ICIPRoB2026 Conference Program

The Program is Scheduled as Sri Lanka Local Time(GMT+5:30)

March 06, 2026

Registration desk (17.00 - 18.00)

The registration desk on March 6 will be available only for pre-contacted international participants

(Registration desk for other participants will be available from 8:45 AM to 5:00 PM on March 7 and 8, 2026)

Day 01 : March 07, 2026

Opening Ceremony **(09.00 - 09.30)**

Welcome speech by ICIPRoB2026 General Chair

ICIPRoB2026 opening speech by Representative / Chair IEEE Sri Lanka section

Keynote speak 01 (Chair: Prof. Prof. Susantha Wijesinghe)(09.30 -10.15)

Prof. Michele Magno (Fellow Member, IEEE)

Head of the Project-Based Learning Center at ETH Zurich and EdgeAI and Sensing System Lab

Title: From Efficient Sensing to Physical AI: Edge Intelligence for Next-Generation Mobile Robotics

Abstract:

Robotic systems are increasingly required to operate autonomously in complex, dynamic environments while facing strict constraints on energy consumption, latency, and reliability. This keynote explores how efficient sensing systems and Edge AI are enabling a new generation of intelligent robots that move beyond cloud-dependent paradigms. The talk will present recent research on multi-modal sensing architectures, combining vision, radar, inertial sensors, and ultra-wideband technologies, tightly integrated with embedded AI. By leveraging hardware–software co-design, event-driven sensing, and lightweight learning models, these systems achieve real-time perception and decision-making directly at the edge, enabling long-term and scalable robotic deployments. A central theme of the keynote is the emerging concept of Physical AI, where intelligence is not only defined by algorithms, but also by the physical interaction between sensors, computation, and the environment. Examples from mobile robots such as nano-drone and autonomous platforms including quadruped robots and autonomous racing cars will demonstrate how exploiting physical constraints can lead to more robust, efficient, and adaptive robotic behaviour. The keynote will discuss also about current challenges and future trends, highlighting opportunities at the intersection of image processing, embedded systems, and robotics, and outlining a roadmap toward sustainable, resilient, and truly autonomous mobile robotic intelligence.

Tea Break : 10.15~ 10.30

Keynote speak 02(Chair: Prof. Susantha Wijesinghe)(10.30 - 11.15)

Prof. Yoshikazu Koike

Professor, College of Engineering, Shibaura Institute of Technology, Japan.

Title: Ocean monitoring system using glass spheres

Abstract:

In recent years, advances in marine development and research have become increasingly important for protecting the marine environment and exploring valuable deep-sea resources. However, marine equipment such as ROVs (remotely operated vehicles) and AUVs (autonomous underwater vehicles) is often very expensive. Therefore, there is a strong need for a low-cost, easy-to-operate system for underwater observation and exploration. To address this need, the authors focus on a free-fall type underwater observation system (UOS), which can be realized at low cost and is simple to deploy. The system uses a glass-sphere pressure housing that can withstand depths of up to 7,800 m. The presentation introduces a recent free-fall UOS that captured the world's first 3D video of the seafloor at a depth of 7,800 m. In addition, the feasibility of underwater positioning is investigated using a micro-electro-mechanical-systems (MEMS) inertial measurement unit (IMU) integrated into the developed camera system. Our research group is also developing an in situ ocean microplastic observation system by further improving the glass-sphere free-fall UOS.

Keynote speak 03 (Chair: Dr. Waruna Premachandra) (11.15 - 12.15)

Dr Hooman Samani

Creative Robotics Reader, University of the Arts London, Creative Computing Institute, United Kingdom

Title: Creative Robotics: Robots That Feel, Express, and Co-Create

Abstract:

This keynote introduces Creative Robotics as an emerging approach that shifts robotics beyond task-oriented functionality toward emotional expression, artistic agency, and human–robot co-creation. Drawing on interdisciplinary research at the intersection of robotics and art, the talk explores how robots can be designed to sense, express, and engage with human emotions.

Through selected experimental robotic systems, the keynote demonstrates how creativity can function as a core design principle. These projects challenge conventional definitions of intelligence and interaction, presenting robots as expressive entities and creative collaborators.

By framing robotics as a medium for emotional communication and cultural reflection, this talk highlights the potential of creative robotics to influence future applications in art, social interaction, and humanity cantered technology, ultimately redefining how robots relate to and coexist with humans.

.

