2025 Fourth International Symposium on Instrumentation, Control, Artificial Intelligence, and Robotics (ICA-SYMP 2025)

Bangkok, Thailand
15-17 January 2025

IEEE

IEEE Catalog Number: CFP25R12-POD
ISBN: 979-8-3315-0541-7

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP25R12-POD
ISBN (Print-On-Demand):	979-8-3315-0541-7
ISBN (Online):	979-8-3315-0540-0

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

Wednesday, January 15

Wednesday, January 15 13:30 - 14:50

WP-1: Image Processing, Computer Vision, and Artificial Intelligence

Chairs: Wittaya Koodtalang (King Mongkut's University of Technology North Bangkok & Faculty of Engineering, Thailand), Somying Thainimit (Kasetsart University, Thailand)

WP-1.1 13:30 ***Efficiency Evaluation of a Combining Compact 1D CNN and Signal Filtering Prototype Algorithm for Vibration Signal Classification.....1***

Thosapon Krinsukont and Taweedej Sirithanapipat (Kasetsart University, Thailand)

This paper presents an experiment and results of the modified CNN algorithm, it was developed by combining a compact 1D convolution neural network with a tuned signal filter (low-pass filter in this experiment). The algorithm was specifically designed for signal shape detection, prediction, and classification. An experiment aimed to evaluate the created algorithm's structure and signal filter to ensure its suitability for vibration signal data analysis. A testbed was built using an inverter motor equipped with various unbalanced conditions by increasing screws. Four-class unbalanced conditions were studied compared with the normal condition. Each conditions produced the distinct signal shape, with slight differences, making them suitable for evaluating the proposed algorithm's performance. The results demonstrate the satisfied performance of the algorithm, which effectively classifies vibration signals unbalance-3 (precision 54%), unbalance-4 (Precision 77%) and a group of normal, unbalance-1, and unbalance-2. The group of normal, unbalance-1, and unbalance-2 can't be easily classified due to the tiny differences in the signal shapes, caused by small mass variations of the unbalanced screw unbalance-1, and unbalance-2. In conclusion, the algorithm proved satisfied effectiveness for its intended purpose of vibration signal classification.

WP-1.2 13:50 ***Accessible AI Wearables Device for Visual Impairment in Low-Income Communities.....5***

Kanjanapan Sukvichai, Noppanut Thongton and Tanapon Kitmut (Kasetsart University, Thailand)

Visual impairment represents a critical challenge for low-income communities in developing countries. Despite their essential contributions to national development, these populations often struggle to access affordable assistive devices, which tend to be prohibitively expensive. In partnership with ophthalmologists from Siriraj Hospital in Bangkok, Thailand. This research presents a modular, customizable, 3D-printed head-mounted visual aid device that utilizes a standard smartphone for processing and display. By integrating advanced image processing algorithms and artificial intelligence, it meets the specific requirements set by the ophthalmologists. This comprehensive system encompasses both software and hardware components, making it versatile and user-friendly. Our study emphasizes the engineering design of the device and includes an evaluation of user satisfaction among patients and medical professionals. Preliminary findings indicate high user satisfaction and confirm that the device fulfills essential medical requirements, marking a significant advancement in addressing visual impairment in underserved communities.

WP-1.3 14:10 ***A Vision Transformer Based Framework with Multi-Level Thresholding for Better Ovarian Cancer Classification.....N/A***

Nivedhitha Mahendran (SRM University, India); Durai Raj Vincent PM and Vanmathi C (Vellore Institute of Technology, India)

Ovarian cancer, commonly called as the "silent killer", due to its vague or mistaken symptoms. It mainly begins from the ovaries of the female reproductive system, which is responsible for production of progesterone, oestrogen, and eggs. As it remains undetected until it has metastasized, it is critical to identify the cancer at an early stage. Thus, we have implemented a deep learning-based framework, which implements Vision Transformer (ViT), an encoder decoder-based architecture. Further, we have implemented a multi-level thresholding technique called the Otsu's thresholding.

The thresholding approach divides the background and foreground of the images for better understanding of the area of interest. The aim of this study is to analyse and compare the results of ViT model on the Ovarian dataset with the ViT model implemented with the segmented images through Otsu's Mullti-level thresholding approach. The results show that the ViT model shows significantly better performance with the images after the thresholding.

WP-1.4 14:30 ***Advanced Neural Networks for Plant Leaf Disease Diagnosis and Classification.....9***

Md. Tanvir Rahman and Durjoy Roy Dipto (American International University-Bangladesh, Bangladesh); Sowrov Komar Shib (American International University- Bangladesh, Bangladesh); Abu Shufian (American International University-Bangladesh, Bangladesh); MD Sajid Hossain (American International University Bangladesh, Bangladesh)

Plant diseases can severely impact crop quality and yield, making early detection essential for safeguarding public health and ensuring agricultural productivity. Traditional manual inspection methods are inefficient for large scale farming and prone to human error. This research introduces a Convolutional Neural Network (CNN) model for automating plant disease diagnosis using leaf images. The model employs advanced architectures such as EfficientNet, ResNet, and Inception, utilizing transfer learning to enhance performance even with smaller datasets, thereby reducing the need for extensive labeled data. Integrating deep learning with machine vision enables real-time monitoring and provides farmers with actionable insights for timely intervention. With an overall accuracy of 97%, the model achieved precision rates of 95.39% for Healthy, 98.89% for Rust-Affected, and 97.06% for Scab-Affected leaves, along with recall rates between 96.49% and 98.33%. These results highlight the potential of deep learning systems in improving plant disease detection accuracy, reducing chemical treatments, and promoting sustainable agricultural practices.

