at a low-voltage point of common coupling (PCC) with 4-seconds logging intervals. Unlike waveform-centric approaches, the method operates exclusively on exported indices and magnitudes, emphasizing robust telemetry conditioning, short-window dynamics, and interpretable voltage-current behavior. The framework delivers (i) IEEE 519 guided voltage harmonic detection across three states (Normal/Watch/Exceedance) and (ii) 60-seconds forecasting of voltage THD and dominant harmonic orders (triplen: 3rd, 9th, 15th; and odd: 5th, 7th, 11th) using multi-output gradient boosting with time-series validation. Performance is compared against persistence, logistic regression, and tree-based methods using an 11-hour operational dataset (10,000 samples) augmented with synthetic harmonic spikes. Field-oriented metrics confirm reliable forecast accuracy and effective detection of both steady regimes and harmonic excursions, demonstrating a practical, deployable solution for proactive monitoring in telemetry-dominant environments.

Optimal Energy Management and Blackout Resilience for Land-Based Aquaculture Using PV and Battery Energy Storage

Niijima Kein, Soichiro Ueda, Akie Uehara, Masahiro Furukakoi, Hiroshi Takahashi and Tomonobu Senjyu

This study targets a land-based aquaculture system equipped with photovoltaic (PV) generation and a battery energy storage system (BESS). By modeling the dynamic behavior of dissolved oxygen (DO) in aquaculture tanks, we perform operational optimization that accounts for equipment operation and evaluate resilience during power outages. The results confirm that DO-based equipment control reduces operating costs and improves blackout resilience. In addition, we show that the attainable operating duration during a blackout (blackout endurance time) strongly depends on the PV generation time series available after the blackout begins. The novelty of this study lies in developing a dynamic DO model for land-based aquaculture tanks, linking it with equipment operating conditions, and conducting both optimal operation and blackout resilience evaluation within a unified framework. Although continuous operation of life-support equipment is essential in land-based aquaculture, integrated evaluations that jointly consider water quality (DO) and energy operation have not been sufficiently investigated. The proposed approach contributes to achieving both economic efficiency and resilience by optimizing equipment operation based on DO constraints.

Thursday, April 16

Thursday, April 16 9:30 - 10:15

KeyNote#2: Virtual Room-1 Trends and Development of the Semiconductor Industry: Insights from Taiwan

Dr. Kuan-Wei Lee, Professor at the Department of Electronic Engineering at I-Shou University

Virtual Room-1, Virtual Room-2, Virtual Room-3

Chair: Mohamad Mostafa Awad

Thursday, April 16 10:15 - 10:30

CB#3: Coffee Break

Virtual Room-1, Virtual Room-2, Virtual Room-3

Thursday, April 16 10:30 - 12:15

S21(A): Antennas, Microwave, Magnetics and RF circuits & Power

Virtual Room-1

Chair: Ernst Huijer

Predicting Electromagnetic Emissions from Cable Configurations Using Deep Neural Networks

Zaynab Hamyeh, Moncef Kadi, Mahmoud Mehdi and Ali Alaeddine

Radiated electromagnetic emission from cable harnesses poses a major challenge in the electromagnetic compatibility (EMC) design of modern electronic systems, particularly in automotive and hybrid electric vehicle applications. This paper considers a representative cable configuration used in hybrid vehicles to connect the battery to DC/DC converters, for which radiated electric field levels constitute a critical EMC concern. A hybrid data-driven framework based on deep neural networks (DNNs), combining spectrum-based and pointwise prediction models, is proposed for the efficient estimation of frequency domain radiated electric fields. The framework is applied to predict the total, horizontal, and vertical components of the radiated electric field. Numerical results demonstrate that the proposed approach achieves high accuracy while reducing computation time compared to full-wave electromagnetic simulations

Design of a Tunable Microstrip Combline Bandpass Filter Using Varactor Diodes for UWB Applications

Raneem Ayman Al-Mashni, Lujain F Al-Hunity and Yanal S Faouri

This paper presents a compact, tunable microstrip combline bandpass filter (BPF) designed for ultra-wideband (UWB) applications. By loading the resonators with varactors, continuous center frequency tuning was achieved from 3.38 to 7.105 GHz, which corresponds to a 2.1:1 ratio. According to the simulation results, the design maintained an insertion loss below 3 dB and a return loss better than -10 dB. Stability in the fractional bandwidth is observed between 310 and 450 MHz across the entire range, whereas group delay fluctuations are maintained within 1.0-2.2 ns. These performance metrics make the filter a practical solution for reconfigurable RF front-end and cognitive radio systems.