Lunch Break : 12.15~ 13.30

Day 01 : March 07, 2026 (13.30~14.45)

Session 01: Computer vision & Image processing 1 (Oral session) Chairs: Prof. Naiwala Chandrasiri, Dr. K.K.L.B. Adikaram	
Paper ID	Title, Authors and Abstract
6	**Title: & Authors:** Accurate 3D Object Detection Using CAM-Guided Weak Piyamini de Saram and Ravinda Meegama **Abstract:** Accurate 3D object detection is critical in applications such as augmented reality, virtual reality, robotics, and human-computer interaction. Traditional approaches respond heavily to fully supervised learning, which requires large-scale 3D annotations and is often costly and labor-intensive. This study explores the efficiency of weakly supervised learning techniques to reduce the dependency on extensive 3D annotations while enhancing the accuracy and reliability of 3D object detection. For object detection, the YOLOv8 model trained with pseudo-labels generated via Class Activation Maps (CAMs) exhibited strong detection capabilities. The model achieved high precision and recall metrics indicating robust performance even under weak supervision. The temporal analysis network improved the model's ability to track hand movements across video frames, achieving a model loss of 0.0006879 and a Mean Absolute Error (MAE) of 0.0189, indicating accurate and stable keypoint predictions.
8	**Title: & Authors**: HARVEE: An Abstract Robot System for Eliciting Cooperative Interaction via Fusion of Multiple Response Modes Ayano Yasui **Abstract:** Achieving a cooperative relationship characterized by mutual adjustment of actions, rather than a master-slave relationship, is necessary for a robot to function as a social partner. In this research, we developed a system that generates abstract robot behaviors in real-time in response to human movement. This system determines the characteristics of human movements from skeletal features detected by AI technology and generates the robot's behavior by fusing multiple response modes, such as human-following and autonomous periodic movements. This fusion enables the robot's behavior to influence the human, thereby creating a feedback loop. Results from the interaction experiments confirmed that the system elicited active and diverse exploratory movements, effectively leading to the formation of a cooperative interaction.

25	**Title: & Authors**:Coconut Bunch Intelligence System: Image-Based Maturity Classification and Nut Count Prediction R.M.P.U. Rajapaksha, K.K.L.B. Adikaram and I.R. Palihakkara **Abstract**: Accurate assessment of coconut maturity and nut count is essential for effective yield estimation and harvest planning in Sri Lanka's coconut industry. However, existing methods rely on manual visual inspection, which is labor intensive, subjective, and inconsistent. While previous studies have focused mainly on detecting individual coconuts, field-level applications require reliable analysis at the bunch level, which represents the actual harvestable unit. Addressing this gap, the present study developed an automated image-based system for classifying maturity stages and predicting nut counts in coconut bunches, aiming to meet real field requirements and support future mechanized coconut picking. Two deep learning approaches—Teachable Machine and a MobileNetV2-based Convolutional Neural Network (CNN)—were employed for maturity classification, and the YOLOv8n object detection model was used for nut count prediction. For nut count prediction, a single-view image of each coconut bunch was used to ensure practicality and ease of field-level data collection. A dataset of 3,000 labeled coconut images representing four maturity stages (Immature, Mature, Over-mature, and Unknown) was used for model training and validation. The MobileNetV2-based CNN achieved superior performance with an accuracy of 99.0% and precision, recall, and F1-scores above 0.99. For nut count prediction, 240 annotated bunch images were used to train the YOLOv8n model, which achieved a mean Average Precision (mAP@0.5) of 91.4%. Bunch-level nut count predictions, adjusted using linear regression to minimize errors, reached an accuracy of 94.2% compared with manual counts. All models were integrated into a Flask-based web application that enables real-time maturity classification and bunch-level nut count prediction. The system provides a practical and field oriented solution for coconut yield estimation and harvest management, marking a significant step toward applying AI based approaches to real-world coconut cultivation.
30	**Title: & Authors:** Monocular Vision for Low-Cost Indoor Robot Localization in Predefined Environments Kumararatnam Dhushanthan, Gamini Dissanayake, Asela K. Kulatunga, Mahanama Dharmawardhana and Tomonari Furukawa **Abstract:** This paper investigates whether the cost of a mobile robot sensor suite can be reduced by using algorithms that are fine tuned for a specific operating environment, at the expense of general purpose applicability. In particular, the work presented evaluates the feasibility of leveraging recent advances in deep learning to process monocular camera images and segment traversable regions, obtain range and bearing observations analogous to those from a LiDAR, and detect obstacles. A convolutional neural network (CNN) trained on images collected from the target environment is used to identify floor regions that are directly accessible from the current robot location and nearby obstacles to motion. The boundaries of the segmented regions that lie in the same plane as the mobile robot are then used to generate range and bearing observations. The approach is illustrated with examples that demonstrate its robustness to varying lighting conditions and floor textures, as well as its ability to disregard irrelevant information within the specific environment in which it was trained.