Wednesday, January 15 15:15 - 15:35

WP-2: Control Theory

Chairs: David Banjerdpongchai (Chulalongkorn University, Thailand), Satit Mangkalajan (KMUTNB, Thailand)

WP-2.1 15:15 ***Intelligent Nonsingular Terminal Sliding Mode Control of DC-DC Buck Converter.....N/A***

Juntao Fei and Xiaoyu Gong (Hohai University, China)

In this paper, a nonsingular fast terminal sliding mode control (NFTSMC) with a self-organizing Chebyshev fuzzy neural network (SOCFNN) is designed to obtain voltage tracking control of a DC-DC buck converter. The NFTSMC can ensure the finite-time convergence property of the voltage tracking error and avoid the singularity problem. To compensate and alleviate the effects of the system uncertainty, the SOCFNN with structure learning mechanism is utilized to estimate the nonlinear function in the system. Experimental comparisons illustrate that the proposed control method presents higher voltage tracking accuracy and faster dynamic response.

Thursday, January 16

Thursday, January 16 8:30 - 9:50

TA-1: Automation and Control Applications

Chairs: Thaksin Sangsuwan (KMUTNB, Thailand), Witthawas Pongyart (King Mongkut's University of Technology North Bangkok, Thailand)

TA-1.1 8:30 ***Interplay Between Node and Edge Laplacians Through Spectral Analysis of Redefined `Degree and***

Adjacency' Matrices of Digraphs.....15

Avinash Kumar Dubey and Dwaipayan Mukherjee (Indian Institute of Technology Bombay, India)

This work seeks to interconnect the well-known concept of the graph Laplacian with its edge counterpart, the Edge Laplacian with respect to a new and updated definition of edge-degree and edge-adjacency matrix. It focuses on establishing spectral connections not only between these two Laplacians but also between their components, namely the degree matrices and the adjacency matrices. To achieve this interconnection, the edge degree and adjacency matrix have been redefined to not only offer a graph-theoretic interpretation of edge-based analysis but also uniquely link the corresponding edge and adjacency matrices through eigenvalue-based analysis.

TA-1.2 8:50 ***Development of a Low-Cost Force Control System for a Cable-Driven Parallel Robot.....19***

Jan-Hendrik Meusener, Kevin Kollek, Jan-Christoph Krabbe and Anton Kummert (University of Wuppertal, Germany)

This paper presents a low-cost force control system for a cable-driven parallel robot. Cable-driven parallel robots offer significant advantages regarding workspace size, flexibility, cost and safety compared to the more common robotic arms. These characteristics make them a suitable candidate for educational and domestic use, however, the choice of models even for industrial purposes is very limited to nonexistent. This work is one key step in the development process of a low-cost cable-driven parallel robot, that is intended to be build and operated by non experts. A critical requirement for cable-driven robots is maintaining proper cable tension to prevent the cables from slipping off sheaves or other guiding structures, which can lead to tangling and system failure. Traditionally, this is achieved using expensive sensors and high-speed control systems, making these robots prohibitively expensive for educational and domestic applications. The work presented in this paper addresses this issue by utilizing low-cost sensors and microcontrollers in a way which overcomes the individual sensors limitations in accuracy or sampling rate. The proposed force control strategy is designed to work within the constraints of these affordable components, ensuring that the target force is consistently achieved, even during robot movement.

TA-1.3 9:10 ***Developing Efficient Temperature Control for HERMS: A Study on P, P-Logic, PI, and PID Controllers.....23***

Sungwan Boksuwan (King Mongkut's Institute of Technology Ladkrabang, Thailand)

The Heat Exchange Recirculating Mash System (HERMS) is widely used in craft brewing to maintain precise temperature control during the mashing process, which is crucial for achieving optimal sugar extraction and mash efficiency. This study investigates the performance of four different temperature control strategies-P, P-logic, PI, and PID-in maintaining the desired mash temperature profile. The system was modeled using both First-Order Plus Delay (FOPD) and Second-Order Plus Delay (SOPD) models to optimize controller gains through Skogestad's method. Validation of the control strategies was conducted through simulations in MATLAB Simulink. The results showed that while P-logic control maintained stable temperature with 0% overshoot, PI and PID controllers achieved the same with only 30% input energy, compared to 100% used by P-logic. A real-world mashing is conducted with P-logic control. Wort quality was also assessed, with specific gravity, pH, and mash efficiency analyzed. This study highlights the trade-offs between control precision and energy consumption, providing valuable insights for improving HERMS system efficiency in both homebrewing and commercial applications.

TA-1.4 9:30 ***A Semi-Supervised Learning Approach for Detecting, Classifying and Counting Blood Cells Using Attention Modules Based YOLOv8.....N/A***

Thinh Nguyen-Quang and Viet Dung Nguyen (Hanoi University of Science and Technology, Vietnam)

A complete blood count (CBC) is a standard blood test that plays an important role in regular checkups and clinical medical diagnoses. Complete blood counts can help identify infections, anemia, immune system problems, and blood cancers. The conventional technique of manually counting blood cells by an experienced specialist using

a hemocytometer is an exceedingly tedious, time-consuming, and imprecise task with a substantial risk of error. Machine learning-based and deep learning-based methods have gained prominence in recent years to overcome the limitations of manual blood cell counts. In this research, we present a semi-supervised learning approach for automatically identifying seven types of blood cells using an improved YOLOv8 algorithm with attention mechanisms such as Convolutional Block Attention Module (CBAM), Efficient Channel Attention (ECA), Shuffle Attention (SA), Global Attention Mechanism (GAM). The experimental results indicate that the blood cell detection method proposed in this paper is feasible and can promote the development of smart, reliable automated blood cell counting, in which integrated ResCBAM YOLOv8 (CBAM attention block with residual structure) can achieve the best possible recognition accuracy of red blood cells (RBCs), platelets, and five types of white blood cells (WBCs) including neutrophils, monocytes, lymphocytes, eosi00%, 97.7%, and 100% respectively.

Thursday, January 16 8:30 - 9:30

TA-2: Power Control and Energy Systems

Chairs: Chakrit Panpean (King Mongkut's University of Technology North Bangkok, Thailand), Teratam Bunyagul (King Mongkut's University of Technology North Bangkok, Thailand)

TA-2.1 8:30 ***Hybrid Deep Learning Technique for Solar Prediction Model.....N/A***

Ashish Singhal (Sagar Institute of Science, Technology & Engineering, India & Senior Member IEEE, India)

The process of predicting solar radiation is a key step in ensuring that solar energy generation is used to its full potential. A wide variety of models based on artificial intelligence (AI) for weather prediction have been used to solve this issue. However, hybridization approaches that combine AI and numerical models to produce a more impactful model can provide a sustainable improvement in prediction accuracy. In this study, a hybrid deep-learning approach for estimating solar irradiance is presented. Python Spyder 3.7 is the version of the application that is used in the process of carrying out the simulation. The results of the simulation provide a more accurate forecasting model and higher levels of performance when compared to the technique that was used in the past.

TA-2.2 8:50 ***A Versatile Li-Ion Battery Charger with Adaptive Current Regulation and Dynamic Voltage Adjustment for Multi-Output Charging.....N/A***

Pang-Jung Liu and Shao-Jin Ding (National Taipei University of Technology, Taiwan)

To minimize charging duration and simplify circuit complexity in parallel charging, this paper introduces a multi-output charger featuring adaptive current regulation (ACR) and dynamic voltage adjustment (DVA) controls. Due to the parasitic resistance, a typical charger transitions from the constant current (CC) to constant voltage (CV) phase without reaching the full voltage of the battery packs. The DVA control calculates the parasitic resistance and identifies the appropriate transition point, thereby extending the duration of CC phase and reducing the CV charging time. Utilizing the battery voltages, the ACR control automatically optimizes the charging currents in CC and trickle current (TC) phases, preventing damage to multiple batteries. The measured results confirm the extension in the durations of CC phase and a reduction in CV phase, and then the corresponding reduction in total charging duration by approximately 6.7%.

TA-2.3 9:10 ***Current Balancing Control for a Grid-Connected Inverter Under Grid Voltage Sag Using LMI.....27***

Chivon Choeung (National Polytechnic Institute of Cambodia, Cambodia); Socheat Yay (NPIC, Cambodia); Heng Tang, Sovannarith Hut, Sokna San, Kakada Sovan and Panha Soth (National Polytechnic Institute of Cambodia, Cambodia); Vichet Huy (Electricité Du Cambodge (EDC), Cambodia)

The increasing integration of renewable energy sources into smart grids demands the use of efficient and reliable

grid-connected inverters to ensure stable and uninterrupted power delivery. These inverters face significant challenges, particularly in maintaining a balanced current during grid voltage sags, which can disrupt power delivery and damage equipment. This paper presents a systematic optimal control design using linear matrix inequality (LMI) techniques for a three-phase grid-connected inverter equipped with an L-filter. The proposed control strategy employs state feedback to ensure system stability and integral control to eliminate offset errors. By solving the LMI problem, the optimal stabilizing gain is determined, minimizing convergence time and simplifying the gain-tuning process. Simulation results demonstrate the proposed method's ability to provide a fast dynamic response with zero offset error, highlighting its efficiency and robustness compared to a state feedback control with a negative sequence compensator.

Thursday, January 16 11:00 - 11:30

Keynote Speaker I - Prof. Dr. Athakorn Kengpol

The application of AI and cyber physical in instrumentations

Prof. Dr. Athakorn Kengpol

Abstract: Artificial Intelligence (AI) and Cyber-Physical Systems (CPS) have revolutionized the field of instrumentations by enabling autonomous decision-making and control in complex systems. These technologies have greatly enhanced the capabilities of instruments by allowing them to analyze data in real-time, predict potential issues, and make adjustments without human intervention. For instance, AI algorithms can be integrated into sensor networks to detect anomalies and adjust sensor settings accordingly, ensuring accurate and reliable measurements.

The application of AI and CPS in instrumentations has also led to the development of smart instruments that are capable of self-optimization and self-adaptation. By leveraging the power of machine learning and deep learning algorithms, these instruments can continuously learn from their environment and improve their performance over time. For example, smart sensors can adjust their calibration settings based on changing environmental conditions, leading to more accurate and consistent measurements.

Furthermore, the integration of AI and CPS in instrumentations has paved the way for the development of intelligent control systems that can autonomously adjust parameters to optimize performance. These systems can be used in various industries such as manufacturing, healthcare, and energy to improve efficiency, reduce downtime, and minimize errors. Overall, the application of AI and CPS in instrumentations has the potential to revolutionize the way we collect, analyze, and interpret data, leading to more reliable and efficient instruments.

Biography: Prof. Dr.Athakorn Kengpol is a distinguished professor at the Faculty of Engineering, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand, and a member of the KMUTNB University Council. With over 20 years of expertise in industrial engineering, artificial intelligence, and decision support systems, Prof. Kengpol has been instrumental in bridging academic innovation and real-world applications. His work has earned numerous accolades, including the National Excellent Lecturer Award and the National Prototype Teacher Award from Thailand's Ministry of Higher Education.

He has also been a principal investigator in multiple United Nations and European Erasmus+ projects, focusing on AI-driven decision-making and sustainable industry solutions. His recent research delves into the application of AI and cyber-physical systems, addressing challenges in areas such as disaster management, sustainable manufacturing, and advanced instrumentation systems.

A prolific author with an H-index of 15 and over 1,250 citations, Prof. Kengpol is renowned for his interdisciplinary approach, making significant contributions to industrial engineering, logistics, and sustainable development. He has also served as a keynote speaker at leading conferences and as a consultant for various government and industry initiatives.

Prof. Kengpol's innovative work continues to inspire the global academic and professional community, driving advancements in intelligent systems and sustainable engineering practices.

Thursday, January 16 11:30 - 12:00

Keynote Speaker II - Assoc. Prof. Dr. Hiroshige Kikura

Remote Measurement by Robot Arm Equipped with Ultrasonic Velocity Profiler (UVP) and Laser-Induced Breakdown Spectroscopy (LIBS)
Assoc. Prof. Dr. Hiroshige Kikura
Abstract:A prototype system for remotely detecting leaks and determining sediment shape and elements in the primary containment vessels (PCVs) of the decommissioned Fukushima Daiichi Nuclear Power Station is presented in this speech. The accident broke the PCVs, leaking cooling water injected to cool the fuel debris and large sediments in the leakage field. The investigation has focused on the vessel's internal structure, leakage position, and reactor nuclear fuel debris distribution.

Ultrasound Velocity Profile (UVP) and Laser-Induced Breakdown Spectroscopy (LIBS) were used to identify sediment elements above the water surface. Radioactivity also created an arm robot that could carry UVP and LIBS. This study found that the visualization flow field map estimated leakage location and sediment characteristics and identified sediment above water, improving detection efficiency. It was found that the UVP technique accurately captured the velocity distribution and leakage location in the simple flow field, while the LIBS technique accurately determined the above-water elemental composition. The arm robot measured remotely without radiation exposure. This study shows UVP and LIBS with an arm robot can be used to investigate leak locations and sediment properties in Fukushima Daiichi Nuclear Power Station PCVs, aiding for decommissioning and nuclear power plant safety and environmental protection.

Biography: Dr. Hiroshige Kikura is currently an Associate Professor of the Laboratory for Zero-Carbon Energy at Tokyo Institute of Technology in Japan. Prior to joining at Tokyo Institute of Technology in 1999, he worked at LSTM, University Erlangen-Nuremberg, Germany, and Paul Scherrer Institute (PSI), Switzerland, from 1993 - 1999. His research includes nuclear safety, thermal hydrodynamics, process instrumentation, transportation of radioactive materials, vitrified waste storage, deep geological repository, solar energy systems, solar power system, robotic measurement, revitalizics. He has authored or co-authored more than 900 publications (124 technical journals, 4 books, 370 international conferences, 410 national conferences), and has 20 patents. He is a member or a chair in several committees at the Japan Society of Mechanical Engineers (JSME), Atomic Energy Society of Japan (AESJ), the Visualization Society of Japan (VSJ), the Japan Society for Multiphase Flow (JSMF), and so on. In addition, he is engaged as an editor board member of several journals.

Thursday, January 16 13:00 - 13:30

Invited Guest Speaker - Dr. Thavida Maneewarn

Robotic and automation technology for sustainable agriculture in Thailand
Dr. Thavida Maneewarn
Abstract: Robotics and automation technology have advanced rapidly in the last few years. These technologies can contribute directly to sustainability in food production and agriculture. At Raina Robotech, our goal is to develop new technologies that are environmentally friendly and cost-effective that will be used in Thailand's farms and fruit orchards to increase efficiency in food production, reduce labor, and eliminate the use of toxic chemicals and pesticides. Our technologies include an autonomous farm vehicle, precise control of fertilizer applicator, and computer vision for germination and growth tracking for vegetable cultivation.

Biography: Dr.Thavida Maneewarn is the founder and director of Raina Robotech co. ltd. Since 2022 and co-founder/

director of Yannix co.ltd. since 2018. Dr.Thavida received a Ph.D. in Electrical Engineering specialized in control and robotics from University of Washington, Seattle, USA in 2000. She began her career as a researcher at Institute of Field Robotics, King Mongkut's University of Technology Thonburi, Thailand, where she got promoted to be the Deputy Director of Research since 2003 - 2014. She was also formerly the President of Thai Robotics Society and the first IEEE RAS-Thailand Chapter Chair which has the mission to promote knowledge and interest in automation and robotics to young generation in Thailand. Her research projects include agricultural robots and automation systems, service robots for industrial applications, humanoid and semi-humanoid robots, and autonomous driving system for unmanned ground vehicle and indoor mobile robots.

Thursday, January 16 13:30 - 14:30

TP-1: Robotics and Intelligent Vehicles

Chairs: Noppadol Pudchuen (King Mongkut's University of Technology North Bangkok, Thailand), Benjamas Panomruttanarug (King Mongkut's University of Technology Thonburi, Thailand)

TP-1.1 13:30 ***Robust Parameter Identification for Robot Manipulators Using Haar Wavelets.....N/A***

Woraphrut Kornmaneesang (National Taiwan Normal University, Taiwan)

Accuracy of the dynamic parameters of the robot is demanded for the advanced robot controller design. This paper proposes a robust parameter identification method using Haar wavelets (IDIM-Haar) for robot manipulators. The Haar wavelet analysis transforms the measured data into the Haar coefficients used for the parameter identification, in which, the additional experiments and data preprocessing are not required. The simulation results show the robustness and effectiveness of the proposed method over other existing methods, under a noisy measurement scenario.

TP-1.2 13:50 ***Disturbance Mitigation in Quadcopter Altitude and Attitude Control.....32***

Ankita Muhury, Smita Sadhu and Tapan Ghoshal (Jadavpur University, India)

Though different sophisticated control techniques have been suggested for quadcopters, contemporary commercial quadcopters still tend to use variants of the traditional Proportional Integral Derivative (PID) control. This paper focusses on quadcopter control schemes with disturbance rejection features to attenuate disturbances. Conventional Disturbance Observer (DOB) based control and the so-named Extended State Observer (ESO) based Active Disturbance Rejection Control (ADRC), which also provide some degree of robustness w.r.t. parameter variations are considered. This paper introduces and characterizes a novel Linear Parameter Varying (LPV) disturbance observer to improve the cross-channel disturbance mitigation performance. Performance of the controllers are evaluated for additive disturbances in the altitude and attitude channels as well as for cross channel disturbances with the help of case studies after ensuring level playing field in terms of actuator amplitude. Some interesting findings are (i) DOB based control is seen to be efficient in eliminating the effects of additive disturbances, (ii) performance of the conventional DOB based controllers to mitigate cross channel disturbance can be substantially improved using the LPV based DOB, (iii) disturbance rejection performance using DOB is seen to be at par or better compared to the ESO based ADRC.

TP-1.3 14:10 ***Fault-Tolerant Controller Design for PMSM Drives with Single-Phase Fault Inverters.....38***

Sornchai Buakaew and Witthawas Pongyart (King Mongkut's University of Technology North Bangkok, Thailand)

Permanent magnet synchronous motors (PMSMs) are commonly used in various electrical drive applications due to their high efficiency and performance. However, these systems are susceptible to several types of faults. To ensure uninterrupted operation in the event of a fault, researchers have focused on developing fault-tolerant control systems. This paper presents a fault-tolerant controller design for PMSM drives with single-phase fault inverters. A faulttolerant inverter is introduced, and an energy-based controller is implemented in the current loop, with a PI-controller governing speed control. The proposed control system is tested under both normal and fault conditions, demonstrating its ability to maintain motor torque and speed while ensuring system stability in both scenarios.

Thursday, January 16 13:30 - 14:10

TP-2: Power Control and Energy Systems

Chairs: Chakrit Panpean (King Mongkut's University of Technology North Bangkok, Thailand), Teratam Bunyagul (King Mongkut's University of Technology North Bangkok, Thailand)

TP-2.1 13:30 ***Enhanced Dynamic Voltage Restorer (DVR) with Fuzzy Logic Control for Voltage Regulation.....42***

Md. Tanvir Rahman (American International University-Bangladesh, Bangladesh); Sowrov Komar Shib (American International University- Bangladesh, Bangladesh); Durjoy Roy Dipto and Abu Shufian (American International University-Bangladesh, Bangladesh); MD Sajid Hossain (American International University Bangladesh, Bangladesh)

Three-phase Dynamic Voltage Restorer (DVR) utilizing a Fuzzy Logic Controller (FLC) to improve power quality in electrical distribution systems. The DVR is designed to protect sensitive loads from voltage sags, swells, and harmonics by monitoring voltage levels and injecting compensating voltages to ensure a stable and reliable power supply. The system includes a three-phase supply connected to a transformer, with the DVR placed after the transformer to mitigate voltage disturbances. The fuzzy logic controller adjusts the DVR output based on reference and load voltage measurements, providing efficient voltage compensation. The proposed DVR system achieves 95 % efficiency in correcting voltage disturbances and reduces total harmonic distortion to 2.41 %. Simulation results validate the effectiveness of the FLC-based DVR demonstrating faster response times and minimal steady-state error compared to traditional controllers. This integration enhances voltage regulation and fault resilience, making it a valuable contribution to renewable energy and power electronics fields, highlighting the potential of advanced control techniques in improving grid-connected system performance. The FLC-based DVR reduces voltage sag to 0.68 % and response time to <0.5 msec. The simulation for this research was carried out using MATLAB Simulink Optimization.

TP-2.2 13:50 ***Mathematical Modelling of Three Phase Four Leg Converters in Quaternion Space.....48***

Witthawas Pongyart and Pisit Vanichchanunt (King Mongkut's University of Technology North Bangkok, Thailand); Suppachai Roengriang (King Mongkut University of Technology Nort Bangkok (KMUT'NB), Thailand)

Typically, AC-DC converters are modeled in twodimensional space using the dq-coordinates, assuming they are supplied by a balanced three-phase system. However, this space vector model struggles to accurately represent converter behavior under unbalanced conditions. This paper presents the development of a mathematical model for a four-leg converter in quaternion space, offering a higher-dimensional model that captures converter behavior under both balanced and unbalanced input voltage conditions. To validate the proposed model, simulations were conducted, and the results confirm its accuracy.

Thursday, January 16 14:10 - 14:50

TP-3: Instrumentation and Measurement

Chairs: Wongsakorn Wongsaroj (KMUTNB, Thailand), Amphawan Julsereewong (King Mongkut's Institute of Technology Ladkrabang, Thailand)

TP-3.1 14:10 ***A Fast Frequency Measurement Circuit with Low Latency Developed Using FPGA.....52***

Yi-Jan Emery Chen, Sahoda Sri Sharani, Kuan-Ping Hsieh, Yun-Chih Lu and Jau-Horng Chen (National Taiwan University, Taiwan)

This paper presents the design and challenges of the statistical frequency measurement technique, which can be implemented using a field-programmable gate array (FPGA) board. The frequency measurement range is from 200

MHz to 715 MHz, with errors of less than 500 kHz. The latency of the first measurement result is only 360 ns, and consecutive measurement results of the same frequency signal can be obtained every 20 ns. Higher frequency accuracy can be effectuated by increasing the measurement latency.

TP-3.2 14:30 ***RNN-Based 3D Joint Angle Determination Using Magnetometer-Free IMU Signals and Joint Kinematic Constraint.....N/A***

Ji Hoon Park, Chang June Lee and Jung Keun Lee (Hankyong National University, Korea (South))

In general, 3D joint angles are determined by estimating 3D orientations of segments using 6-axis inertial measurement units (IMUs) and 3-axis magnetometers. However, magnetometers are vulnerable to magnetic disturbances caused by ferromagnetic materials and environments factors, which directly lead to inaccurate joint angle estimation. In this paper, we propose a recurrent neural network model that estimates joint angles using the joint kinematic constraint instead of using magnetometer signals. Although based on a model from a previous study, the proposed model uses the joint acceleration vectors which are components of the joint constraint equation, as model inputs so that the constraint is explicitly applied. The verification results showed that the proposed model had a superior performance of more than 10° compared to the two conventional Kalman filter (KF)-based methods that do not use the constraint, and had a superior performance of 0.47° and 0.81° compared to a KF using the constraint and the recurrent neural network model of the previous study, respectively.

Thursday, January 16 15:15 - 17:15

TP-4: ECTI-ICROS Organized Session on Estimation, Control Design, and Applications

Chairs: Napasool Wongvanich (KMITL, Thailand), PooGyeon Park (POSTECH, Korea (South)), David Banjerdpongchai (Chulalongkorn University, Thailand)

TP-4.1 15:15 ***A Novel Practical Fixed-Time Speed Control of Permanent Magnet Synchronous Motors with Input Saturation.....56***

Varin Cholahan (King Mongkut Institute of Technology Ladkrabang, Thailand); Napasool Wongvanich (KMITL, Thailand); Worapong Tangsrirat (King Mongkut's Institute of Technology Ladkrabang (KMITL) & Faculty of Engineering, Thailand)

In this article, we focus on a control problem for the speed control of a permanent magnet synchronous motor (PMSM). An antisaturation adaptive fixed-time nonsingular sliding mode control (AFFTNSM) with disturbace estimation compensation is designed for a class of second-order nonlinear systems to improve PMSM system performance. Firstly, a novel fast fixed-time nonsingular sliding mode surface is chosen based on the error dynamic equation. Then, a practical fixed-time sliding mode control algorithm is proposed and stability analysis method of Lyapunov function is presented to demonstrate the velocity tracking error converges to a set of neighborhood of origin in a fixed time. Moreover, considering the effect of lump disturbance and input saturation, an algorithm to estimate total disturbance and input saturation compensation are proposed. With feedforward compensation of disturbance, the fast fixed-time nonsingular sliding mode control law can provide better dynamic performance with lower chattering phenomenon. Finally, the numerical comparasion results are provided to verify the efficiency of antisaturation proposed method.

TP-4.2 15:35 ***Utilizing Reinforcement Learning with Task Decomposition and Specific Reward Systems for Nut Assembly Automation.....N/A***

Gunam Kwon (Yeungnam University, Gyeongsan-si, Gyeongsangbuk-do, South Korea); Sejik Oh (Yeungnam University, Gyeongsan, South Korea, Korea (South)); Nam Kyu Kwon (Yeungnam University, Korea (South))

This paper introduces a reinforcement learning method that leverages task decomposition and a task-specific reward system to address nut assembly task. The nut assembly task is decomposed into various subtasks, with the grasping and putting tasks executed through single joint and gripper actions, while other tasks are trained using the Soft Actor-Critic (SAC) algorithm alongside the task-specific reward system. The task-specific reward system aims to increase the learning speed, enhance the success rate, and enable more efficient task execution. Experimental results demonstrate the efficacy of the proposed method, achieving success rates of 80.8% for square nut assembly, and 90.9% for round nut assembly. Overall, this method presents a promising solution to address the challenges associated with complex tasks, offering improvements over the traditional end-to-end approach.

TP-4.3 15:55 ***Improved Stability Analysis of Generalized Neural Networks with Interval Time-Varying Delays.....62***

Hye Seung Hong, Hye Jin Lee and PooGyeon Park (POSTECH, Korea (South))

This paper proposes an improved stability analysis of generalized neural networks using the generalized integral inequality based on free matrices. The delay has the upper and lower bounds, but the information of delay's derivative is unknown. For the stability analysis of this system, main results use the Lyapunov Krasovskii Functionals method which is most widely used. The generalized integral inequality based on free matrices can obtain more improved results, since this inequality uses both the single integral term and the higher-order multiple integral terms. Additionally, the negative definite conditions of the matrix-valued cubic polynomials enable to form linear matrix inequalities. Using these inequalities and the reciprocally convex approach, sufficient stability conditions are derived in the linear matrix inequalities form. Eventually, a well known numerical example will show the effectiveness of the proposed approaches.

TP-4.4 16:15 ***Direct Data-Driven H∞ Control for Linear Discrete-Time Delay Systems.....66***

Hye Jin Lee, Hye Seung Hong and PooGyeon Park (POSTECH, Korea (South))

This paper proposes a direct data-driven approach to H∞ control for linear discrete-time delay systems. It has been previously demonstrated that the input and state trajectories of a linear system can be represented using persistently exciting input data. Building on this result, the paper presents a data-driven representation of the system using a Hankel matrix derived from input-state data collected through experiments. Stability conditions are then formulated in terms of linear matrix inequalities that rely solely on this data representation, thereby eliminating the need for explicit system matrices. These conditions are further extended to address H∞ control problems, which constitute the primary objective of this paper. A numerical example illustrates the effectiveness of the proposed data-driven approach.

TP-4.5 16:35 ***Real-Time IoT-Based Control of Building HVAC Systems Considering Occupancy Levels and Thermal Comfort.....N/A***

Emmanuel Agabi (Chulalongkorn University, Thailand); Lattapon Suwankanit (Swift Dynamics Co. Ltd, Thailand); David Banjerdpongchai (Chulalongkorn University, Thailand)

The conventional Heating, Ventilation, and Air Conditioning (HVAC) control systems that rely on planned schedules and fixed set-points have contributed to unnecessary energy waste, leading to inefficient energy usage and dissatisfied occupant comfort. This study explores the challenges associated with building HVAC systems, which are contributors to major energy consumption and greenhouse gas emissions. To solve these difficulties, this paper proposes a real-time occupancy-based control (OBC) that integrates wireless sensor nodes and edge devices to monitor environmental variables and occupancy data in real-time. A LoRaWAN gateway is used as the coordinator, collecting data from the sensor nodes and transmitting it to a cloud-based database for storage and further processing. Raspberry Pi acts as an edge device for controlling the HVAC system operations, with the aim to minimize energy consumption while maintaining comfort levels. Our system involves designing and implementing a control algorithm for a single zone in an office building, analysing thermal comfort using direct occupant feedback, and evaluating its effectiveness in improving energy efficiency. The result shows that implementing the OBC system reduced energy consumption by

40.75% compared to baseline control of the fixed set-point.

TP-4.6 16:55 ***Stability Analysis and Hopf-Bifurcation of Three Species Prey-Predator Model with Harvesting and Additional Food.....N/A***

Sivasamy Ramasamy and David Banjerdpongchai (Chulalongkorn University, Thailand)

The primary goal of theoretical ecologists is to discover mechanisms for controlling the chaos in ecological models in order to maintain positive species population densities and forecast future populations. In the present study, we attempt to control chaos in a three-species prey-predator model with species harvesting and additional food supply to predators. The model consists of two prey and one predator species, with one of the prey species exhibiting a group defense mechanism against the predator population while the other does not. We derive the essential conditions for the existence of ecologically feasible equilibrium points and their local stability. Furthermore, we determine the conditions for Hopf-bifurcation around the proposed model's coexistence equilibrium point. We conduct numerical simulations to validate the theoretical results and demonstrate the effects of species harvesting and additional food parameters on system dynamics.

Thursday, January 16 15:15 - 16:55

TP-5: ECTI-SICE Advances in Control Engineering and Application

Chairs: Sudchai Boonto (King Mongkut's University of Technology Thonburi, Thailand), Kou Yamada (Gunma University, Japan)

TP-5.1 15:15 ***Feature Extraction Based on LASSO Regression for Enhancing Fault Classification in Ball Bearings and Shafts.....N/A***

Jirayu Samkunta (Gunma University, Japan); Nghia Thi Mai (Posts and Telecommunications Institute of Technology & Gunma University, Vietnam); Kotaro Hashikura, Md Abdus Samad Kamal, Iwanori Murakami and Kou Yamada (Gunma University, Japan); Nattagit Jiteurtragool (King Mongkut's University of Technology North Bangkok, Thailand)

Traditional fault diagnosis of machines typically involves analyzing changes in the characteristics of time-series data caused by system degradation and faulty components. However, applying universal-purpose multi-class classification techniques to fault diagnosis becomes challenging due to the complexity introduced by large-scale datasets. These classification techniques often rely heavily on feature extraction and the quality of the training dataset. In this work, a feature extraction based on LASSO regression is developed specifically for fault diagnosis applications using time-series data. The proposed LASSO regression technique effectively extracts features by examining the relationship between the rotational speeds of the shaft and the acceleration signals from piezoelectric accelerometers. To benchmark the effectiveness of the proposed method, we also utilize other feature extraction techniques such as Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). The k-Nearest Neighbors (kNN) algorithm is employed as the classifier to evaluate the performance of these feature extraction methods. Results indicate that the proposed LASSO-based approach achieves an accuracy of 93.94% and a low error rate of 6.06%, highlighting its potential in accurately distinguishing between PCA and LDA features in both single and double fault scenarios using vibration signal datasets.

TP-5.2 15:35 ***Closed-Loop System Identification of an Unstable Nonlinear System Using Koopman Operator.....70***

Benjaset Maneeloke (Kasetsart University, Thailand); Sudchai Boonto (King Mongkut's University of Technology Thonburi, Thailand); Peerayot Sanposh, Yodyium Tipsuwan, Natthawut Chinthaned and Warit Tanaprasitpattana (Kasetsart University, Thailand)

This paper presents a novel methodology for closed-loop system identification of unstable nonlinear systems using the Koopman operator with Extended Dynamic Mode Decomposition with control (EDMDc). The study highlights the critical role of selecting appropriate observable functions to develop accurate and efficient Koopman models. We demonstrate that the resulting Koopman models exhibit excellent fitting and validation properties and retain the stabilizability of the original nonlinear systems. These models are verified through time and frequency responses under closed-loop control using a Linear Quadratic Regulator (LQR), confirming their effectiveness. Future work will extend this framework to more complex systems and incorporate machine learning techniques to refine the selection of observable functions. This approach aims further to enhance the adaptability and robustness of Koopman-based control strategies.

TP-5.3 15:55 ***A Fault Tolerance of the Double Feedback Control System for Faults That Lose a Controller.....N/A***

Daisuke Koyama (Gunma University, Japan); Nghia Thi Mai (Posts and Telecommunications Institute of Technology & Gunma University, Vietnam); Kotaro Hashikura, Md Abudus samal Kamal, Iwanori Murakami and Kou Yamada (Gunma University, Japan)

Several researchers consider the robust stabilization problem. To design a control system with robust stability and low sensitivity, a double feedback control system is proposed. However, the double feedback control system is vulnerable to faults of a controller. This is because the double feedback control system uses two feedback controllers to stabilize its control system. If the output from one of the two feedback controllers used in the double feedback control structure does not work, the structure of the control system will be changed. In this paper, we propose a design method for robust fault-tolerant control using the double feedback control system with robust low sensitivity for the Single-Input and Single-Output time-invariant minimum phase systems.

TP-5.4 16:15 ***The Experiment and Investigation of Tunable Pendulum Energy Harvester with Cone Continuously Variable Transmission Under Chirp Signal Base Excitation.....N/A***

Chattarika Uttachee, Kou Yamada, Iwanori Murakami, Kotaro Hashikura and Md Abdus Samad Kamal (Gunma University, Japan); Nghia Thi Mai (Posts and Telecommunications Institute of Technology & Gunma University, Vietnam); Surat Punyakaew (Naresuan University, Thailand)

This paper proposes an experimental research of a tunable pendulum energy harvester under chirp signal-based excitation. The aim is to assess the performance of the energy harvester, which utilizes a cone continuously variable transmission (CVT) for tuning. Unlike previous research that predominantly focused on harmonic excitation, this work investigates the system's behavior under chirp signal excitation, with a focus on both resonance-controlled and non-resonance-controlled conditions. The experimental results show a significant improvement in the energy harvester's output, with maximum voltage and Root mean square(RMS) voltage increasing by factors of 2.112 and 1.9764, respectively. These findings demonstrate the proposed energy harvester's enhanced performance, confirming its ability to operate effectively under real-world excitation frequencies.

TP-5.5 16:35 ***Investigating Feature Reduction Effects on Genetic Algorithm Feature Selection Process and Output.....N/A***

Auapong Yaicharoen (KMUTT, Thailand); Nghia Thi Mai (Posts and Telecommunications Institute of Technology & Gunma University, Vietnam); Kotaro Hashikura, Md Abudus samal Kamal, Iwanori Murakami and Kou Yamada (Gunma University, Japan)

Two feature reduction techniques are used on a group of data sets to obtain reduced data sets. The first one is based on a feature selection technique, and the other one is a feature extraction technique. Two sets of data are used where the first set does not contain dependency among features while the second set contains some interdependency among features. The original data set and the reduced data set are then used as input in classification problem. The reduced data set is also used as input for genetic algorithm feature selection to observe the improvement in the speed or

classifier quality. The reduced data sets from both Three machine learning models are chosen to perform a classifier training task. The time used to train each classifier, and the accuracy of each result classifier are collected, compared, and discussed. From the results, size of a data set can be reduced with both feature selection and feature extraction when there is no dependency among features. However, if there are dependency among features in the data set, feature extraction is a preferable technique.

Thursday, January 16 16:55 - 17:15

TP-6: Special Session on Navigating Resilience: Business Continuity, Risk Management, and Technology Insights

Chairs: Natt Leelawat (Chulalongkorn University, Thailand & Keio University, Japan), Kenji Watanabe (Nagoya Institute of Technology, Japan), Naohiko Kohtake (Keio University, Japan)

TP-6.1 16:55 ***Navigating Legal Frameworks for National Resilience: A Comparative Analysis of Key Disaster Management Laws in Thailand and Japan.....76***

Ampan Laosunthara (Tokyo Institute of Technology, Japan); Ratchaneekorn Thongthip (Asian Institute of Technology, Thailand); Kodchakorn Krutphong (Mahidol University, Thailand)

This study compares the disaster management laws of Thailand and Japan. The research reveals significant differences in legislative approaches, reflecting each country's unique historical, and governance contexts. Japan's law demonstrates a more comprehensive approach to the disaster management cycle and stakeholder involvement, with integrated financial provisions. Thailand's law emphasizes organizational aspects. Both prioritize response measures but show potential gaps in addressing preparedness and mitigation phases. The study identifies areas for further investigation, including financial measures, and international cooperation approaches. This comparative analysis offers valuable insights into both countries' ongoing development of disaster management systems and highlights potential areas for mutual learning and improvement in disaster risk reduction strategies. Creating resilience in the society through the core of the government working and stakeholders' given authorities.