A Compact Frequency Reconfigurable Hybrid Monopole-Patch Antenna for Wideband Applications

Lujain F Al-Hunity, Raneem Ayman Al-Mashni and Yanal S Faouri

This paper introduces a compact frequency-reconfigurable wideband antenna for ultrawideband (UWB) adaptive and spectrum-aware applications. The antenna inherently operates as a wideband (WB) radiator, where frequency reconfiguration is realized by shifting the wideband operating region across the UWB spectrum, enabling full

UWB coverage. The proposed antenna was fabricated on a low-cost FR-4 substrate with compact dimensions of 20 mm × 60 mm × 1.6 mm. Frequency tuning is implemented using two PIN diodes, which alter the surface current paths and effective electrical length of the radiator. Stable impedance matching and reliable radiation performance were maintained across the entire reconfiguration range. Owing to its compact size, simple structure, and continuous wideband frequency reconfigurability, the proposed antenna is a suitable candidate for cognitive radio systems and reconfigurable wireless communication platforms that require efficient and flexible spectrum utilization.

Design and Performance Analysis of a High-Efficiency 5G RF Front -End Receiver

Khaled El Hajj, Bassem Saad, Heba El-Halabi and Ziad Osman

The rapid growth in wireless communication technologies has increased the demand for high data rates and more effective systems. In this article, a complete RF-receiver has been designed on Advanced System Design (ADS) software, in the frequency range from 3.4GHz to 3.8GHz and centered at 3.6GHz for 5G applications. This system consists of a Low Noise Amplifier (LNA) cascaded with a Band Pass Filter (BPF), an oscillator, and a mixer. LNA with a gain of 15 dB is connected to a BPF with less than 1 dB insertion loss and is fed to one of the input ports of a mixer, while a local oscillator of 3.6GHz is fed to the other port. This mixer act is a down-converter that converts the Radio Frequency (RF) signal to an Intermediate Frequency (IF). The total gain of the system at the center frequency of 3.6 GHz is approximately 11.5 dB.

PVT-Resilient 10-15 GHz Doherty PA with On-Chip Power Sensing and LUT-Based Retuning in 22-nm FD-SOI

Ahmed Tulan, Mohamed Abdalla, Mohamed Mobarak and Mohamed Moussa Esmael

Sixth-generation (6G) radios require power amplifiers (PAs) that maintain high output power and efficiency under high peak-to-average power ratio signals and process, voltage, and temperature (PVT) variations. The Doherty PA (DPA) achieves high back-off efficiency through load modulation using a λ/4 impedance inverter, but in integrated realizations its performance is highly sensitive to PVT drift, which shifts the effective inverter and matching behavior, moves auxiliary turn-on, and distorts the intended main-path impedance trajectory from 2Ropt toward Ropt. This work presents a forward-power-aware DPA architecture that senses the output forward power level using an on-chip directional coupler and a CMOS square-law power detector with RMS-equivalent calibration, and uses it to drive LUT-based retuning of the output shunt-capacitor bank and the main/auxiliary cascode gate biases. Circuit and electromagnetic (EM) co-simulations in 22-nm FD-SOI CMOS over 10-15 GHz show peak PAE above 32% across the band and 6-dB back-off PAE up to ≈ 30.1% at 12.5 GHz. To the authors' knowledge, this is the first Doherty PA in 22-nm FDSOI incorporating forward-power-sensed PVT correction in the 10-15 GHz band.

Multi-Resolution vs Multi-Horizon Models for Household Energy Consumption Forecasting: A GRU-Based Comparative Study

Maissa Taktak, Ahmed Fakhfakh and Faouzi Derbel

Multi-horizon energy forecasting remains a fundamental challenge for smart grid management, with the optimal modeling strategy for different forecast horizons remaining an open question. Effective energy management requires accurate predictions from 6 hours to 24 hours in advance to enable proactive load balancing, generator dispatch scheduling, and demand response activation. This paper compares two distinct approaches: Multi-Resolution Models (MRM) that train specialized models for each forecast horizon using resampled data matching the prediction time scale, and Multi-Horizon (MH) models that employ fixed 1 hour temporal resolution with multi-step-ahead prediction. We evaluate both strategies using GRU networks with binomial frequency decomposition on datasets collected over 14 months from household energy consumption in northeastern Mexico. Results demonstrate that resolution adaptation provides substantial advantages: MRM achieves 63-89 %

lower RMSE across all horizons compared to MH, with R^2 values above 0.53 even at 24-hour horizons versus 0.22 for MH. These findings indicate that matching data granularity to forecast horizon substantially improves prediction accuracy for smart grid applications requiring multi-temporal forecasting.

Hybrid Machine Learning Approach for Short-Term Photovoltaic Power Forecasting Using Meteorological Data

Adhin Thomas and Mohamad Nassereddine

Photovoltaic (PV) power generation is characteristically dependent on meteorological conditions, accurate day ahead forecasting is a critical operational stage for scheduling, reserve management, and grid stability. However, many existing Machine Learning (ML) based PV forecasting approaches rely on very limited meteorological integration or evaluate such inputs in an ad-hoc manner, resulting in sub-optimal performance for longer forecasting horizons. This paper, derived from ongoing bachelor's thesis research, investigates a hybrid deep learning approach for day-ahead PV power forecasting that integrates multiple meteorological variables within a single production feasible architecture. A Convolutional Neural Network (CNN) and Long Short Term Memory (LSTM) model is employed to cooperatively capture the hidden structured relationships between meteorological inputs and the temporal dynamics of the PV power output. The key contribution of the paper is the systematic evaluation of individual meteorological variables irradiance, air pressure, wind speed, temperature, humidity, and cloud cover within a unified forecasting hybrid ML architectural framework, which subsequently addresses the existing gap in studies that often include such variables without explicit contribution analysis. Experimental results demonstrate that meteorological augmentation yields measurable improvements in forecasting accuracy compared to basic models like persistence, Random Forest, XGBoost and LSTM only baselines, while sensitivity analysis provides actionable insight into the relative operational value of each input variable. The findings support more informed sensor integration and deployment strategies for practical PV forecasting applications.

S21(B): Control Systems, Instrumentation and Robotics

Virtual Room-2

Chairs: Naseem Daher, Michel Owayjan

Adaptive Control-Instrumentation Co-Design Framework for Real-Time IoT-Based Process Control

Hifsah Nasir, Wajahat Riaz, Alaaeddine Ramadan and Maqbool Khan

Industrial IoT-based process control systems are usually based on fixed instrumentation and fixed control measures, which results in inefficient resource utilization and slower system response, especially in resource-rich environments. This paper proposes co-design framework of adaptive control based instrumentation for real-time IoT-based process control, where sensing and control decisions are optimally derived through a closed-loop approach. The proposed framework embeds smart decision logic within the instrumentation layer, enabling sensors to dynamically adjust their sampling behavior in response to changing process dynamics and control performance. This control-aware instrumentation significantly reduces unnecessary data transmission without compromising process stability or control accuracy. The effectiveness of the proposed approach is validated through simulation using real industrial sensor time-series data and is compared against traditional fixed-sampling strategies. Experimental results demonstrate improved efficiency, reduced data usage, and enhanced control responsiveness, highlighting the suitability of the proposed framework for real-time, resource-constrained industrial IoT applications.

Voice as Policy: A Language-Driven HMI with Visual Target Coordinates

Soufiane Ameur, Mohamed Tabaa, Mohamed Hamlich and Kaouter Karboub

Programming collaborative robots remains tedious for non-experts, especially when tasks depend on the current scene. This paper presents Voice as Policy, a language-based HMI that transforms spoken goals into safe actions for robots anchored in the visual coordinates of targets. Speech is transcribed and normalized into a compact intent schema (action, target, parameters) a lightweight OpenCV pipeline segments the target and converts the centroids of pixels into metrics (x, y) via an eight-point planar homography with z fixed to the plane of the work surface. Verifiable controller links the intention to the unearthed object checks accessibility and human zone constraints and executes movements via the cobot SDK while the HMI exposes transcripts, normalized intentions generated action code and execution logs. Implemented on a tabletop cell the system consistently located the screwdriver handle within a calibrated ROI and executed predictable seamless voice-action cycles under typical lighting and clutter. The contribution is a practical recipe minimal detection explicit security gates and an explicable control surface that makes policy-like voice interaction, both deployable and trustworthy in shared workspaces.

ATLCS: An Educational Linear Control System Tool

Mohamad Arnaout, Khaled Chahine and Hassan Noura

Lecturers are increasingly utilizing sophisticated application tools to provide students with intuitive, high-fidelity simulation environments that offer greater structural adaptability. This paper presents the Application Tool Interface for Linear Control Systems (ATLCS), a comprehensive computational framework developed using MATLAB GUIDE and Simulink. The tool streamlines modeling of electrical and mechanical systems by integrating transfer functions, state-space equations, and root-locus analysis. By employing a user-centered graphical interface, the ATLCS bridges the gap between theoretical abstraction and real-world application, enabling rapid assessment of parameter variations on system performance. Empirical validation through a comparative study of two student cohorts (N=60) demonstrated that integrating this software significantly enhances learning outcomes and student mastery of core pedagogical concepts. Statistical survey results highlight the tool's efficacy in improving research efficiency and reinforcing foundational control theory within modern engineering curricula.

An Analog Edge Detector Based on a Hardware-Friendly Difference of Gaussians Method

Charalampos Papadopoulos, Andreas Papathanasiou, Vassilis Alimisis, Vasileios Moustakas, Roy Abi Zeid Daou and Paul P Sotiriadis

In this work, we present an ultra-low-power analog integrated Difference-of-Gaussian edge detector for energy efficient vision systems. The proposed architecture performs Gaussian filtering using compact current-mode Gaussian function generators with two distinct standard deviations, followed by current-domain subtraction to approximate a Laplacian-of Gaussian response. A square-root circuit enhances edge visibility, and thresholding circuits generate a binary edge map. The fully analog signal-processing chain enables edge extraction with minimal computational overhead and high energy efficiency, making it suitable as a pre-processing stage for vehicle perception systems under strict power constraints. To evaluate system-level performance, the generated edge maps are used as direct inputs to a pretrained YOLO object detector adapted via transfer learning. Simulation results show that sufficient structural information is preserved for reliable object detection. The design is validated through schematic and post-layout simulations in a TSMC 65-nm CMOS technology.

An Analog Integrated, Low-Power Decision Tree Classifier Architecture for Heart Attack Detection

Vassilis Alimisis, Andreas Papathanasiou, Anna Mylona, Vasileios Moustakas, Alak Majumder, Roy Abi Zeid Daou and Paul P Sotiriadis

This paper presents a fully analog, ultra-low-power decision tree classifier designed for real-time heart attack detection using electrocardiogram signals. The proposed architecture operates entirely in the sub-threshold region, achieving 450 K classifications per second with 328 nW power consumption, while attaining a classification accuracy of 92.65% (vs 93.24% of the software equivalent). Decision-making is fully hardware embedded: each feature node and the final decision employ a binary analog Winner-Takes-All circuit, with the final one performing the argmax operation. The classifier is implemented in a 65 nm CMOS process and evaluated using electrocardiogram data representative of heart attack events. Post-layout simulation results demonstrate robust performance under process, voltage, and temperature variations, as well as Monte Carlo analysis. Based on its low power consumption, real-time operation, and accurate decision-making, the proposed architecture is ideal for edge and wearable cardiac monitoring applications.

A Fractional Charge-Pump Based DC-DC Converter Supporting Dual Operating Modes

Maximos Ioannis Tryfonas, Vasileios Moustakas, Andreas Papathanasiou, Vassilis Alimisis, Roy Abi Zeid Daou and Paul P Sotiriadis

This paper introduces a dual-mode, inductorless charge pump based on a fractional architecture with buck-boost capability. The proposed design extends the conventional cross-coupled topology by incorporating a single additional flying capacitor. This modification enables multiple capacitor configurations within the cross-coupled core, allowing the realization of fractional conversion ratios of 1/3, 1/2, 2/3, 3/2, and 2. As a result, the charge pump supports a wide range of output voltage levels while maintaining a compact die area, without compromising efficiency or increasing output ripple. The design was implemented in a TSMC 65nm CMOS process and evaluated using industry-standard simulation tools, achieving a peak efficiency greater than 85%.

Explainable Reinforcement Learning-Based Adaptive PID Control for Servo Motor Positioning

Katia Hamdan, Hassan Diab and Michel Owayjan

This paper presents an explainable reinforcement learning-based adaptive PID control framework for servo motor position regulation. The proposed approach employs the Twin Delayed Deep Deterministic Policy Gradient (TD3) algorithm to dynamically tune the proportional, integral, and derivative gains of a PID controller in real time, enabling improved tracking performance under varying system conditions. Unlike conventional fixed-gain PID controllers, the proposed method adapts the control parameters online based on the observed system error dynamics. To enhance transparency and trustworthiness, an explainability layer is incorporated to provide human-interpretable insights into the learned control behavior by analyzing the contribution of state variables to the gain adaptation process. The servo motor is modeled using a transfer function representation, and the controller performance is evaluated through simulation under step reference inputs. Comparative results demonstrate that the TD3-based adaptive PID controller achieves reduced overshoot, faster settling time, and smoother control effort compared to a conventional PID controller, while maintaining interpretability of the learning-based control decisions. The proposed framework highlights the potential of explainable deep reinforcement learning for reliable and transparent control in industrial servo systems.

S21(C): Communications and Information Systems

Virtual Room-3

Chair: Kabalan Chaccour

Dynamic Task Reallocation in UAV-Assisted LoRaWAN Networks for Smart Farming

Samar Sindian, Imad Jawhar, Mohamad Kadery and Hussein Hachem

Smart farming increasingly relies on wireless sensor networks for environmental monitoring, yet collecting data from distributed sensors remains challenging in large rural fields where fixed gateways are infeasible. This paper proposes CRAFT (Cooperative Relay-Aware Flight Tasking), a decentralized dynamic task reallocation framework for multi-UAV LoRaWAN-based data muling. CRAFT partitions the monitored area into relay-assisted zones and enables unmanned aerial vehicles (UAVs) to cooperatively and adaptively reassign sensing tasks during flight based on workload disparity and received signal strength indication (RSSI). A model-based performance evaluation, derived from analytical mobility and communication assumptions, indicates that CRAFT reduces mission completion time by approximately 23%, significantly improves energy balance across UAVs, and maintains high packet delivery reliability compared to static partitioning and greedy reassignment baselines. The results demonstrate that lightweight cooperative control is essential for scalable and energy-efficient UAV-assisted LoRaWAN networks in smart farming applications.

A Standalone LoRa Mesh Network with LoRa-Optimized AODV and End-to-End Encrypted Payloads on MCU-Class Devices

Tala Jezzini and Mohamad Alwan

Low-power long-range (LoRa) radios are attractive for communication in disaster zones, rural regions, and infrastructure-poor environments. However, LoRa's extremely low bitrate, lack of native routing, and limited built-in end-to-end protection for standalone multi-hop operation limit its ability to form reliable mesh networks. This paper presents RelayCom, a fully standalone LoRa mesh system running on ultra-constrained microcontrollers (Arduino Nano and RYLR890) and providing end-to-end payload confidentiality, while embedding a LoRa-aware AODV routing optimization that significantly reduces control overhead. Unlike classical AODV, RelayCom introduces a unicast-first route request (RREQ) strategy, falling back to broadcast only after a timeout, thereby preserving LoRa bandwidth and reducing collision probability. RelayCom integrates AES-CTR encryption at the firmware level to provide payload confidentiality across multi-hop forwarding. A complete modular firmware architecture, including a LoRa handler, routing manager, state machine, and message buffer, is implemented and evaluated across multiple routing scenarios. Experimental results obtained using a real three-node testbed demonstrate successful multi-hop route discovery, encrypted message forwarding, reduced route-discovery broadcast transmissions, and robust operation under constrained radio conditions. RelayCom illustrates a practical and low-cost blueprint for resilient, confidentiality-preserving, and infrastructure-independent LoRa mesh networks suitable for emergency communication and off-grid deployment.

SLIPT-Based Hybrid VLC/RF Cooperative Communication via Harvest-Store-Use Relays

Chadi Abou-Rjeily, Nour Rajeh and Lourdes Gerges

This paper addresses relay selection in hybrid Visible Light Communication (VLC)/Radio Frequency (RF) dual-hop systems. In the first hop, a cluster of randomly distributed relays receives a VLC signal transmitted by a light source. The relays decode the information message while simultaneously harvesting energy from the optical signal using Simultaneous Lightwave Information and Power Transfer (SLIPT). The harvested energy is stored in buffers at the relays and later used to forward the message to a destination node via RF in the second hop. Within this framework, we propose and analyze three relay selection protocols. The first protocol selects the relay with the maximum stored energy. The second protocol minimizes energy consumption by choosing the relay that can deliver the message to the destination with the least transmission power. The third protocol jointly accounts for both accumulated and consumed energies. To further improve system performance, a Relay-to-Relay Energy Harvesting (RREH) mechanism was adopted, allowing non-selected relays to store extra energy from the RF signal of the selected relay. Simulation results demonstrate significant improvements in outage probability compared to benchmark schemes without energy storage at the relays.

Formal IoT Device Recruitment Architecture and Case Study

Mubarak Mohammad, Fatima Abdallah and Hussein Othman

This paper extends our recently published architecture for automated IoT device recruitment and service provisioning using smart contracts. While the initial work established the rationale, motivation, and high-level architecture, this paper deepens the contribution by providing a formal foundation and comprehensive case study validation. We present a detailed formal specification of the smart contract service components, decomposing them into functional, non-functional, and contractual parts with precise logical expressions. The architecture is further formalized using Web Ontology Language (OWL), enabling machine-processable modeling and validation. A rigorous framework for completeness and correctness verification at three critical stages (before publication, before execution, and after execution) is defined. To demonstrate practical applicability, we implement a case study on autonomous train gate control at road intersections, showcasing the architecture's effectiveness in a real-world IoT scenario. The integration of formal methods with blockchain-based automation provides a robust, verifiable foundation for trusted IoT service deployment in dynamic environments.

IoT over Non-Terrestrial Networks: A Bibliometric Analysis

Aya Mhalla, Sébastien Maudet, Chamseddine Zaki, Abbass Nasser and Guillaume Andrieux

The integration of the Internet of Things (IoT) with Non-Terrestrial Networks (NTN) has attracted increasing research attention as a promising solution for achieving global connectivity. In recent years, satellite based IoT technologies leveraging Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Earth Orbit (GEO) constellations have emerged as key enablers for large scale, low power, and wide area communication with global coverage. To systematically examine the evolution and research trends of IoT-NTN research, this paper presents a comprehensive bibliometric study that identifies dominant topics and highlights emerging trends and research directions. The analysis is based on 4,878 publications, primarily conference papers and journal articles, published between 2015 and 2025. The IEEE emerges as the leading publisher in this research area and IEEE Internet of Things Journal represents the top publication venue in terms of the number of publications. Among the publications, "Orbits" is the most popular topic. A keyword co-occurrence analysis identifies five main clusters. The leading keywords in each cluster are Internet of Things (Cluster 1), satellite communication (Cluster 2), antennas (Cluster 3), 5G (Cluster 4), and GPS (Cluster 5). Among these, the first two clusters are the most dominant and together include 30 keywords. In addition this study investigates the growing research focus on LPWAN-based IoT technologies, including NB-IoT, LoRaWAN, LoRa, and LR-FHSS, highlighting their role in enabling global, low-power, and scalable connectivity for IoT devices.

Crowdsourcing Platform for Mobile Network Performance Monitoring in Lebanon

Abdul Rahman El Falou, Nisreen Dankar, Sarah Hakam, Mahmoud Hussein and Jawad Samad

The drive test is a traditional method used to evaluate the performance of mobile networks. However, it suffers from limited spatial and temporal coverage and often failS to capture the real user experience. This paper presents a smartphone-based crowdsourcing platform for monitoring mobile network performance in Lebanon. The proposed system allows the collection of radio and network performance parameters such as Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), Signal-to-Interference-plus-Noise Ratio (SINR), geolocation data, and mobility context directly from end-user's devices (smartphones). Measurements that were

collected during late 2025 and the beginning of 2026 were grouped and analyzed to assess the performance of one of the mobile network operators. The results showed the variations in the coverage distribution, signal quality, and the performance across different regions, demonstrating the effectiveness and reliability of crowdsourced measurements as a supplement tool for traditional network evaluation methods.

A Dual-Model Approach to Intrusion Detection for Enhanced 5G Network Security

Samar Sindian, Batoul Issa and Zeinab Tabel

This paper proposes a new intrusion detection system (IDS) for Software Defined 5G Networking using machine learning techniques to tackle the increasing cyber-security threats in future 5G networks. The authors proposed and designed dual IDS architectures; one was a combined model of autoencoder and random forest classifier. By testing and evaluation on the benchmark's datasets, the proposed models achieved detection rate above 99%. In addition, we implemented our IDS into a real SDN-based network and developed an iOS application that would allow authorized users to view the network's current security situation easily. This work is important because it offers a large-scale and efficient security solution for 5G that is currently threatened by more vulnerabilities.

Thursday, April 16 12:15 - 12:45

CC-Room1: Closing Ceremony

Virtual Room-1, Virtual Room-2, Virtual Room-3