47	**Title: & Authors:** An Explainable Expert System for Treatment Recommendation in Type 2 Diabetes Mellitus Ann Ratnayake, Ravindu Weerasinghe, Amasha Weerasinghe and Upeksha Ganegoda **Abstract:** The treatment choice in Type 2 Diabetes Mellitus (T2DM) is a complicated clinical procedure that demands the concurrent evaluation of glycemic control, comorbidity, kidney, patient safety, and cost constraints. Although machine learning-based clinical decision support systems have demonstrated potential, most of them are black boxes and are not transparent, which restricts their clinical trust and adoption. In order to fill this gap, this paper introduces an explainable, rule-based pharmacological treatment recommendation expert system based on the American Diabetes Association (ADA) Standards of Care. The proposed system represents guideline knowledge in the form of prioritized decision rules, which include comorbidity-aware logic in case of cardiovascular disease, heart failure, chronic kidney disease, and obesity. The system is built to handle the incomplete or missing patient inputs, which are a reflection of the real-world clinical conditions, and yet generate safe and guideline-consistent recommendations. Every recommendation is supported by clear explanations, such as the clinical rationale that triggers it and the reference to the guidelines, which improves interpretability and clinical transparency. The expert system is developed as a prototype in the form of a web-based application based on a modular rule engine and an interactive user interface. The study does not involve any formal clinical assessment; nevertheless, a systematic assessment plan is described to be used in future validation. The proposed solution demonstrates the feasibility of explainable, guideline-based decision support in the management of T2DM is possible.
53	**Title: & Authors**: A Multifactor Approach for Quantifying Severity in Patients with Type II Diabetes Amasha Weerasinghe, Ravindu Weerasinghe, Anne Rathnayake and Upeksha Ganegoda **Abstract:** Type II Diabetes is a complex chronic disease that is caused by various factors including genetic and lifestyle behaviors. Existing indices such as United Kingdom Prospective Diabetes Study (UKPDS), Finish Diabetes Risk Score (FINDRISC), Charlson Index try to capture diabetes severity, but those indices are very narrow and fail to provide a comprehensive, multi domain measure to assess the severity of diabetes Type II patients. This study proposes a novel multidimensional Diabetes Severity Index (DSI) and Mortality Weighted Diabetes Severity Index (DSI-MW) developed using National Health and Nutrition Examination Survey 1988 - 2018 (NHANES). Diabetes Type II classification was done using validated NHANES specific classification algorithm and these two proposed indices are developed based on that. The proposed system is holistic, population wide, and has a reproducible approach for, quantifying diabetes severity of Type II diabetes patients. Expected outcomes of this system include improved severity stratification, enhance early risk detection and strong predictive utility for mortality and address issues of existing indices that focus only on one aspect.

Day 01 : March 07, 2026 (14.45~15.45)

Session 02(Poster session with tea break) - AI and applications-

Chairs: Ms. U.S. Samarasinghe and Ms. Dulari Perera

Paper ID	Title, Authors and Abstract
13	**Title: & Authors:** Real-Time Human–Computer Interaction Using CNN-Based Gaze Tracking for Hands-Free Control Neethika Hariharasakthy, Jeevarethinam Praveenan, Nirasha Morais, Ahamed Minhaj and Yugani Gamlath **Abstract:** This paper introduces LOOK TRACK VISION, a multi-modal Human-Computer Interaction (HCI) system that can be used to control computers hands-free with the help of gaze direction, blink gestures, and voice commands. The system is built based on a regular webcam and a Convolutional Neural Network (CNN) model to classify gaze directions (LEFT, RIGHT, UP, DOWN, CENTER), with MediaPipe facial landmarks to estimate blink and head-pose. Multi-modal interface is an interface which incorporates gaze based cursor control, blink based clicking, voice-to-text conversion and an assistive Communicator module. The solution does not require any specialized hardware to operate so that it is low-cost, portable and can be used by users with motor impairments. The proposed CNN was experimentally analyzed and achieved approximately 95% accuracy in webcam-based inputs with various lighting conditions. The elaborated desktop application also confirm the usability, robustness and potential of the system as a comprehensive HCI solution.
15	**Title: & Authors:** Device-Free Hand Gesture Recognition for Human Computer Interaction Using Deep Learning Chiara Vanderlan, Chamika Weerawanni, Sandunika Thanthriwatta and Yugani Gamlath **Abstract:** Gesture-driven interfaces are improving Human–Computer Interaction (HCI) by offering users a more natural, intuitive way to communicate with systems. This research presents a real-time hand gesture recognition framework that serves as an alternative to traditional input hardware with static and dynamic gestures captured through an ordinary webcam. A custom-built dataset of 88,000 images and a deep Convolutional Neural Network (CNN) were developed to support robust gesture recognition under diverse lighting and background conditions. Unlike existing systems that depend on depth sensors or computationally heavy models, the proposed method infers dynamic gestures by combining static CNN predictions with real-time directional hand movement analysis. The system enables seamless control of media players, presentations, system-level functions, and other frequently used applications, supported by a PyQt based interface and mobile remote-control support. Achieving 99.81% testing accuracy with low latency, this work demonstrates an accessible, efficient, device-free and practical approach to gesture-

	based interaction. The proposed framework advances HCI by enhancing usability, reducing device dependency, and broadening accessibility for a wide range of users.
19	**Title: & Authors:** Ancient Geometric Mysteries and Their Role in Shaping Future Artificial Intelligence Susara Thenuwara, Chinthaka Premachandra and Hiroharu Kawanaka **Abstract:** This research investigates the mathematical geometry embedded in ancient architectural and sculptural structures across different civilizations. These constructions demonstrate advanced uses of proportionality, symmetry, curvature shaping, harmonic scaling, and fractal repetition indicating intentional mathematical intelligence rather than intuitive craftsmanship. Using modern computational tools such as parametric curve fitting, curvature extraction, polar-lobed modeling, and hyperbolic representations, the study identifies measurable geometric consistencies that align with principles used today in computational geometry and geometry-aware machine learning. The proposed methodology converts architectural profiles into mathematical parameter sets and maps these descriptors into geometry-informed AI pipelines. Experimental evaluations show that geometric priors such as curvature signatures, harmonic ratios, and fractal dimensions improve AI performance in tasks like shape reconstruction, style classification, and generative modeling. Models incorporating these geometric features demonstrated 8-12% improved accuracy, lower reconstruction error, and more stable feature embeddings compared to conventional Euclidean baselines. These findings suggest that ancient geometry encodes structural and representational efficiencies that remain valuable for developing next generation AI architectures.:
24	**Title: & Authors:** Improved Flood Management and Risk Communication Through LLM Imaya Ranaweera, Susara Thenuwara and Chinthaka Premachandra **Abstract:** This paper presents a multimodal flood decision-support system that combines Large Language Models (LLMs), a Retrieval Augmented Generation (RAG) pipeline, and a Flood Knowledge Graph (FKG) for operational flood risk communication. The system ingests GIS layers, real-time hydrological sensor streams, meteorological forecasts, and social media posts into a Neo4j-based FKG, which is then queried by a RAG framework to ground LLM outputs in current and historically validated flood conditions. A human in the loop governance layer validates critical messages before dissemination, ensuring that generated alerts, summaries, and evacuation suggestions remain traceable and policy compliant. The hydrological forecasting component achieved a Nash Sutcliffe Efficiency (NSE) of 0.89, while knowledge graph grounding reduced factual hallucinations in LLM responses by 78.6% compared to a text-only baseline. The integrated system further supported dynamic risk classification and real-time visualization of optimized evacuation routes. These results demonstrate that the proposed architecture can transform raw, heterogeneous flood data into reliable, actionable intelligence for emergency managers, moving beyond generic chat responses toward deployable, decision-grade flood early warning and response.

32	**Title: & Authors:** Towards a New Era of Smart Wheelchair Navigation: Estimating Door Opening Direction with a 360-Degree Camera Shioji Watanabe and Chinthaka Premachandra **Abstract:** Autonomous wheelchairs have been deployed in airports, hospitals, and similar environments; however, their mobility is still limited because they cannot open or pass through standard doors other than automated ones. To navigate standard doors autonomously, a wheelchair must detect the door area, the door handle position, and the door-opening direction (left or right). Conventional approaches use onboard camera images and deep learning–based object detection to classify these elements into three classes: right-opening doors, left-opening doors, and door handles. However, this multi-class detection increases computational cost and is further constrained by the limited field of view of standard RGB cameras. To overcome these limitations, we propose a novel method that equips a wheelchair with an omnidirectional camera. Using 360-degree images processed by YOLO11, the proposed method detects the door area and handle position, while the door-opening direction is determined without deep learning, based on the spatial relationship between the door and its handle. Experimental results show that, compared to the conventional method, the proposed approach improves performance, achieving a 2.5% increase in mAP50, a 5.4% increase in accuracy, and approximately a 5% improvement in F1-score across all detection classes. In addition, it achieves over 95% detection accuracy for objects within 4 meters and extends the detection range by 1 meter. These results demonstrate that the proposed method outperforms the conventional approach and is suitable for practical applications.
86	**Title: & Authors:** Seamless Over-the-Air Updates for Edge AI-Powered Air Mouse Tenura Pinsara and Bopagoda Sudantha **Abstract:** The deployment of Machine Learning (ML) models on edge devices, known as TinyML, has revolutionized Human-Computer Interaction (HCI). However, the Day-2 operations specifically the maintenance and updating of these models in the field—remain a critical challenge for embedded systems with limited connectivity and storage. AirSense is a dual- mode AI-powered air mouse that addresses these challenges by integrating precise cursor navigation and gesture-based media control into a single ESP32-based device. This paper presents two significant contributions: (1) An asymmetric dual-core processing architecture using FreeRTOS to decouple deterministic sensor fusion from stochastic AI inference, ensuring sub-5ms latency; and (2) A novel Serverless Over-the-Air (OTA) firmware update mechanism. This OTA architecture utilizes GitHub Releases as a secure, version-controlled artifact repository, allowing the device to autonomously query, download, and flash updates via HTTPS without dedicated infrastructure. Experimental results validate the system's robustness, achieving a scalable blueprint for open- source IoT lifecycle management.

89	**Title: & Authors:** A Solar-Powered IoT-Based Outdoor Air Quality Monitoring System with Dual Connectivity and Data Quality Validation Bopagoda Sudantha, Lakdini Manchanayaka, Chinthaka Premachandra, Umesh Nethmina and Buddika Bandara **Abstract:** This paper presents the design and implementation of a solar-powered, IoT-enabled outdoor air quality monitoring system capable of real-time measurement of key air pollutants and environmental parameters. The system integrates an ESP32 microcontroller with multiple sensors to monitor PM2.5, PM10, CO, CO2, temperature, humidity, and pressure. Dual communication using Wi-Fi and GSM ensures reliable operation in both urban and remote environments. Field deployment results demonstrate stable operation, accurate measurements, and effective AQI computation.
90	**Title: & Authors:** A Hybrid Sensor-Fusion Framework for Linguistically Complete Sign Language Recognition I.S.B. Warnasooriya, Chinthaka Premachandra and B.H.Sudantha **Abstract:** The evolution of powerful automated Sign Language Recognition (SLR) systems represents a key technological intervention to resolve the communication barriers faced by the worldwide deaf and hard-of-hearing community. Contemporary research methodologies can be broadly broken into two different paradigms; vision-based, which use standard RGB Cameras, or sensor-based, which use dedicated equipment such as the Leap Motion Controller (LMC). This paper argues that neither of these paradigms, in isolation, can capture the total linguistic complexity of American Sign Language (ASL) which is inherently dependent on the simultaneous articulation of manual gestures (handshape, movement) and non-manual markers (facial expressions, body posture). Vision-based systems though have good features for holistic capture have significant fragility in the environmental factors and a basic 2D data bottleneck. On the other hand, the LMC achieves high fidelity 3D skeletal tracking that is robust to lighting variations and occlusion, but makes the system insensitive to essential non-manual grammatical cues. Through an extensive literature review, a major gap in hybrid sensor fusion frameworks is identified in this paper. While the use of individual modalities has been well studied, combining LMC for robust estimation of hand poses with RGB cameras for facial expression analysis has not been well studied. This review combines the results of hardware assessments, unimodal SLR studies, and multimodal fusion studies to establish the need for a cross-modal attention-based architecture that can dynamically weight modality reliability and model complex spatio - temporal dependencies.

Day 01 : March 07, 2026(15.45~17.15)

Session 03 -Robot, IOT1-(Oral session)

Chairs: Dr. Hooman Samani, Dr. Yoshihiro Maeda

Paper ID	Title, Authors and Abstract
45	**Title: & Authors:** Adaptive Navigation of Transformer Robot for Transporting Objects in a Warehouse Environment H.A.D. Madhusanka, R.M.S. Lakruwani, K.P.G. Sandamal, A.G. Tharindu Gimras, Buddhika Jayasekara, M. A. Viraj J. Muthugala and Mohan R. Elara **Abstract:** Developing an adaptive navigation system for transformer robots in warehouse environments is essential for improving efficiency and flexibility in operations. This paper proposes a novel adaptive navigation framework that integrates perception, path planning, robot reconfiguration, localization and path tracking into a unified solution. An overhead camera is used to capture the warehouse layout, and image processing methods are used to extract obstacles and free space through binary segmentation and contour detection. The processed environment is converted to a grid-based representation for path planning using a customized A* algorithm. This customized A* algorithm finds an efficient path for navigation considering the work envelope of the robot's shape and transformations with the available free space. For each path segment, it determines whether the robot should maintain its compact "O" configuration or transform into the elongated "I" configuration to access narrow passages. The localization of the robot in the environment is carried out through tracking an ArUco marker mounted on the robot enabling the path tracking capability during the navigation. The applicability of the proposed system has been validated through case studies conducted in scaled mock warehouse environments, demonstrating the potential of deploying transformer robots in warehouse environments.
58	**Title: & Authors:** Bio-inspired Soft Crawling Robot HISOYAKA II: Adaptive Behavior Emerging from the Dynamics of a Redesigned Soft Arm Koki Hirota and Kazuyuki Ito **Abstract:** We investigate a mobile robot that locomotes using two long octopus-like soft arms in environments with many protruding objects. In this study, we improve the previous robot by redesigning the arms to enable non-uniform motion. A prototype is developed, and experimental results demonstrate that the proposed arms achieve more complex and adaptive motion than conventional designs, despite employing the same simple controller.

71	**Title: & Authors:** VisualNav : Visually Grounded Natural Language Crawler Robot Navigation Lakmina Gamage, Haritha Weerathunga, Sudantha Bh, Chinthaka Premachandra and Vishwani Geeganage **Abstract:** The integration of Vision-Language-Action (VLA) models into robotic systems promises to bridge the gap between high-level semantic intent and low-level control. However, deploying these computationally intensive models on resource-constrained mobile platforms while ensuring open-world generalization remains a significant challenge. This paper presents a comparative study of two distinct VLA architectures for natural language-driven navigation on a crawler robot. this work first evaluate a monolithic end-to-end approach, fine-tuning a Large Vision-Language Model to map visual observations directly to control commands. While highly effective in trained scenarios, this method suffers from severe overfitting and fails to generalize to novel objects. To address this issue, this work propose a modular architecture that decouples reasoning and perception using a Small Language Model for intent extraction and an Open-Vocabulary Detector for visual grounding, linked by a lightweight Multi-Layer Perceptron (MLP) control policy. The experiments demonstrate that this modular approach achieves superior zero-shot generalization and lower inference latency compared to the monolithic baseline. These findings suggest that disentangling semantic understanding from control offers a more robust and scalable path for deploying embodied AI on edge devices.
74	**Title: & Authors:** Development of an Augmented Reality Based Educational Platform for Learning Robotics Vihangi Gunasekara, Sahan Edirimanna and Lahiru Dilran **Abstract:** This paper presents an augmented reality (AR) based educational platform mainly integrating robotic arms. It allows users to interactively explore robotics concepts in an AR environment. This platform facilitates hands-on learning experiences for robotics enthusiasts, bridging the gap between theoretical robotics concepts and practical implementations.This paper is also a demonstration of the potential of AR-based systems to provide cost-effective, scalable, and immersive learning experiences in the field of robotics. This presents the feasibility of deploying interactive learning experiences using commercially available hardware and software. The adaptability of the system allows easy customization for various robotic arms, enabling broader educational outreach across different learning environments.

77	**Title: & Authors:** Context-Aware Particle Filtering Framework for Belief-Driven Human-Robot Navigation Nimantha Adikaram, Isuru Munasinghe, Charitha Dombawala, Diluka Moratuwage and Asanka Perera **Abstract:** Human-robot interaction (HRI) navigation in crowded indoor spaces must prioritize safety and social comfort. Particle Filters (PFs) are widely used to track dynamic agents because they can represent non-Gaussian, multimodal human motion. However, existing literature often employs fixed-uncertainty tracking and standard resampling, which can lead to overconfidence, particle impoverishment, and poor recovery during missed detections and occlusions. We introduce a belief-aware HRI navigation pipeline that explicitly maintains and propagates realistic uncertainty about human states. We propose a context-aware particle filter (CA-PF) that adapts motion uncertainty online based on interaction distance, robot motion, visibility, and observation reliability, together with a context-aware resampling strategy that conditions resampling on effective sample size, occlusion status, and risk level to preserve hypothesis diversity in ambiguous situations. Experimental results in crowded navigation scenarios demonstrate improved robustness under occlusion, better hypothesis retention, a 12.7% reduction in resampling operations, and a 5.1% improvement in motion smoothness (RMS acceleration).
84	**Title: & Authors**: MAMEYAKA IV: A Soft Robot Inspired by Octopus Behavior Ryota Ishii and Kazuyuki Ito **Abstract:** In our previous work, we developed a bio-inspired soft robot that could climb vertical ladders and move on horizontal planes. However, the robot moved on horizontal planes using a crawling motion, which limited its mobility. In this paper, we improve upon the previous robot by adding two legs and propose a new robot with two long soft arms for climbing and two short soft legs for walking. Experimental results confirm that the proposed robot can walk on horizontal planes and steps, in addition to climbing vertical ladders.
18	**Title and Authors**: Vision Compass for Drones: An Alternative Use of a Limitation in Vision Models for Localization Kolitha Warnakulasooriya and Aviv Segev **Abstract:** This study investigates the performance of state-of-the-art deep learning models in achieving rotation-invariant visual localization for drones, with a particular emphasis on extraterrestrial applications such as Mars exploration. While vision-based positioning systems have become increasingly important for Unmanned Aerial Vehicles (UAVs) in environments lacking reliable GNSS signals, the challenge of classifying symmetrically rotated surface images remains significant. Leveraging the National Aeronautics and Space Administration (NASA) HiRISE Mars image dataset, the authors evaluate several convolutional neural network architectures, including ResNet, VGG, ConvNeXt, and others, on their ability to maintain classification accuracy under rotations of 0°, 90°, 180°, and 270°. Experimental results indicate that most models exhibit strong performance for the original orientation but suffer marked declines at different rotational angles. The findings underscore the need for improved model designs or augmented training strategies to ensure reliable drone navigation and localization in diverse and unpredictable environments. Nevertheless, this study proposes that the inability to classify images that are at different angles can be used as a vision compass to identify the direction of the UAV.

End of Day 01

Day 02 : March 08, 2026

Keynote speak 03(Chair: Prof. Susantha Wijesinghe)(09.00 - 09.45)

Prof. Tomohiro Shibata

Professor, Kyushu Institute of Technology,
Graduate School of Life Science and Systems Engineering, Human and Social Intelligence Systems Lab.

Title: Human-Centered Robotics in an Aging Society: Control, Interaction, and the Challenge of Social Deployment

Abstract:

Japan's super-aging society has positioned the country as a global frontrunner in care and assistive robotics. Through national programs led by the Ministry of Health, Labour and Welfare and the Ministry of Economy, Trade and Industry, platforms for the development, demonstration, and dissemination of care robots have been systematically promoted. This keynote presents these national initiatives alongside representative research from the Shibata Laboratory, including an imitation-learning-based dressing assistance robot, a wearable artificial-muscle-powered walking assist robot, and an assistive robotic walker. Focusing on systems advancing toward real-world use, the talk discusses how control and physical human–robot interaction must be integrated with usability, safety, institutional constraints, and user acceptance to achieve sustainable social deployment.

Workshop 01 (Chair: Dr. K.K.L.B. Adikaram)(09.45 - 10.15)

Dr. Kolitha Warnakulasooriya

Assistant Professor, School of Computing, University of South Alabama, United States

Title: Optimizing control and trajectory planning for large systems of unmanned aerial vehicles using swarm intelligence

Autonomous precise control is a critical factor and a significant challenge for large UAV systems. Cooperative intelligence plays a vital role in ensuring smooth and fault-free mission completion. Nature offers remarkable insights through the swarming behavior of biological entities, demonstrating how to operate as a group to achieve specific objectives. Swarm intelligence has been developed for various applications, with high-order optimization being a particularly valuable aspect for optimizing multiple UAV systems. This session will delve into how swarming behavior, inspired by nature, provides substantial support for optimizing trajectories and enhancing control precision. We will cover a comprehensive introduction, explore the current state of trajectory optimization, and discuss the usefulness and limitations of swarm intelligence in the context of large-scale multiple UAV systems.

Workshop 02 (Chair: Prof. Naiwala Chandrasiri)(10.15 - 10.45)

Prof. Yoshihiro Maeda

Associate Professor, Shibaura Institute of Technology, Tokyo, Japan

Title: Computational Imaging Techniques for Quanta Image Sensors

Quanta image sensors (QIS) are an emerging class of sensors capable of capturing individual photons with ultra-high temporal resolution. These sensors enable new applications in difficult imaging conditions, such as low-light scenes or fast motion.Unlike conventional sensors, QIS outputs a sequence of binary images indicating whether a photon was incident at each pixel. While this mechanism offers high sensitivity, it also introduces unique challenges for image processing.This session introduces our research on computational imaging techniques for QIS.Topics include the challenges of processing binary images and the use of model-based and data-driven methods to reconstruct clear images.

Day 02 : March 08, 2026 (10.45~12.00)

Session 04 (Poster session with tea break): Data Analytics, AI, Data Mining- **Chairs: Ms. U.S. Samarasinghe and Ms. Dulari Perera**	
Paper ID	Title, Authors and Abstract
31	**Title: & Authors:** Development of an Adaptive LED Matrix Headlights for Enhanced Visibility and Road Safety Sasindu Adikari and Isuru Lakmal **Abstract:** Driving at night can be challenging, especially when glare from oncoming and outgoing traffic headlights reduces visibility. This project focuses on developing an automated adaptive headlight system that uses LED matrix technology to make driving safer and more comfortable by selectively controlling LEDs of a LED matrix based on real-time driving conditions. This innovative approach works toward optimizing visibility for drivers while minimizing glare for oncoming traffic, hence greatly reducing the risks of accidents in night driving and adverse weather conditions. Distinctive adaptive headlight systems combine sophisticated sensors with intelligent algorithms for what is finally a great stride away from traditional fixed beam headlights. They use various sensor technologies, including LDRs and radar, to gather critical data from the environment that will enable the adjustment of headlight beam patterns. The proposed system is developed in such a way that the integration of the LED matrix arrays, stereo vision cameras and smart controllers will enhance road safety to develop better night driving experiences. A prototype is made for testing in simulated conditions in verification of its effectiveness. The goal is to create a headlight that adjusts in real time to avoid blinding other drivers while still illuminating the road effectively.
41	**Title: & Authors:** The Relationship between the Performance of Tetris AI and the State of the Board at the Start of the Episode Masafumi Mukaida, Danushka Bollegala and Naiwala Chandrasiri **Abstract:** Advances in deep reinforcement learning have enabled complex game-playing agents, and this study applies these techniques to the game of Tetris. Focusing on the initial board state at the start of each episode, we trained an agent under five conditions that combined three board-height settings (Zero, Random, Full) with two board-density settings (Sparse, Dense): Zero, Random–Sparse, Random-Dense, Full-Sparse, and Full-Dense. Our results showed that the Full condition enabled more efficient learning of line clearing near the top of the board compared to the Random and Zero conditions.

42	**Title: & Authors:** CasteriX: A Wheel Configurable Caster Wheel-Based Prototype Design for Electric Wheelchair Motion Dynamics Research A.G. Tharindu Gimras and Buddhika Jayasekara **Abstract:** While Electric Wheelchairs(EW) usage is rising in the modern world, challenges related to insufficient motion precision are becoming more prominent. Therefore, it's crucial to analyze EW's motion dynamics behavior with different wheel configurations. When considering EWs with non-reconfigurable caster wheels, most prior studies rely on a particular wheel configuration type EW for each study. Thus, understanding those EW's motion dynamics for different wheel configurations while keeping other parameters constant is challenging. Hence, it's notable that to overcome that issue, a wheel configurable EW research platform needed to be designed. Although there is an attempt to design a wheel configurable EW platform, it didn't have configurability in caster wheel arrangements. In order to solve that issue, this paper proposes a prototype wheel configurable modular robot research platform named CasteriX, which can be used for EWs with non-reconfigurable caster wheel motion dynamic analysis studies. CasteriX provides configurability in caster-wheel sizes and in both caster and drive-wheel positions while featuring a scalable, low-cost, modular design. It supports 212 wheel configurations covering the three major EW types and can be extended to robot wheel configurations with more than four caster wheels. To align with the quantitative characteristics of the reference Jazzy EW, the scale ratio is preserved throughout the design process. Moreover, to validate the qualitative characteristics, two main motion studies were conducted. The first one is to compare the reference Jazzy Air EW model and CasteriX motion studies, and the second one is to understand the complexity of motion studies by operating CasteriX under selected wheel configurations.
46	**Title: & Authors:** Soil Moisture Prediction for Indoor Potted Plants Using an ANN-Based Drying Model Tzu-Hsuan Tsai, Ping-Tse Lee, