IEEE IEACon 2025
INDUSTRIAL ELECTRONICS AND APPLICATIONS CONFERENCE

# 2025 IEEE Industrial Electronics and Applications Conference

## PROGRAMME BOOK

Le Meridien Hotel, Kota Kinabalu, Sabah, Malaysia

8 to 9 September 2025

Organizer:

IEEE
IEEE Malaysia IE/IA Joint Chapter

Technical Co-Sponsor:

IAS IEEE Industry Applications Society
Linking Research to Practice

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# IEACon 2025

## 2025 IEEE Industrial Electronics and Applications Conference

**LE MÉRIDIEN HOTEL KOTA KINABALU, SABAH, MALAYSIA**
**8 to 9 September 2025**

# CONTENT

# WELCOME MESSAGE

It is my great pleasure to welcome you to the 6th edition of the IEEE Industrial Electronics and Applications Conference (IEACon 2025), taking place in the beautiful city of Kota Kinabalu, Sabah, Malaysia, from 8th to 9th September 2025. Organized by the IEEE Malaysia Industrial Electronics (IE) and Industrial Applications (IA) Joint Chapter, and technically co-sponsored by the IEEE Industry Applications Society, IEACon has firmly established itself as a premier event in the field of industrial electronics and applications.

The primary objective of IEACon 2025 is to provide a high-quality platform for researchers, engineers, and industry professionals to share their latest innovations, exchange technical knowledge, and foster collaboration. This year's program features keynote addresses from distinguished experts, oral presentations, and opportunities for professional networking that encourage meaningful engagement and knowledge exchange.

We are honoured to welcome Professor Sanjib Kumar Panda from the National University of Singapore, Fellow IEEE, Chair of PELS TC 12, and Associate Editor for multiple IEEE Transactions, who will deliver a keynote on a futuristic medium-voltage grid-connected multi-port electric vehicle ultra-fast charging station with bidirectional G2V and V2G capabilities, highlighting its architecture, control strategies, and high-efficiency performance for future EV infrastructure.

We are also pleased to acknowledge the support of the Sabah Convention Bureau, whose contribution has helped make this event possible.

We are proud to bring IEACon 2025 to Kota Kinabalu, a vibrant coastal city renowned for its breathtaking natural beauty, diverse cultural heritage, and warm hospitality. With its stunning beaches, majestic mountains, and rich biodiversity, Sabah offers an inspiring backdrop for the exchange of ideas and the exploration of future technologies in industrial electronics and applications.

On behalf of the Organizing Committee, I extend my sincere appreciation to all authors for their valuable contributions, to the Technical Program Committee and reviewers for their dedication, and to our partners and sponsors for their support in making this conference possible.

We hope IEACon 2025 will be an enriching and memorable experience for you, offering not only valuable technical insights but also lasting professional connections. We look forward to your active participation in making this year's conference a success.

Thank you, and see you in Kota Kinabalu!

**Rahimi Baharom**
**General Chair**
**2025 IEEE Industrial Electronics and Applications Conference (IEACon 2025)**

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# TECHNICAL PROGRAM

| Time (Malaysia) | Mahua Room 1, Level 3 | Mahua Room 2, Level 3 |
|---|---|---|
| **Monday, September 8** | | |
| 08:00am - 08:45am | *Registration and Welcome Refreshments* | |
| 08:45am - 09:00am | *Welcoming Speech* | |
| 09:00am - 09:10am | *Cultural Performance: Sabah Welcome Dance* | |
| 09:10am - 10:10am | *Keynote Session*<br>A Futuristic Medium-Voltage Grid-Connected Multi-Port Public Electric-Vehicle Ultra-Fast Charging-Station with G2V and V2G capability | |
| 10:10am - 10:25am | *Announcement and Best Paper Award Presentation* | |
| 10:25am - 10:30am | *Group Photo Session* | |
| 10:30am - 10:45am | *Morning Break 1* | |
| 10:45am - 12:30pm | **S11**: *Signal and Image Processing and Computational Intelligence* | |
| 12:30pm - 14:00pm | *Lunch and Networking Session at Latest Recipe Restaurant (Lobby Level)* | |
| 14:00pm - 15:30pm | **S12**: *Power Electronics 1* | |
| 15:30pm - 15:45pm | *Afternoon Break 1* | |
| 15:45pm - 17:15pm | **S13**: *Industrial Automation, Communication, Networking and Informatics* | |
| 19:00pm - 21:00pm | | *Conference Dinner with Cultural Performance & Live Band (Excludes Student Registration)* |
| **Tuesday, September 9** | | |
| 08:00am - 08:30am | *Registration and Welcome Refreshments* | |
| 08:30am - 10:30am | **S21**: *Renewable Energy* | |
| 10:30am - 10:45am | *Morning Break 2* | |
| 10:45am - 12:30pm | **S22**: *Power Systems and Smart Grids, & Electronic Systems on Chip and Embedded Control* | |
| 12:30pm- 14:00pm | *Lunch and Networking Session at Latest Recipe Restaurant (Lobby Level)* | |
| 14:00pm - 15:30pm | **S23**: *Control Systems, Robotics and Mechatronics, Industrial Electronics and Applications, Cloud Computing, Big Data and Software Engineering* | |
| 15:30pm - 15:45pm | *Afternoon Break 2* | |
| 15:45pm - 17:00pm | **S24**: *Power Electronics 2, Electrical Machines and Drives, Engineering Education* | |
| 17:00pm | *End of conference* | |

## Monday, September 8, 2025

**Session** : **Keynote**
**Title** : **A Futuristic Medium-Voltage Grid-Connected Multi-Port Public Electric-Vehicle Ultra-Fast Charging-Station with G2V and V2G capability**
**Presenter** : **Professor Sanjib Kumar Panda (National University of Singapore)**
**Time** : **9:10am - 10:10am**
**Room** : **Mahua Room 1, Level 3**
**Session Chair** : **Ts. Dr. Wan Noraishah Wan Abdul Munim (Universiti Teknologi MARA, Malaysia)**

**Abstract**
Medium-voltage (MV) grid-connected solid-state-transformer (SST) based fast-charging (FC) stations provide several merits in terms of improved efficiency, power density, current limiting capability, etc. However, the propositions in literature are either not bidirectional (to simultaneously support V2G and G2V) or are unable to interface multiple types of plug-in electric-vehicles (PEVs), which are not able to meet the expectations of future fast-charging infrastructures. The fast-charging solutions available commercially are mostly for interfacing with the low voltage grid, and are unable to connect multiple type of PEVs. In this lecture, a futuristic MV grid-connected public multi-port FC/dC station is presented which not only resembles a conventional vehicle refuelling station's functionality by simultaneously interfacing all three types of PEV categories (heavy or hPEVs, medium or mPEVs and light or lPEVs), but also facilitates bidirectional power flow for V2G applications. The modulation, operation and control schemes of the front-end (FE) MVAC-LVDC single-stage conversion and back-end (BE) DC-DC conversion of the proposed architecture are presented in details. Real-time digital-simulator (RTDS) based Hardware-in-loop (HIL) test results for full-scale 22 kV, 1 MVA architecture's bidirectional operation verifies the proposed operation and controller for full-scale operation. The architecture facilitates simultaneous FC/dC of 1 hPEV within 49.5 min, 2 mPEVs within 28 min and 4 lPEVs within 16 min, while adhering closely to the prescribed charging/discharging schedules of each PEV. Finally, a proportionally scaled down 1 kV, 13.2 kVA experimental verification validates the architecture's performance during drastic net power flow change conditions and exhibits a peak efficiency of 96.4% with a power density of 3.2 kVA/L. A comprehensive benchmarking of the proposed architecture with commercially available FC products is also presented.

**10:10am - 10:25am** : **Announcement and Best Paper Award Presentation**
**10:25am - 10:30am** : **Group Photo Session**

**10:30am - 10:45am** : **Morning Break 1**

**Date** : **Monday, September 8, 2025**
**Time** : **10:45am - 12:30pm**
**Session** : **S11: Signal and Image Processing and Computational Intelligence**
**Room** : **Mahua Room 1, Level 3**
**Chair** : **Ramani Kannan (Universiti Teknologi Petronas, Malaysia)**

**10:45** *Low-Complexity and Stability-Ensured Least Pth-Error Odd-Order Tunable Filters*
Tian-Bo Deng (Toho University, Japan)

**11:00** *Effect of Lookback on Feature-Based Prediction Using XGBoost for Dehydration*
Marina Yusoff and Nurain Ibrahim (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); Mohamad Taufik Mohd Sallehud-Din and Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Yuzi Mahmud and Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

**11:15** ***AIREM: AI-Based Residential Electricity Monitoring System for Non-Intrusive Monitoring***
Wai Kong Lee (Universiti Tunku Abdul Rahman, Malaysia); Nor Aziah Amirah Nor Muhammad and Tengku Nurulhuda Tengku Abd Rahim (MIMOS Berhad, Malaysia); Boon Yaik Ooi (Universiti Teknologi PETRONAS, Malaysia); Woan Lin Beh and Xin Yi Kh'ng (Universiti Tunku Abdul Rahman, Malaysia); Keh Kok Yong (MIMOS Berhad, Malaysia)

**11:30** ***Comparative Predictive Modeling of $CO_2$ Adsorption Bed Performance Using LSTM with Particle Swarm Optimization***
Nurain Ibrahim, Yuzi Mahmud and Marina Yusoff (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Hanif M Halim and Wei Kian Soh (PETRONAS Research Sdn Bhd, Malaysia); Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

**11:45** ***Multi-Sensor Imaging-Based Detection of Road Surface Conditions***
Minkyo Youm, Ji Lee Hyun, In Ko Kwang and Ji Yun Kim (Advanced Institute of Convergence Technology (AICT), Korea (South))

**12:00** ***Predictive Analytics with $CO_2$ Dehydration Time Series Data Using LGBM***
Marina Yusoff and Nurain Ibrahim (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Yazid Jay Jalani and Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Yuzi Mahmud and Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

**12:15** ***Long Short Term Memory with Dynamic Sub-Swarm PSO for Molecular Sieve CO2 Adsorption***
Siti Nur Kamaliah Kamarudin, Marina Yusoff, Nurain Ibrahim and Yuzi Mahmud (Universiti Teknologi MARA, Malaysia); Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Yazid Jay Jalani, Mohamad Taufik Mohd Sallehud-Din, Wei Kian Soh and M Hanif M Halim (PETRONAS Research Sdn Bhd, Malaysia)

**12:30pm - 14:00pm : Lunch and Networking Session at Latest Recipe Restaurant (Lobby Level)**

**Date : Monday, September 8, 2025**
**Time : 14:00pm - 15:30pm**
**Session : S12: Power Electronics 1**
**Room : Mahua Room 1, Level 3**
**Chair : Khairul Safuan Muhammad (Universiti Teknologi MARA, Malaysia)**

**14:00** ***Bidirectional LLC Converter with Wide Range Operation Based on Hybrid Modulation***
Xuewei Pan (Harbin Institute of Technology Shenzhen, China); Xulin Chen (Harbin Institute of Technology, Shenzhen, China); Sinan Li (Harbin Institute of Technology, China); Can Wang (Harbin Institute of Technology (Shenzhen), China)

**14:15** ***An Isolated Bidirectional DC/DC Converter with Wide Output Voltage Range***
Xuewei Pan (Harbin Institute of Technology Shenzhen, China); Xulin Chen (Harbin Institute of Technology, Shenzhen, China); Ziran Wang (Harbin Institute of Technology, China); Can Wang (Harbin Institute of Technology (Shenzhen), China)

**14:30** ***Isolated DC-DC Converter with Active Clamping Circuit for Renewable Energy Systems***
Nabil A. Ahmed (College of Technological Studies, Kuwait & Assiut University, Egypt); Bader Alajmi (College of Technological Studies, Kuwait); Ibrahim Abdelsalam (Arab Academy for Science and Technology, Egypt); Mostafa I. Marei (Ain Shams University & Faculty of Engineering, Egypt)

**14:45** ***Reduced Switching Noise Buck-Type DC/DC Converter with Advanced Modulation Control***
Atsushi Hirota (National Institute of Technology, Akashi College, Japan)

**15:00** ***An Adaptive Multi-Mode Inverter with FPGA Control for High-Efficiency Power Conversion***
Siti Khodijah Mazalan, Baharuddin Ismail, Mohd Syahril Noor Shah, Nurhakimah Mohd Mukhtar and Ahmad Afif Nazib (Universiti Malaysia Perlis, Malaysia); Arash Toudeshki (University of California, Merced, USA); Samir Kouro (Universidad Tecnica Federico Santa Maria, Chile)

**15:15** ***A Comprehensive Study on Neutral Current Problems and Their Solutions in ACMV System of Data Center***
Hasmat Malik (Universiti Teknologi Malaysia & NSIT Delhi, India); Kiran Kumar Kandregula (Tata Consultancy Services, USA); Awang Jusoh (Universiti Teknologi Malaysia, Malaysia); Abhishek Thapliyal (Tata Consultancy Services, USA); Nik Rumzi Idris (UTM, Malaysia); Shahrin Md Ayob (University Teknologi Malaysia, Malaysia); Mohd Junaidi Abdul Aziz (UTM, Malaysia); Md Waseem Ahmad (NIT Karnataka, India); Muhammad Faizzudin Bin Leezam (UTM Malaysia, Malaysia)

**15:30pm - 15:45pm : Afternoon Break 1**

**Date : Monday, September 8, 2025**
**Time : 15:45pm - 17:15pm**
**Session : S13: Industrial Automation, Communication, Networking and Informatics**
**Room : Mahua Room 1, Level 3**
**Chair : Shamsul Aizam Zulkifli (Universiti Tun Hussein Onn Malaysia, Malaysia)**

**15:45** ***Digital Phase-Compensating Filter Design Using Complex-Valued Quadratic Cone Programming***
Tian-Bo Deng (Toho University, Japan)

**16:00** ***On Solving the Maximum Flow Problem with Conflict Constraints***
Roberto Montemanni (University of Modena and Reggio Emilia, Italy); Derek Smith (University of South Wales, United Kingdom (Great Britain))

**16:15** ***AODV-Inspired Routing with Next-Hop Caching and Path Selection for LoRa Mesh Networks***
Melissa J.Y. Chong, Shoon Kit Lim, Kei Kheng Tan and Jing Huey Khor (University of Southampton Malaysia, Malaysia)

**16:30** ***On-Site Integrated Multi-View Imaging Measurement System for Frozen Skipjack Tuna for Quality Assessment and Fisheries Digitalization***
Eisuke Nakata (Ishida Tec Co. Ltd, Japan); Yuki Fujita (Tokyo University of the Arts, Japan); Takuya Aoki (University of Tsukuba, Japan); Koki Okutomi (Xtrans Tech, Inc., Japan); Ryusuke Miyamoto (Tokyo University of Marine Science and Technology, Japan); Naoto Ienaga (University of Tsukuba, Japan); Hisashi Ishida (Ishida Tec Co, Ltd, Japan & SONOFAI INC, Japan); Keiichi Zempo (University of Tsukuba, Japan)

**16:45** ***Octagonal Shaped UWB MIMO Antenna for Wireless Communication Applications***
Mahesh Mathpati (SVERI Pandharpur, India)

**17:00** ***Deep Reinforcement Learning Based Resource Allocation in O-RAN***
Xin Yi Tan (Universiti Tunku Abdul Rahman, Malaysia); Mau Luen Tham (UTAR, Malaysia); Ying Loong Lee (Universiti Tunku Abdul Rahman, Malaysia); Chee Onn Chow (Universiti Malaya, Malaysia); Yi Jie Wong (Universiti Tunku Abdul Rahman, Malaysia); Chuan Hsian Pu (University of Nottingham Malaysia, Malaysia)

**19:00pm - 21:00pm : Conference Dinner featuring Cultural Performance (Magunatip Dance) & Live Band Entertainment (*Not Included in Student Registration*)**

## Tuesday, September 9, 2025

**Date** : **Tuesday, September 9, 2025**
**Time** : **8:30am - 10:30am**
**Session** : **S21: Renewable Energy**
**Room** : **Mahua Room 1, Level 3**
**Chair** : **Khairul Safuan Muhammad (Universiti Teknologi MARA, Malaysia)**

**8:30** ***Snow Ablation Optimizer-Based MPPT for PV Systems Under Various Partial Shading Conditions***
Norazlan Hashim and Rahimi Baharom (Universiti Teknologi MARA, Malaysia); Ahmad Farid Abidin (Faculty of Electrical Engineering, Universiti Teknologi MARA, Malaysia); Khairul Safuan Muhammad and Wan Noraishah Wan Abdul Munim (Universiti Teknologi MARA, Malaysia)

**8:45** ***Simulation of Energy Consumption and Solar Generation for Urban Farming via PV Syst Software***
Siti Amely Jumaat, Ahmad Fateh Mohamad Nor, Suriana Salimin, Mohd Noor Abdullah and Muhammad Nafis Ismail (Universiti Tun Hussein Onn Malaysia, Malaysia)

**9:00** ***A Hybrid Spiral Sine Cosine Optimized P&O - PI Controller for Enhanced Maximum Power Point Tracking in Photovoltaic System***
Nizaruddin M.Nasir (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Nor Maniha Abdul Ghani (Universiti Malaysia Pahang, Malaysia); Kamal Zuhairi Zamli and Nur Zahirah Mohd Ali (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Meng Chung Tiong (Universiti of Technology Sarawak, Malaysia); Norazila Jaalam (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

**9:15** ***Machine Learning Approaches for Predicting Solar Power Generation: A Comparative Study***
Nureisya Dania Mohd Zuinuddin, Nur Zahirah Mohd Ali, Muhammad Zulfadhli Mohd Azhar and Wan Syahirah Wan Samsudin (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

**9:30** ***Optimization of Fuzzy Logic MPPT Controllers Using a Hybrid Spiral Sine Cosine Algorithm for Photovoltaic Systems***
Nizaruddin M.Nasir (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Nor Maniha Abdul Ghani (Universiti Malaysia Pahang, Malaysia); Nur Zahirah Mohd Ali, Suliana Ab Ghani and Nur Huda Ramlan (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

**9:45** ***ML-Based Refrigerator Scheduling for Energy Efficiency in Renewable-Integrated Smart Homes***
Sanjiban Roy (Indian Institute of Information Technology Guwahati, India); Nilotpal Chakraborty and Yamini Sisodia (Indian Institute of Information Technology, Guwahati, India); Preveen Kumar Devarajan (NCMRWF, India)

**10:00** ***Optimization of Solar Photovoltaic with Storage Utilization Using Lithium-Ion and Lead-Acid Batteries***
Mohd Amran Mohd Radzi (Universiti Putra Malaysia, Malaysia)

**10:15** ***Analysis of Installation Factors Affecting the Performance of PV Systems in Malaysia***
Xiaoqing Zhu (Institute for Advanced Studies, University of Malaya); Jeyraj Selvaraj (UM Power Energy Dedicated Advanced Centre (UMPEDAC), University of Malaya); Ruochen Zu (Institute for Advanced Studies, University of Malaya)

**10:30 - 10:45 : Morning Break 2**

**Date** : **Tuesday, September 9, 2025**
**Time** : **10:45am - 12:30pm**
**Session** : **S22: Power Systems and Smart Grids, & Electronic Systems on Chip and Embedded Control**
**Room** : **Mahua Room 1, Level 3**
**Chair** : **Mohd Amran Mohd Radzi (Universiti Putra Malaysia, Malaysia)**

**10:45** ***Optimized Unified Power Quality Conditioner for Nonlinear Load Connected Microgrid Using Artificial Rabbit Search Optimization***
Abdulwahab Ibrahim and Nuraddeen Adam Iliyasu (Ahmadu Bello University, Nigeria); Ekundayo Kayode Rasaq (Federal University Dutsin-Ma, Nigeria); Aminu Jibrin Aliyu (Universiti Teknologi PETRONAS, Malaysia & Ahmadu Bello University, Nigeria); Md Mahmudul Hasan (Universiti Teknologi PETRONAS, Malaysia); Ramani Kannan (Universiti Teknologi Petronas, Malaysia)

**11:00** ***Optimization of Load Frequency Control for a Multi-Area Power System Based on Bio-Inspired Metaheuristic Algorithms***
Hazlee Azil Illias, Li Yang Lee and Hazlie Mokhlis (University of Malaya, Malaysia)

**11:15** ***Scalable Optimization of BESS Integration in Transmission Networks Using IICSEP: A Case Study on Large-Scale Systems***
Nur Farahiah Ibrahim (Universiti Teknologi MARA, Malaysia); Ismail Musirin (Universiti Teknologi MARA Shah Alam, Selangor, Malaysia); Nor Azwan Mohamed Kamari (Universiti Kebangsaan Malaysia, Malaysia); Nor Zulaily Mohamad (Universiti Teknologi MARA Shah Alam, Selangor, Malaysia); Fatimatul Anis Bakri (Master, Malaysia); Fathiah Zakaria (Universiti Teknologi MARA, Malaysia)

**11:30** ***Enhancing Inverter Synchronization: a Resilient Static Solution for Adverse Grid Environments***
Chang-Yi Chou (National Sun Yat-sen University, Taiwan); Mohammed Ansar Mohammed Manaz (National Sun Yat-Sen University, Taiwan)

**11:45** ***Applying the NIST Statistical Test Suite to a TRNG of an Open-Source RISC-V Sub-System for PQC-Aware Industrial SoCs***
Armando Astarloa (University of the Basque Country (UPV/EHU), Spain); Edurne Primicia, Alejandro Arteaga, Leire Muguira and Sara Alonso (University of the Basque Country, Spain)

**12:00** ***Modified March C- Algorithm for STT-MRAM Testing***
Jun Jia, Guilin Zhao and Chao Wang (China Electronics Technology Group Corporation No. 58 Research Institute)

**12:15** ***Prediction of IGBT Peak Junction Temperature Using Hybrid Voting-Based Ensemble Model***
Swaraj Umesh Jagade and Mohana Sundaram Muthuvalu (Universiti Teknologi PETRONAS, Malaysia); Andrei C. Ribeiro (State University of Campinas, Brazil); M Sambath (Periyar University, India)

**12:30pm - 14:00pm : Lunch and Networking Session at Latest Recipe Restaurant (Lobby Level)**

**Date** : **Tuesday, September 9, 2025**
**Time** : **14:00pm - 15:30pm**
**Session** : **S23: Control Systems, Robotics and Mechatronics, Industrial Electronics and Applications, Cloud Computing, Big Data and Software Engineering**
**Room** : **Mahua Room 1, Level 3**
**Chair** : **Syed Farid Syed Adnan (Universiti Teknologi MARA, Malaysia)**

**14:00** ***Reconstruction of a Nonlinear Dynamical Model for Floating Offshore Wind Turbines***
Masayoshi Toda (Tokyo University of Marine Science and Technology, Japan)

**14:15** ***Path Planning of Unmanned Surface Vehicle for Water Waste Collection***
Nur Arfa Aqilah Abdullah (Universiti Teknologi PETRONAS, Malaysia); Illani Mohd Nawi (Universiti Teknologi Petronas, Malaysia)

**14:30** ***Centralized Protection and Control (CPC): Smart Solutions for Digital Protection System***
Fitriah Binti Shafei (PETRONAS, Malaysia); Azwanizam Che A Rahman (Malaysia); A KARIM BIN A RAHMAN, Faizah Binti Othman, Ts. Wan Azura Binti Mohd Azhar and M Zulhilmie Bin Mat Kana (PETRONAS, Malaysia)

**14:45** ***Primary Water Plant Nuclear Reactor Prediction Modeling Using CNN Forward-Fill and Forward-Backward Fill Imputation Method***
Intan Nabina Azmi and Murizah Kassim (Universiti Teknologi MARA, Malaysia); Mohd Sabri Minhat (MALAYSIAN NUCLEAR AGENCY, Malaysia); Wan Fairos Wan Yaacob (Universiti Teknologi MARA Cawangan Kelantan, Malaysia); Ibnu Hajar (Universiti Teknologi MARA, Malaysia & Institut Teknologi Perusahaan Listrik Negara, Malaysia)

**15:00** ***Model Prediction Direct Torque Control for Permanent Magnet Synchronous Generator Using Five-Level Vienna Rectifier***
Bryan Tan and Sook Yee Yip (Tunku Abdul Rahman University of Management and Technology, Malaysia); Thien Yee Von (Tunku Abdul Rahman University of Management and Technology (TAR UMT), Malaysia); Kah Haur Yiauw (Tunku Abdul Rahman University College, Malaysia); Wong Jee Keen Raymond (University of Malaya, Malaysia)

**15:15** ***YOLOv11-Based Threat Detection and Zigbee-Enabled Energy Management for Smart Home Automation***
Syed Farid Syed Adnan (Universiti Teknologi MARA, Malaysia)

**15:30pm - 15:45pm : Afternoon Break 2**

**Date : Tuesday, September 9, 2025**
**Time : 15:45pm - 17:00pm**
**Session : S24: Power Electronics 2, Electrical Machines and Drives, Engineering Education**
**Room : Mahua Room 1, Level 3**
**Chair : Wan Noraishah Wan Abdul Munim (Universiti Teknologi MARA, Malaysia)**

**15:45** ***Wireless EV Charging Efficiency Under Coil Misalignment: Quantitative Analysis and Optimization Using Resonant Inductive Power Transfer***
Rahimi Baharom, Wan Muhamad Hakimi Wan Bunyamin, Wan Noraishah Wan Abdul Munim, Norazlan Hashim and Khairul Safuan Muhammad (Universiti Teknologi MARA, Malaysia)

**16:00** ***Performance Evaluation of a Fault-Tolerant Bridgeless Boost Rectifier for Universal AC Voltage Levels and Non-Linear Load Conditions***
Khairul Safuan Muhammad, Muhamad Akram Mohamed Sany, Wan Noraishah Wan Abdul Munim, Rahimi Baharom and Norazlan Hashim (Universiti Teknologi MARA, Malaysia)

**16:15** ***Current and Voltage Limits in Symmetrical Six-Phase Induction Machine Under One Open Circuit Fault***
Wan Noraishah Wan Abdul Munim, Nur Suhailah, Nooradzianie Muhammad Zin, Rahimi Baharom, Khairul Safuan Muhammad and Norazlan Hashim (Universiti Teknologi MARA, Malaysia)

**16:30** ***Flying Start with ANN-Based Precise Position Compensation in Flux-Weakening Region***
Yoon-Seong Lee (Hyundai Kefico, Korea (South) & Hyundai Kefico, Korea (South)); Ki-Wang Kim, Sung-Jin Park, Chae-Eun Lee, Min-Hyo Kim and Jun-Hyung Kim (Hyundai Kefico, Korea (South))

**16:45** ***Teaching Experience Based on Study of Motor Speed Control Using PI and Neural Network Controllers***
Shamsul Aizam Zulkifli (UTHM, Malaysia & Universiti Tun Hussein Onn Malaysia, Malaysia); Syazmie Sepeeh (MAHSA University, Malaysia)

**17:00pm : End of conference**

# PAPER ABSTRACT

## S11: Signal and Image Processing and Computational Intelligence

***Low-Complexity and Stability-Ensured Least Pth-Error Odd-Order Tunable Filters***

Tian-Bo Deng (Toho University, Japan)

The coefficients of a tunable (variable) filter need to be changeable during online operations. This can be accomplished through expressing the filter's coefficients as different polynomial functions of the so-called spectral parameters that are introduced for tuning filter's bandwidths. This paper shows a methodology for implementing an odd-order variable bandpass filter (OO-VBPF) with significantly reduced implementation complexity, and the OO-VBPF design criterion is the least p-norm error of amplitude response. When using polynomials to express OO-VBPF's coefficients, some of the OO-VBPF's coefficients do not necessitate high polynomial degrees, and low degrees are sufficient to get an accurate implementation. That is, if some of the OO-VBPF coefficients change smoothly, low-degree polynomials are enough, and it is unnecessary to use high-degree polynomials to represent such OO-VBPF coefficients. This reduces the total number of polynomial degrees and in turn leads to a highly reduced complexity. To validate this novel scheme, simulation results are given for verifying the significant complexity reduction.

***Effect of Lookback on Feature-Based Prediction Using XGBoost for Dehydration***

Marina Yusoff and Nurain Ibrahim (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); Mohamad Taufik Mohd Sallehud-Din and Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Yuzi Mahmud and Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

Accurately forecasting operational parameters in dehydration systems is crucial for enhancing gas processing industries' efficiency, reliability, and sustainability. This study investigates the impact of lookback duration on the effectiveness of the eXtreme Gradient Boosting (XGBoost) algorithm in predicting essential parameters such as moisture content, outlet temperature, and natural gas flow in a multi-bed $CO_2$ dehydration unit. Three separate lookback periods 1-day, 3 days, and 6 days-were evaluated across data attributes. The results indicate that the ideal lookback period is contingent upon the attributes of each variable. Moisture-related characteristics demonstrated improved predictive accuracy with a 3-day analysis, reflecting the cyclical dynamics of the adsorption-regeneration process. Conversely, temperature parameters and natural gas flow attained optimal accuracy with a 1-day look back, indicating heightened sensitivity to short-term operational variations. These results highlight the significance of employing a feature-specific methodology in organizing time-series forecasting inputs. Customizing the lookback configuration to the intrinsic dynamics of each parameter can markedly enhance model accuracy and interpretability. This study provides practical insights for implementing XGBoost in industrial predictive analytics and emphasizes prospects for future research on adaptive, data-driven lookback strategies in real-time monitoring contexts.

***AIREM: AI-Based Residential Electricity Monitoring System for Non-Intrusive Monitoring***

Wai Kong Lee (Universiti Tunku Abdul Rahman, Malaysia); Nor Aziah Amirah Nor Muhammad and Tengku Nurulhuda Tengku Abd Rahim (MIMOS Berhad, Malaysia); Boon Yaik Ooi (Universiti Teknologi PETRONAS, Malaysia); Woan Lin Beh and Xin Yi Kh'ng (Universiti Tunku Abdul Rahman, Malaysia); Keh Kok Yong (MIMOS Berhad, Malaysia)

Non-intrusive load monitoring (NILM) is an important technique for energy management and conservation. Extensive research was performed along this direction to allow automatic residential energy monitoring in a non-intrusive manner. The key to a successful NILM system development is to have a robust event detector and lightweight disaggregator for classifying each type of appliances and their power consumption. In this paper, we present an AI-based non-intrusive monitoring system able to automatically detect events, classify the types of active appliances, and estimate energy consumption. A novel table-based disaggregation method is proposed to easily disaggregate the power consumed by a particular appliance from the total power consumption. An efficient and robust rise/fall algorithm is also proposed to detect the targeted appliances. The backend (cloud server) and frontend (mobile application) designed are also presented in this paper.

***Comparative Predictive Modeling of $CO_2$ Adsorption Bed Performance Using LSTM with Particle Swarm Optimization***

Nurain Ibrahim, Yuzi Mahmud and Marina Yusoff (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Hanif M Halim and Wei Kian Soh (PETRONAS Research Sdn Bhd, Malaysia); Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

The increasing frequency of extreme weather events has intensified global efforts to reduce greenhouse gas emissions. One promising method is the injection of carbon dioxide ($CO_2$) into shale reservoirs, which enhances oil and gas recovery while enabling long-term carbon sequestration. However, $CO_2$ management in industrial systems, particularly in refinery adsorption beds, remains underexplored. Accurate prediction of cycle life in these beds is crucial to minimize inefficiencies and reduce operational costs. Artificial Intelligence (AI) offers an effective alternative to traditional manual calculations for forecasting adsorption behavior. Long Short-Term Memory (LSTM) networks are well-suited for time-series prediction but require complex hyperparameter tuning to achieve optimal accuracy. This study develops LSTM-based models to predict Net Loading Capacity (NLC) and estimate the remaining life of $CO_2$ dehydration units using adsorption data from Mod 1. Particle Swarm Optimization (PSO) and its variant, starPSO, are employed to automate hyperparameter tuning and evaluate model performance across three different adsorption bed configurations. Results show that LSTM+starPSO achieves the highest accuracy for Bed 1 (Root Mean Squared Error (RMSE): 0.68 wt%, Mean Absolute Error (MAE): 0.6156 wt%), while LSTM+PSO performs best for Bed 2 (RMSE: 0.58 wt%, MAE: 0.5657 wt%). However, LSTM+starPSO shows reduced performance in Bed 2 and is the least effective for Bed 3, with the highest RMSE (1.00 wt%) and MAE (0.8955 wt%). Overall, the findings highlight the potential of hybrid AI approaches in improving adsorption bed efficiency. A comprehensive, data-driven framework is recommended to support predictive maintenance and sustainable $CO_2$ management in industrial operations.

***Multi-Sensor Imaging-Based Detection of Road Surface Conditions***

Minkyo Youm, Ji Lee Hyun, In Ko Kwang and Ji Yun Kim (Advanced Institute of Convergence Technology (AICT), Korea (South))

South Korea, characterized by its distinct four seasons, frequently experiences accidents caused by black ice during the winter season. Over the past five years, 166 such incidents have been recorded, including a severe 44-vehicle pileup in 2025 that resulted in significant human and property losses. This study investigates road surface condition detection using multiple imaging sensors, including RGB, infrared (IR), and thermal cameras. To conduct this research, the three types of sensors were installed on actual roads to collect data. Special emphasis was placed on nighttime experiments, when black ice formation is more likely, to evaluate the decrease in recognition accuracy compared to daytime and to determine the optimal sensor for each road surface condition. The results indicate that RGB cameras are highly effective during the daytime, whereas IR and thermal cameras exhibit superior recognition performance at night. However, black ice showed a recognition rate of only about 51% in nighttime data, suggesting the limitations of passive imaging-based sensors. Consequently, the study highlights the need to incorporate active sensors, such as radar, for more reliable detection.

***Predictive Analytics with $CO_2$ Dehydration Time Series Data Using LGBM***

Marina Yusoff and Nurain Ibrahim (Universiti Teknologi MARA, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Yazid Jay Jalani and Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Yuzi Mahmud and Siti Nur Kamaliah Kamarudin (Universiti Teknologi MARA, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia)

Precise prediction of $CO_2$ dehydration efficacy is essential for maintaining operational efficiency in industrial gas processing systems, especially in $CO_2$ dehydration units. This research presents a predictive analytics framework that utilizes the Light Gradient Boosting Machine algorithm to forecast $CO_2$ dehydration behavior using time series data. The model utilizes historical operational parameters to identify temporal dependencies and forecast essential adsorption-related characteristics. A systematic methodology was employed to determine the ideal lookback period, with 72 hours (3 days) identified as the optimal interval that effectively encompasses both short-term variations and long-term trends. The model's performance was assessed using Root Mean Squared Error and Mean Absolute Error, consistently attaining a "Very Good" acceptance level across the majority of features. Essential process variables, such as vessel pressures and adsorption-related parameters, exhibited minimal error rates, whereas temperature output variables displayed marginally greater variability yet remained within acceptable performance thresholds. This research demonstrates that LGBM offers a robust, scalable, and efficient solution for

predictive analytics in $CO_2$ dehydration systems, thereby facilitating the advancement of data-driven decision-making and operational optimization in industrial environments.

***Long Short Term Memory with Dynamic Sub-Swarm PSO for Molecular Sieve CO2 Adsorption***

Siti Nur Kamaliah Kamarudin, Marina Yusoff, Nurain Ibrahim and Yuzi Mahmud (Universiti Teknologi MARA, Malaysia); Amiza Surmi (PETRONAS Research Sdn Bhd, Malaysia); Iylia Idris (UiTM Shah Alam, Malaysia); Jasni Mohamad Zain (Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Malaysia); M Yazid Jay Jalani, Mohamad Taufik Mohd Sallehud-Din, Wei Kian Soh and M Hanif M Halim (PETRONAS Research Sdn Bhd, Malaysia)

Adsorption process to remove moisture from gases and liquids are vital in some industries like natural gas processing and carbon capture, as the process can help extend the equipment life span used. Using molecular sieves (molsieve) for adsorption process are particularly effective due to the molsieve property being high selectivity and adsorption capacity for CO2 molecules. However, the efficiency of the adsorption process is determined by the net loading capacity (NLC) of the adsorption bed, which influence the moisture and CO2 removal performance. To optimize the adsorption process performance, much research applies predictive modelling to predict the lifespan of the adsorption beds. Additionally, in real situations, different beds may have different behaviour thus making it difficult to predict the NLC for each for the adsorption bed. Current predictive models also lack accuracy and efficiency to handle the different behaviour of multiple adsorption beds. Furthermore, the availability and chaotic behaviour of relevant data necessary for the prediction of adsorption performance also present a problem. This increases the need for more advanced and adaptable methodologies to overcome the limitation presented by the current techniques. Thus, this research explored the use of Long Short-Term Memory with Particle Swarm Optimization (LSTM-PSO) and a variation of PSO, Dynamic Sub-Swarms Particle Swarm Optimization (LSTM-dssPSO) to predict the usefulness of its adsorption bed by predicting its NLC. Overall results show excellent variety achievements of Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE) values for both LSTM-PSO and LSTM-dssPSO, indicating promising prospects of implementing the techniques in industrial predictive analytics in the CO2 adsorption prediction.

## S12: Power Electronics 1

***Bidirectional LLC Converter with Wide Range Operation Based on Hybrid Modulation***

Xuewei Pan (Harbin Institute of Technology Shenzhen, China); Xulin Chen (Harbin Institute of Technology, Shenzhen, China); Sinan Li (Harbin Institute of Technology, China); Can Wang (Harbin Institute of Technology (Shenzhen), China)

To achieve high efficiency operation under the constraint of bidirectional operation over wide output voltage for the electric vehicles charging station with V2G function, a hybrid regulation strategy is proposed for bidirectional LLC converter. In forward power transmission, LLC full bridge variable frequency, full bridge phase shift, half bridge variable frequency, and burst modulation techniques are combined to effectively improve the output voltage range of LLC converter. In case of reverse power transmission, a delayed boost modulation is proposed in addition to conventional variable frequency modulation. The smooth switching methods between multiple modulation techniques are proposed as well. The simulation model and experimental prototype have been built. The experiment results show that the proposed hybrid modulation strategy can effectively realize the wide range soft switching operation of the bidirectional LLC converter.

***An Isolated Bidirectional DC/DC Converter with Wide Output Voltage Range***

Xuewei Pan (Harbin Institute of Technology Shenzhen, China); Xulin Chen (Harbin Institute of Technology, Shenzhen, China); Ziran Wang (Harbin Institute of Technology, China); Can Wang (Harbin Institute of Technology (Shenzhen), China)

In DC power supply systems, there is often a significant voltage difference between the supply and load sides, which can lead to poor compatibility of the power system. To address this issue, this paper proposes a new isolated bidirectional DC/DC converter. It integrates a four-switch Buck-Boost with a LLC converter with partial switch reuse, effectively enhancing overall performance. A hybrid control strategy that combines PWM and frequency modulation is designed, enabling a wide soft-switching range under varying output conditions. The paper provides a detailed analysis of the converter's operating modes. Additionally, a simulation model and an experimental prototype are designed to validate the theoretical results. The final results confirm that the converter can maintain soft-switching characteristics over a wide output voltage range.

***Isolated DC-DC Converter with Active Clamping Circuit for Renewable Energy Systems***

Nabil A. Ahmed (College of Technological Studies, Kuwait & Assiut University, Egypt); Bader Alajmi (College of Technological Studies, Kuwait); Ibrahim Abdelsalam (Arab Academy for Science and Technology, Egypt); Mostafa I. Marei (Ain Shams University & Faculty of Engineering, Egypt)

This paper presents a soft-switching isolated phase-shifted full-bridge DC-DC converter with an active clamping circuit, specifically designed for fuel cell power generation applications. The proposed converter incorporates an active clamping circuit on the primary side of the high-frequency transformer to mitigate voltage spikes and recover energy stored in the leakage inductor. The design offers several advantages, including a reduced component count, a straightforward circuit configuration, lower voltage stress, and a broad input voltage range. The soft-switching capability of the converter enables high switching frequencies while maintaining high power conversion efficiency. Detailed investigations are conducted in various operation modes and their corresponding equivalent circuits throughout the operating cycle. To validate the converter's performance, a downscaled 1.2 kW simulation and a 350 W experimental prototype were developed. The results demonstrate the converter's ability to achieve a wide output voltage gain while maintaining a stable output voltage across a wide range of low input voltages. The prototype achieved maximum power conversion efficiencies of 98% in simulation and 96.5% in experimental testing under full load conditions, attributed to the converter's ability to minimize switching losses at rated power.

***Reduced Switching Noise Buck-Type DC/DC Converter with Advanced Modulation Control***

Atsushi Hirota (National Institute of Technology, Akashi College, Japan)

Switching power supplies generally use PWM control method, which controls the pulse width of the switch device. However, in PWM method, large switching noise components appear at every integer multiple of the carrier frequency, which can adversely affect other electronic devices and cause problems in terms of noise regulation measures. In order to solve this problem, this paper proposes a DC/DC converter that incorporates a new switching method. This study clarifies the effectiveness of the proposed DC/DC converter by comparing its characteristics in suppressing the switching noise generated with that of PWM method. In addition, this method does not require a complex configuration or changes to the main circuit configuration, so it can also be used to improve existing systems.

***An Adaptive Multi-Mode Inverter with FPGA Control for High-Efficiency Power Conversion***

Siti Khodijah Mazalan, Baharuddin Ismail, Mohd Syahril Noor Shah, Nurhakimah Mohd Mukhtar and Ahmad Afif Nazib (Universiti Malaysia Perlis, Malaysia); Arash Toudeshki (University of California, Merced, USA); Samir Kouro (Universidad Tecnica Federico Santa Maria, Chile)

This paper presents a compact multilevel inverter (MLI) that achieves adaptive multi-mode operation through FPGA-based control, a reconfigurable switching circuit, and an asymmetric DC-link configuration. The design significantly decreases component count compared to traditional MLIs, diodeclamped, flying capacitor, and cascaded H-bridge (CHB) topologies, while having dynamic mode adaptation capabilities for different DC-link distribution and switching reconfiguration. The FPGA-based implementation provides digital control for precise switching sequence management and swift-mode transitions. Experimental testing with an induction motor under varying frequency conditions confirms that the proposed topology reduces the inverter circuit size while maintaining THD performance comparable to CHB-MLI. The topology achieves a 64.29% reduction in component count per 15-level module while maintaining the same circuit stress level, with the highest switch rating decreased from 7 p.u. (366 V) to 6 p.u. (288 V) compared to conventional 2-level inverters. Additionally, the prototype developed in this research achieves a power rating of 5.9 kW with an efficiency of 99.48%, demonstrating the topology's potential for industrial motor drives. Future work will focus on expanding the inverter design's compatibility with renewable energy sources and grid integration requirements.

***A Comprehensive Study on Neutral Current Problems and Their Solutions in ACMV System of Data Center***

Hasmat Malik (Universiti Teknologi Malaysia, Indonesia & NSIT Delhi, India); Kiran Kumar Kandregula (Tata Consultancy Services, USA); Awang Jusoh (Universiti Teknologi Malaysia, Malaysia); Abhishek Thapliyal (Tata Consultancy Services, USA); Nik Rumzi Idris (UTM, Malaysia); Shahrin Md Ayob (University Teknologi Malaysia, Malaysia); Mohd Junaidi Abdul Aziz (UTM, Malaysia); Md Waseem Ahmad (NIT Karnataka, India); Muhammad Faizzudin Bin Leezam (UTM Malaysia, Malaysia)

The main focus of this study is the design, simulation, and analysis of a method that will improve the power quality and reduce power losses caused by harmonic distortion (HD) from nonlinear loads in a data center (DC). The Shunt Active Power Filter (SAPF) was designed using MATLAB Simulink tools, which focuses on its ability to

reduce an HDs, reproduce a sinusoidal voltage and current waveforms that meet the requirements of the IEEE 519 standard. A Variable Frequency Drive (VFD) that powers a cooling system pump of DC was identified as one of the main sources of HDs, and this issue highlighted the need for harmonic filtering solutions. As part of the proposed mitigation solution, the SAPF was formulated and tuned with a Proportional-Integral (PI) controller which aiming to improve the stability and dynamic response of the active filter. The results from this mitigation method show that the SAPF will be suitable for reducing significant HDs that will then lead to the improvement of power quality and efficiency of the system. After the implementation of this filter, the voltage and current waveforms became more balanced, which also contributed to a drop in power losses. These results demonstrated the effectiveness of an active filter in monitoring energy usage in a high-demand environment like a DC. Beyond performance, the study also emphasizes the role of SAPF in improving DC operations. By reducing harmonic distortions, the filter not only lowers power consumption but also supports better cooling system performance and boosts the Power Usage Effectiveness (PUE) ratio.

## S13: Industrial Automation, Communication, Networking and Informatics

***Digital Phase-Compensating Filter Design Using Complex-Valued Quadratic Cone Programming***
Tian-Bo Deng (Toho University, Japan)
This paper presents a novel technique for designing an allpass digital phase-compensating filter for reliable digital communications via using quadratic cone programming (QconeP). The QconeP is formulated under complex-valued QconeP constraints. That is, complex-valued vectors and matrices are used to describe the QconeP constraints. After the problem of designing a phase-compensating filter (PCF) is transformed to a QconeP problem, the transformed problem is solved iteratively to get a PCF design solution. This paper exemplifies an allpass PCF design for showing the significant accuracy improvement over other design schemes based on QconeP.

***On Solving the Maximum Flow Problem with Conflict Constraints***
Roberto Montemanni (University of Modena and Reggio Emilia, Italy); Derek Smith (University of South Wales, United Kingdom (Great Britain))
The Maximum Flow Problem with Conflict Constraints is a generalization that adds conflict constraints to a classical optimization problem on networks used to model several real-world applications. In the last few years several approaches, both heuristic and exact, have been proposed to attack the problem. In this paper we consider a mixed integer linear program and solve it with an open-source solver. Computational results on the benchmark instances commonly used in the literature of the problem are reported. All the 160 instances benchmark instances normally used in the literature are solved to optimality for the first time, with 28 instances closed for the first time. Moreover, in the process, 6 improvements to the best-known heuristic solutions are also found.

***AODV-Inspired Routing with Next-Hop Caching and Path Selection for LoRa Mesh Networks***
Melissa J.Y. Chong, Shoon Kit Lim, Kei Kheng Tan and Jing Huey Khor (University of Southampton Malaysia, Malaysia)
The high mobility of Unmanned Aerial Vehicles (UAVs) leads to constant changes in node positioning, which disrupts communication links and affects overall network stability. Therefore, routing protocols such as the conventional Ad hoc On-demand Distance Vector (AODV) have been widely utilised in mobile ad hoc networks to ensure reliable data delivery. However, AODV's on-demand routing nature leads to repetitive distribution of routing packets to re-establish overwritten routes, which is especially detrimental for low-data rate communication networks such as Long Range (LoRa). This paper introduces an AODV-inspired routing protocol that integrates a next-hop caching strategy alongside a multi-route memory mechanism, enhanced by weight-based route selection. A proof-of-concept implementation is conducted in a real-world mesh network consisting of five static LoRa nodes and a mobile LoRa node traversing the network. Experimental analysis demonstrates that the proposed protocol is functional and achieves a reduction in average routing latency of 23μs when compared to the standard AODV protocol. This reduction in routing latency is vital for enabling efficient data delivery in dynamic topology networks.

***On-Site Integrated Multi-View Imaging Measurement System for Frozen Skipjack Tuna for Quality Assessment and Fisheries Digitalization***
Eisuke Nakata (Ishida Tec Co. Ltd, Japan); Yuki Fujita (Tokyo University of the Arts, Japan); Takuya Aoki (University of Tsukuba, Japan); Koki Okutomi (Xtrans Tech, Inc., Japan); Ryusuke Miyamoto (Tokyo University of

Marine Science and Technology, Japan); Naoto Ienaga (University of Tsukuba, Japan); Hisashi Ishida (Ishida Tec Co, Ltd, Japan & SONOFAI INC, Japan); Keiichi Zempo (University of Tsukuba, Japan)
To enable non-destructive and rapid assessment of fish quality, such as fat content and freshness, high-quality multimodal imaging data is essential. In this study, we developed an integrated measurement system that simultaneously captures 2D and 3D images from five viewpoints and automatically measures the weight of fish specimens conveyed on a production line. By integrating HDR-enabled cameras, the system achieves high-resolution imaging while minimizing ambient light interference without requiring a darkroom or dedicated lighting. Validation experiments using frozen skipjack tuna (Katsuwonus pelamis) demonstrated the effectiveness of the system in (i) full-body visualization through multi-view image merge and (ii) body length estimation based on 3D shape features.

***Octagonal Shaped UWB MIMO Antenna for Wireless Communication Applications***
Mahesh Mathpati (SVERI Pandharpur, India)
In wireless communication, the antenna is a critical component. For short-range communication, various protocols like BLE, Bluetooth, Zigbee, and WiFi are widely used. Ultra-Wideband (UWB) technology also serves this purpose with its high data rates and wide frequency range. Multiple Input Multiple Output (MIMO) technology is employed in this study to enhance UWB performance. This paper presents a 2x2 or 4-port MIMO antenna with an octagonal configuration designed to operate in the UWB frequency range for short-range communication. Each radiator element, etched with a "+" pattern and arranged octagonally, produces dual polarization, improving isolation and reducing mutual coupling. The proposed antenna's dimensions are 40x46x1.6 $mm^3$. The primary objective of this study is to reduce mutual coupling and enhance antenna performance by integrating a neutralization line with the ground structure. Using an FR4 substrate, the simulated and fabricated antenna achieves a return loss of over 30 dB, mutual coupling under 15 dB, and isolation of approximately 35.72 dB. The Diversity Gain (DG) is recorded at 10 dB, and Total Active Reflection Coefficient (TARC) at 0.57. The proposed antenna design supports various UWB devices, providing an effective solution for short-range wireless applications.

***Deep Reinforcement Learning Based Resource Allocation in O-RAN***
Xin Yi Tan (Universiti Tunku Abdul Rahman, Malaysia); Mau Luen Tham (UTAR, Malaysia); Ying Loong Lee (Universiti Tunku Abdul Rahman, Malaysia); Chee Onn Chow (Universiti Malaya, Malaysia); Yi Jie Wong (Universiti Tunku Abdul Rahman, Malaysia); Chuan Hsian Pu (University of Nottingham Malaysia, Malaysia)
The evolution of Radio Access Network (RAN) architecture towards 6th Generation (6G) network introduces Artificial Intelligence (AI)-driven automation and open, disaggregated design, enabling dynamic and intelligent resource optimization. Traditional resource allocation schemes typically rely on fixed algorithms to assign Physical Resource Blocks (PRBs) to multiple users, often targeting a single performance metric and lacking adaptability to real-time network conditions. This paper investigates two deep reinforcement learning (DRL)-based downlink PRB allocation algorithms, namely Proximal Policy Optimization (PPO) and Twin Delayed Deep Deterministic Policy Gradient (TD3), within a 5G Open RAN (O-RAN)-compliant simulation. The system integrates the Open5GS core network with a Software Radio Systems Radio Access Network (srsRAN) stack, configured as a disaggregated gNodeB (gNB) architecture consisting of an O-RAN Distributed Unit (O-DU) and O-RAN Radio Unit (O-RU). The control plane is managed by the Edge RAN Intelligent Controller (EdgeRIC), and a multi-objective reward function combining throughput and Jain's fairness index is formulated to jointly optimize spectral efficiency and equitable resource distribution. The performance of both DRL algorithms is evaluated against traditional baselines in the O-RAN environment. Results show that TD3 demonstrates faster convergence and outperforms both PPO and rule-based methods in terms of fairness, while PPO achieves higher overall throughput.

## S21: Renewable Energy

***Snow Ablation Optimizer-Based MPPT for PV Systems Under Various Partial Shading Conditions***
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Artificial intelligence (AI)-based maximum power point tracking (MPPT) algorithms play a crucial role in enhancing the efficiency of photovoltaic (PV) systems under partial shading conditions (PSCs). With the increasing variety of AI algorithms available, selecting an effective MPPT solution remains a challenge. This paper proposes a Snow Ablation Optimizer (SAO)-based MPPT algorithm, a novel physics-inspired metaheuristic derived from

the sublimation and melting behavior of snow and evaluates its performance under various PSC scenarios in MATLAB/Simulink. The proposed algorithm is compared against two established techniques-Particle Swarm Optimization (PSO) and Grey Wolf Optimization (GWO)-using two key metrics: success rate (SR) in locating the global maximum power point (GMPP) and convergence speed (CS). The overall performance is assessed using a performance indicator (PI) score that balances both metrics. Results show that PSO achieves the highest PI score of 0.564, followed by GWO at 0.500, while SAO records 0.446. Although SAO ranks third, its potential for improvement remains significant, supporting the No Free Lunch Theorem, which implies that no single optimization algorithm performs best in all scenarios.

***Simulation of Energy Consumption and Solar Generation for Urban Farming via PV Syst Software***

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The study focuses on urban farming is modern agricultural technology utilizing solar energy as the primary source through the PS Syst Software simulation. The main objective of this research is to obtain the Performance Ratio (PR) and system efficiency. The study was conducted at the Main Campus of Universiti Tun Hussein Onn Malaysia (UTHM), Parit Raja, Batu Pahat, Johor, Malaysia. The project uses a one (1) unit of a 405W, 37.85V, and 10.7A solar PV panel. Additionally, two (2) units of 12V 200Ah lead-acid batteries were used. The simulation results show that the system generates 1.3kWh/kWp/day or 520.20kWh/year, with an energy loss of 0.54kWh/kWp/day or 1.89kWh/year, which equates to a 0.9% PV loss due to irradiance levels. The battery efficiency loss is 13.6%. The PR value is 29.4%, and the SF is 99.3%.

***A Hybrid Spiral Sine Cosine Optimized P&O - PI Controller for Enhanced Maximum Power Point Tracking in Photovoltaic System***

Nizaruddin M.Nasir (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Nor Maniha Abdul Ghani (Universiti Malaysia Pahang, Malaysia); Kamal Zuhairi Zamli and Nur Zahirah Mohd Ali (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Meng Chung Tiong (Universiti of Technology Sarawak, Malaysia); Norazila Jaalam (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

This paper presents a novel hybrid optimization technique for enhanced Maximum Power Point Tracking (MPPT) in photovoltaic (PV) systems by implementing a Spiral Sine Cosine Algorithm (SSCA) into the conventional Perturb and Observe (P&O) algorithm with Proportional-Integral (PI) control. The SSCA is employed to simultaneously optimize the PI controller parameter gains and the P&O step size, enhancing dynamic adaptability, minimizing power ripple, and accelerating convergence to the maximum power point (MPP). A scalarized multi-parametric fitness function based on Root Mean Squared Error (RMSE), power ripples, and duty cycle oscillation guides the optimization to ensure both high tracking efficiency and system stability. Simulation results show that under standard test condition irradiance (1000 W/m²), the proposed SSCA-P&O-PI controller achieved the highest average power output (847.00 W), lowest ripple (2.95%), and a low RMSE (32.22 W) with a fast-settling time of 0.025 s. The controller also demonstrated robust performance under lower irradiance of 400 W/m², confirming its reliability under different irradiance levels. These findings validate the SSCA approach as an effective and practical solution for high-efficiency MPPT in dynamic solar environments.

***Machine Learning Approaches for Predicting Solar Power Generation: A Comparative Study***

Nureisya Dania Mohd Zuinuddin, Nur Zahirah Mohd Ali, Muhammad Zulfadhli Mohd Azhar and Wan Syahirah Wan Samsudin (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

Energy comes in various types, renewables and non-renewables. Solar energy is included in renewable energy category as it is always sustainable whenever the sun is available. Radiation from the sun is collected through a solar module and converted to electricity. Nowadays, electricity has become one of important component in human's life as most of the activity required human to turn on the electricity. However, energy is considered as expensive although it is a necessity to human kind. In order to save energy and cut cost, produced electricity and demanded electricity must be balance and enough for any future demand. Predicting electricity is essential for any future grids. This paper shows the comparison of using two machine learning algorithm, Decision Tree and Random Forest to predict the generated power from a solar energy power grid for commercial uses. The result shows that both algorithms have high accuracy but the error for random forest is slightly better than error for decision tree.

***Optimization of Fuzzy Logic MPPT Controllers Using a Hybrid Spiral Sine Cosine Algorithm for Photovoltaic Systems***

Nizaruddin M.Nasir (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia); Nor Maniha Abdul Ghani (Universiti Malaysia Pahang, Malaysia); Nur Zahirah Mohd Ali, Suliana Ab Ghani and Nur Huda Ramlan (Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

This paper proposes a hybrid Fuzzy Logic Controller (FLC) designed using the Spiral Sine Cosine Algorithm (SSCA) for Maximum Power Point Tracking (MPPT) in photovoltaic (PV) systems with variable irradiation circumstances. Conventional MPPT approaches, such as Perturb and Observe (P&O) and Incremental Conductance (InC), are frequently utilized but have limitations due to oscillatory behaviour and decreased accuracy during dynamic irradiance changes. To improve MPPT performance, the proposed technique optimizes four important fuzzy scaling gains: two input gains for voltage (ΔV) and power (ΔP) and two output gains control. SSCA, a hybrid metaheuristic algorithm that combines spiral dynamics and sine-cosine techniques, was used to produce rapid convergence and efficient parameter adjustment. The approach was tested at irradiance levels of 1000, 800, and 400 W/m². At 1000 W/m², the SSCA-based FLC had the lowest RMSE of 18.89, power ripple of 1.39%, and average output power of 845.10 watts. In comparison, PSO had an RMSE of 19.03, whereas CSA had 57.98. The SSCA also had the quickest settling time during high irradiance, at 4.6 ms, compared to 5.0 ms for PSO and 27.2 ms for CSA. These findings show that the suggested SSCA-FLC approach improves MPPT efficiency, lowers power oscillations, and enables faster dynamic reaction under varying environmental circumstances.

***ML-Based Refrigerator Scheduling for Energy Efficiency in Renewable-Integrated Smart Homes***

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Global energy demand has surged due to rapid population growth and economic expansion, which has prompted a worldwide focus on the need to promote energy efficiency and transition to sustainable energy sources. Innovative approaches that integrate renewable resources and balance energy usage are needed to address these issues, guaranteeing sustainability without compromising operational performance. This study introduces a machine learning (ML) framework to optimize refrigerator operations in smart homes, maximizing renewable energy use and minimizing dependence on the main grid. The system combines forecasting solar energy generation and fridge energy prediction to adjust the device's internal temperature, which prioritizes solar power and stored battery energy to maintain efficiency. Demonstrating its potential for sustainable household energy management, the approach reduces daily energy consumption from the main grid by approximately 79.5% in tropical regions of Southeast and Western Asia.

***Optimization of Solar Photovoltaic with Storage Utilization Using Lithium-Ion and Lead-Acid Batteries***

Mohd Amran Mohd Radzi (Universiti Putra Malaysia, Malaysia)

This paper aims to propose the best combination through optimization of solar photovoltaic (PV) system with energy storage utilization. Two types of energy storage selected for the study are lead-acid and lithium-ion batteries. By using HOMER Pro simulation tool, the system will be compared to determine the best results between both batteries. The work covered one of the key buildings in Faculty of Engineering, Universiti Putra Malaysia to represent critical electrical operation of the higher learning institution. The simulation by implementing both types of batteries depends on the prices of components and their capacity. The optimization will cover total net present cost (TNPC) and cost of energy (COE), which are the key points in identifying the best proposed model. This analysis facilitates the evaluation of feasible and optimal configurations for the proposed system. The findings show the optimization of solar energy using a PV/lithium-ion battery system shows the lowest TNPC and COE, compared to using lead-acid batteries.

***Analysis of Installation Factors Affecting the Performance of PV Systems in Malaysia***

Xiaoqing Zhu (Institute for Advanced Studies, University of Malaya); Jeyraj Selvaraj (UM Power Energy Dedicated Advanced Centre (UMPEDAC), University of Malaya); Ruochen Zu (Institute for Advanced Studies, University of Malaya)

In Malaysia, solar power technology is quickly advancing, and investors are interested in establishing solar power plant. With the support of Renewable Energy Act, NEM (Net Energy Metering), and MyRER (Malaysia Renewable Energy Roadmap), NREPAP (National Renewable Energy Policy) target implemented by the state, the deployment of photovoltaic systems has accelerated in recent years. but selecting the most suitable PV installation configuration across diverse climate regions remains a critical challenge for large-scale installations. Using PVsyst simulation

tool, we modeled 96 system configurations and analyzed performance ratio (PR) and energy yield per unit (SEY) key indicators. The results show that PV technology, sites, and inverter type significantly affected system performance, with capacity having minimal influence. Based on these factors, the study identified an optimal system configuration in Malaysia.

## S22: Power Systems and Smart Grids, & Electronic Systems on Chip and Embedded Control

***Optimized Unified Power Quality Conditioner for Nonlinear Load Connected Microgrid Using Artificial Rabbit Search Optimization***

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Modern microgrids are required to maintain power quality standards; however, this becomes highly challenging when a non-linear load is connected to the system. To address these challenges, the unified power quality conditioner (UPQC) has become a prominent solution due to its versatile capability to handle various power quality issues. Moreover, the performance of the UPQC heavily depends on the optimal tuning of its controller parameters. In this research, the artificial rabbit search optimization (ARSO) technique is employed to determine optimal controller parameters for a multilevel UPQC-based microgrid system. Major power quality issues were simulated using MATLAB/Simulink, and the system's performance was verified under voltage sag and swell conditions. The proposed approach successfully mitigated these voltage disturbances while maintaining a THD of only 1.10%, thereby meeting the IEEE 519-2014 standard. Furthermore, a comparative analysis with other optimization techniques shows that ARSO outperforms them in terms of THD, highlighting the potential of this work in achieving more efficient and reliable microgrids.

***Optimization of Load Frequency Control for a Multi-Area Power System Based on Bio-Inspired Metaheuristic Algorithms***

Hazlee Azil Illias, Li Yang Lee and Hazlie Mokhlis (University of Malaya, Malaysia)

Load Frequency Control (LFC) is vital for maintaining stability in interconnected power grids by managing frequency variations and regulating power transfers. In this work, bio-inspired metaheuristic algorithms, Jellyfish Search Optimization (JSO) and Whale Optimization Algorithm (WOA) were employed to optimize the performance of LFC for two-area power system by tuning the PID controller parameters. The results demonstrate a significant LFC performance improvement compared to without using the optimization algorithms. JSO and WOA managed to reduce the settling time of the LFC response by more than 90% compared to the unoptimized system and more than 60% compared to Ziegler-Nichols tuning. The overshoot was reduced by 84.0% and the integral time absolute error (ITAE) was decreased by 98.1% compared to the unoptimized system. Thus, this demonstrates that JSO and WOA managed to improve the performance of LFC for two-area power system significantly by tuning the PID controller parameters.

***Scalable Optimization of BESS Integration in Transmission Networks Using IICSEP: A Case Study on Large-Scale Systems***

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The rapid expansion of large-scale power systems and the integration of renewable energy sources have increased the need for advanced energy storage solutions to enhance grid efficiency and stability. Modern transmission networks have a major challenge in minimizing power losses while ensuring consistent performance under different load conditions. This paper presents a scalable optimization approach for the strategic positioning and size of Battery Energy Storage Systems (BESS) in a large transmission network using a newly proposed optimization technique termed Integrated Immune Chaotic Squirrel Evolutionary Programming (IICSEP). IICSEP increases search efficiency and optimization accuracy by embedding the elements of chaotic, cloning, and squirrel search mutation technique into traditional evolutionary programming. Validation was conducted on the IEEE 118-Bus Reliability Test System (RTS) in the effort to realize the performance of the proposed IICSEP technique. Results demonstrate that the IICSEP technique consistently reduced power loss by approximately 15% across various system conditions. These findings highlight the capability of IICSEP to provide an effective and adaptable solution

for optimizing BESS deployment in large-scale power grids, contributing to enhanced system performance and supporting the transition towards energy-efficient transmission infrastructures. A limitation of this study is that dynamic operational constraints such as frequency response and state-of-charge degradation of BESS were not considered, which may affect the real-world performance of the proposed solution.

***Enhancing Inverter Synchronization: a Resilient Static Solution for Adverse Grid Environments***

Chang-Yi Chou (National Sun Yat-sen University, Taiwan); Mohammed Ansar Mohammed Manaz (National Sun Yat-Sen University, Taiwan)

Accurate and robust synchronization is crucial for grid-connected power converters, especially under dynamic or distorted grid conditions. Conventional methods such as the synchronous reference frame phase-locked loop (SRF-PLL) and dual second order generalized integrator PLL (DSOGI-PLL) provide effective performance under normal conditions but often struggle during grid disturbances such as phase jumps and frequency drops. This paper proposes a novel synchronization method called DSOGI-SS, which integrates the DSOGI with a static-synchronizer (SS) to eliminate the need for a PLL. The SS method generates synchronized sine and cosine signals through algebraic equations on instantaneous three-phase voltage measurements, avoiding the introduction of dynamic state estimation and sine function generators. A detailed stability analysis is performed, and the frequency characteristics of DSOGI-PLL and DSOGI-SS are compared. Furthermore, time-domain simulations under phase jump and frequency variation scenarios are conducted in the PLECS environment to validate the performance of the proposed method. The results indicate that DSOGI-SS exhibits improved high-frequency response characteristics and significantly faster synchronization during transient events, making it as a promising solution for inverter control in modern power systems.

***Applying the NIST Statistical Test Suite to a TRNG of an Open-Source RISC-V Sub-System for PQC-Aware Industrial SoCs***

Armando Astarloa (University of the Basque Country (UPV/EHU), Spain); Edurne Primicia, Alejandro Arteaga, Leire Muguira and Sara Alonso (University of the Basque Country, Spain)

Industrial applications can benefit from next-generation Post-Quantum Cybersecurity (PQC) and Open ISA CPU architectures like RISC-V. However, the sector demands an analysis of the application of these innovations in the context of industrial standards and networking protocols. This work reviews how PQC can be applied to new-generation OT/IT (Operational Technology/Information Technology) Industrial Networking protocols and be integrated into a custom RISC-V CPU device with a Dilithium-IP crypto-core. Specifically, the results of the randomness testing of the entropy source of the True Random Number Generator (TRNG) embedded in the CPU are presented. For this purpose, NIST SP 800-22 Rev 1.a and NIST SP 800-90B have been used. The results of these two tests suggest that the random numbers generated in the TRNG of the selected NEORV32 microprocessor are inadequate to implement PQC, and future work should focus on developing a new TRNG.

***Modified March C- Algorithm for STT-MRAM Testing***

Jun Jia, Guilin Zhao and Chao Wang (China Electronics Technology Group Corporation No. 58 Research Institute)

Spin Transfer Torque Magnetic Random Access Memory (STT-MRAM) is one of the most promising emerging memory technologies due to its advantages of non-volatility, fast access speed, high durability, and near-zero leakage power consumption. The incidence of single-cell faults in STT-MRAM is higher than that in SRAM. The Memory Built-In Self-Test (MBIST) circuit based on the March algorithms is a widely employed memory testing methodology in the industry. However, the traditional March algorithms exhibit low fault coverage for STT-MRAM. In this paper, a new algorithm extension, based on the traditional March C- algorithm, can cover all single-cell faults that may occur in the STT-MRAM cells. And it also maintains a high coverage for coupling faults. The new algorithm is more suitable for STT-MRAM.

***Prediction of IGBT Peak Junction Temperature Using Hybrid Voting-Based Ensemble Model***

Swaraj Umesh Jagade and Mohana Sundaram Muthuvalu (Universiti Teknologi PETRONAS, Malaysia); Andrei C. Ribeiro (State University of Campinas, Brazil); M Sambath (Periyar University, India)

The reliability and operational life of power semiconductor devices, such as Insulated Gate Bipolar Transistors (IGBTs), are highly dependent on the peak junction temperature and its fluctuation, which contribute to thermal stress and degradation. Accurate prediction of junction temperature is therefore essential for developing effective thermal management strategies. This paper proposes a hybrid ensemble learning approach that combines classification and regression models through a soft voting mechanism, integrating Random Forest (RF) and Extreme Gradient Boosting (XGBoost) to enhance predictive performance. The model utilises key operational

parameters including switching frequency, ambient temperature, global horizontal irradiance and fluctuation of junction temperature to capture complex nonlinear dependencies. Simulation evaluations show that the hybrid model achieves a classification accuracy of 99%, a regression R-squared value of 0.9939, a Mean Squared Error (MSE) of 3.5877, and a Mean Absolute Error (MAE) of 0.6928. These results demonstrate superior performance compared to individual models, highlighting improved generalisation and robustness. The proposed method provides an effective solution for precise thermal modelling of IGBTs and offers scalable potential for broader applications in semiconductor reliability and predictive maintenance.

## S23: Control Systems, Robotics and Mechatronics, Industrial Electronics and Applications, Cloud Computing, Big Data and Software Engineering

***Reconstruction of a Nonlinear Dynamical Model for Floating Offshore Wind Turbines***

Masayoshi Toda (Tokyo University of Marine Science and Technology, Japan)

This paper addresses a reconstruction methodology of a nonlinear dynamical model for floating offshore wind turbines from a linear-time-invariant (LTI) model, which has been obtained in advance in some manner. In particular, the paper considers an LTI model which was experimentally built by using a scale model to capture the dynamics of the rotor speed and platform pitching to the wind speed and rotor blade pitching angle variation, which is the most important to develop the control system. We present three methods to reconstruct a nonlinear model that replicates more accurately the behavior of the original system than the LTI one. Model evaluations on the three nonlinear models show that one of which is considerably reasonable because the model reveals more natural behaviors as physical phenomena than the LTI one while maintaining the basic properties of the LTI one. Further, using the nonlinear model, we demonstrate a control design based on linear-quadratic (LQ) servo control to regulate the rotor speed while suppressing the platform pitching via blade pitch control. Simulation results suggest that the LQ-servo-based approach can be a promising candidate for the blade pitch control system.

***Path Planning of Unmanned Surface Vehicle for Water Waste Collection***

Nur Arfa Aqilah Abdullah (Universiti Teknologi PETRONAS, Malaysia); Illani Mohd Nawi (Universiti Teknologi Petronas, Malaysia)

This paper presents the development of an autonomous Unmanned Surface Vehicle (USV) designed for efficient collection and management of floating debris in riverine environments. Conventional waste collection approaches-such as manual retrieval and fixed barriers-are often hindered by labor intensity, inefficiency, and limited operational coverage. To address these challenges, the proposed system integrates autonomous navigation capabilities via an optimized path planning algorithm and a remote waste detection mechanism powered by the YOLOv8 object detection model. The USV autonomously navigates aquatic environments, detects and classifies surface-floating debris into recyclable and non-recyclable categories, and sorts them into dedicated compartments using an onboard separation mechanism. Field testing confirmed the system's reliability, scalability, and potential for enhancing waterway cleanliness. The modular design of the system allows for easy integration of future features such as return to- base functionality and obstacle avoidance using LiDAR and ultrasonic sensors. This adaptability makes the system suitable for deployment in various stagnant water environments beyond Malaysia. This work contributes to the advancement of intelligent, low-cost, and autonomous waste collection solutions, supporting broader goals in environmental sustainability. Index Terms-Autonomous navigation, Unmanned Surface Vehicle (USV), waste management, YOLOv8, object detection, path planning, environmental sustainability.

***Centralized Protection and Control (CPC): Smart Solutions for Digital Protection System***

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As power electronics systems evolve in complexity and scale, there is a growing demand for intelligent protection architectures that align with the principles of digitalization and advanced control. Centralized Protection and Control (CPC) systems emerge as a transformative approach, replacing conventional relay-based schemes with software-defined, centralized platforms. This paper examines the role of CPC in modern power electronic environments, focusing on its integration with digital substation architectures and smart grid technologies and the proven case of its implementation in industry. Key benefits of CPC are include reduced hardware footprint, enhanced system visibility, cyber-resilient architecture, and scalable automation. Challenges such as IEC 61850 interoperability, online calibration, and data-driven validation are also addressed. The findings support CPC as a critical enabler for the next generation of digitalized power electronics systems, advancing both reliability and

operational efficiency in future-ready substations. The paper is written based on IEEE Paper on CPC and testing conducted on CPC units for its performance capability demonstrates CPC's potential to replace existing relay technologies, paving the way for a more resilient and adaptive design towards industry shaping.

***Primary Water Plant Nuclear Reactor Prediction Modeling Using CNN Forward-Fill and Forward-Backward Fill Imputation Method***

Intan Nabina Azmi and Murizah Kassim (Universiti Teknologi MARA, Malaysia); Mohd Sabri Minhat (MALAYSIAN NUCLEAR AGENCY, Malaysia); Wan Fairos Wan Yaacob (Universiti Teknologi MARA Cawangan Kelantan, Malaysia); Ibnu Hajar (Universiti Teknologi MARA, Malaysia & Institut Teknologi Perusahaan Listrik Negara, Malaysia)

Nuclear reactors in primary water plants require precise monitoring of operational parameters to ensure safety and efficiency. However, missing or incomplete data from sensor failures or communication disruptions poses a challenge for predictive modeling. This study presents a comparative analysis of the performance of Convolutional Neural Networks (CNNs) using two data imputation methods: forward-fill (ffill) and forward-backward fill (fbfill). The CNN model was evaluated on two operational periods which is February-March-April (FMA) and October-November-December (OND). The measure of error metrics was analyzed for Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and Symmetric Mean Absolute Percentage Error (SMAPE). The results show that FFill consistently outperforms FBFill for the prediction error. The analysis has presented that the lower error values across several performance evaluations, including MSE is 2.4391, RMSE is at 1.5618, and MAPE is at 19.10%. These findings suggest that FFill yields more accurate predictions, particularly when comparing the error metrics between the two imputation methods. The findings also highlight the effectiveness of the proposed technique in improving predictive modeling for nuclear reactor operations, contributing to more accurate forecasting and safer energy production.

***Model Prediction Direct Torque Control for Permanent Magnet Synchronous Generator Using Five-Level Vienna Rectifier***

Bryan Tan and Sook Yee Yip (Tunku Abdul Rahman University of Management and Technology, Malaysia); Thien Yee Von (Tunku Abdul Rahman University of Management and Technology (TAR UMT), Malaysia); Kah Haur Yiauw (Tunku Abdul Rahman University College, Malaysia); Wong Jee Keen Raymond (University of Malaya, Malaysia)

This project outlines the design and performance evaluation of a Permanent Magnet Synchronous Generator (PMSG) with a five-level Vienna rectifier (5L-VR) based on Model Predictive Direct Torque Control (MPDTC) strategy. The stator voltage model was created to facilitate a detailed analysis of how the 5L-VR switching vectors influence direct torque control performance. The proposed control strategy was validated using MATLAB/Simulink, proving that the tailored MPDTC manages precise torque and speed control across various reference speeds with small errors under low total harmonic distortion. These results confirm the proposed MPDTC strategy's suitability under high- and low-speed scenario, enhancing PMSG performance in wind energy systems and offering valuable insights for real-world applications.

***YOLOv11-Based Threat Detection and Zigbee-Enabled Energy Management for Smart Home Automation***

Syed Farid Syed Adnan (Universiti Teknologi MARA, Malaysia)

This paper presents an advanced Smart Home System that integrates YOLOv11-based threat detection with Zigbee-enabled energy management for enhanced security and efficiency. Traditional smart home systems often suffer from inefficient energy management and unreliable security measures, leading to higher costs and potential vulnerabilities. To address these issues, YOLOv11 enables real-time, high-accuracy threat detection, ensuring proactive security monitoring with minimal false alarms. Zigbee-based communication facilitates low-power connectivity, allowing real-time energy consumption monitoring and automation, such as turning off lights in vacant spaces, promoting sustainability and reducing energy expenses. Furthermore, YOLOv11 utilizes advanced image preprocessing techniques, including normalization and contrast adjustments, to enhance detection accuracy across varying lighting conditions, ensuring reliable threat identification even in low-light environments. The system delivers low-latency operation, achieves 90% accuracy in bright light condition, with threat detection and access control response times of less than two seconds. A centralized controller seamlessly integrates security and energy management, maintaining high performance in diverse environments. With its scalable and intuitive design, this smart home solution represents a step forward in intelligent automation, offering improved safety, energy efficiency, and user convenience.

## S24: Power Electronics 2, Electrical Machines and Drives, Engineering Education

***Wireless EV Charging Efficiency Under Coil Misalignment: Quantitative Analysis and Optimization Using Resonant Inductive Power Transfer***

Rahimi Baharom, Wan Muhamad Hakimi Wan Bunyamin, Wan Noraishah Wan Abdul Munim, Norazlan Hashim and Khairul Safuan Muhammad (Universiti Teknologi MARA, Malaysia)

This paper presents a comprehensive analysis and optimization of the impact of coil misalignment on the efficiency of Wireless Power Transfer (WPT) systems, with a focus on electric vehicle (EV) charging applications. Misalignment between transmitter and receiver coils significantly reduces magnetic coupling, leading to efficiency degradation, which remains a major challenge in WPT deployment. To address this, the study employs Resonant Inductive Power Transfer (RIPT) technology, leveraging magnetic resonance to enhance energy transfer across an air gap. A circular coil design with 30 turns and a 20 mm air gap is used as the test model. Quantitative analysis is conducted using electromagnetic simulations in CST Studio Suite, evaluating efficiency variations under misalignment conditions ranging from 0 mm to 30 mm in precise increments. Three coil configurations are analyzed: (i) without ferrite, (ii) with ferrite, and (iii) with ferrite and casing. Simulation results reveal that incorporating ferrite materials significantly improves magnetic coupling, reducing leakage flux and mitigating misalignment-induced efficiency losses. Further enhancements with protective casing provide additional shielding and robustness, leading to superior efficiency retention under misalignment conditions. The optimized design achieves compliance with SAE J2954 standards for EV wireless charging, demonstrating its practical viability. These findings provide critical insights for designing high-efficiency WPT systems, optimizing coil configurations, and ensuring reliable wireless charging solutions for electric mobility. This work contributes to advancing sustainable power technologies by improving WPT efficiency, reliability, and real-world applicability in dynamic EV charging scenarios.

***Performance Evaluation of a Fault-Tolerant Bridgeless Boost Rectifier for Universal AC Voltage Levels and Non-Linear Load Conditions***

Khairul Safuan Muhammad, Muhamad Akram Mohamed Sany, Wan Noraishah Wan Abdul Munim, Rahimi Baharom and Norazlan Hashim (Universiti Teknologi MARA, Malaysia)

This paper presents the performance evaluation of a Fault-Tolerant Bridgeless Boost Rectifier (FTBBR) system based on a fault-tolerant topology introduced in previous research. The project begins by simulating the FTBBR under two input supply conditions, 156 V and 325 V peak, representing standard voltages used in different countries. The controller parameters are tuned to ensure stable operation under both supply levels. The system is then used to supply a buck converter to assess its performance under non-linear load condition. To further evaluate system robustness, the buck converter is subsequently replaced with a separately excited DC motor drive to simulate dynamic load disturbances. Simulations were conducted using PSIM software. The results show that the FTBBR maintains a stable output voltage, achieves Total Harmonic Distortion (THD) of the input current below 5% as defined by IEEE 519, and delivers high efficiency across all scenarios. These findings confirm the system's power quality compliance and suitability for global deployment.

***Current and Voltage Limits in Symmetrical Six-Phase Induction Machine Under One Open Circuit Fault***

Wan Noraishah Wan Abdul Munim, Nur Suhailah, Nooradzianie Muhammad Zin, Rahimi Baharom, Khairul Safuan Muhammad and Norazlan Hashim (Universiti Teknologi MARA, Malaysia)

This paper analyses the post-fault performance of symmetrical six-phase induction machine (S6-IM), considering both current and voltage limits during healthy and faulty operations. The study focuses on one open-circuit fault (1 OCF) scenario under single-isolated neutral and two-isolated neutral configurations. The line voltages depend on machine parameters and operating points, which are determined by synchronous speed (ws) and slip speed (wslip). The relationship between line voltage and current limit is represented using K coefficients, which help limit the mutual interference between current and voltage. Simulation results indicate that, under 1 OCF, the current limit becomes the main constraint because the healthy phases carry higher currents to compensate for the lost phase. This leads to current saturation and thermal stress being reached earlier than the voltage limit, as confirmed by the results where current reaches its threshold before the line voltage limit of 1 p.u. (1N) or 0.866 p.u. (2N). This highlights the critical need for an optimal post-fault control strategy for current and voltage limits to maximise torque and efficiency, particularly in applications such as electric vehicles and renewable energy systems. Future research will focus on developing a Full-Range Minimum Losses (FRML) approach that combines the strengths of the Maximum Torque (MT) and Minimum Loss (ML) strategies, aiming to enhance the real-world performance of fault-tolerant six-phase machines.

***Flying Start with ANN-Based Precise Position Compensation in Flux-Weakening Region***

Yoon-Seong Lee (Hyundai Kefico, Korea (South) & Hyundai Kefico, Korea (South)); Ki-Wang Kim, Sung-Jin Park, Chae-Eun Lee, Min-Hyo Kim and Jun-Hyung Kim (Hyundai Kefico, Korea (South))

A flying start using the DC current of a three-phase diode rectifier enables rotor position estimation in flux weakening region through four procedures: integration, initialization, scaling, and compensation. The compensation step, which offsets the position error between the rising point of a-phase current and the back electro motive force(EMF), requires different values depending on the current mode of the three-phase diode. Therefore, proper compensation for each mode is essential for accurate position estimation. This paper, prior to applying appropriate compensation based on the mode, processes the phase current to calculate the number of conducting diodes according to the mode. Using this as training data, artificial neural network(ANN) is employed to determine the mode, and the estimated phase is compensated using different formulas depending on the mode. The proposed accurate mode identification and compensation strategy improve the position estimation accuracy of the flying start. The consistency of the proposed method has been validated through simulation results.

***Teaching Experience Based on Study of Motor Speed Control Using PI and Neural Network Controllers***

Shamsul Aizam Zulkifli (UTHM, Malaysia & Universiti Tun Hussein Onn Malaysia, Malaysia); Syazmie Sepeeh (MAHSA University, Malaysia)

The experiments are focused on experience studies on the AC and DC motor speed controllers through digitalized method with Proportional-Integral (PI) and Neural Network (NN) using a low-cost microcontroller. This project employs software simulation and hardware integration, where the NN controller is trained inside the speed PI controller for AC speed control, in order for having faster response times by using STM32F401RE microcontroller. Meanwhile, for the DC motor speed control, the PI controller is embedded in the DC converter with Arduino Mega 2560 for self-automated speed control operations. All tests have been shown the speed effectiveness, where firstly with the NN controller training in achieving stable speed control at 1250rpm at reference speed. As for DC motor control, it is by implementing with the closed-loop control system, where the output speed is closely tracked the reference speeds and the actual speed with minimal error. These studied concluded that the students have gain the experiences in integrating several subjects in his program in order to be implemented in this project. At the end, the experiences also suggested to use low-cost and low power microcontrollers in accurate speed control circuits for a beginner and applied in the university level.

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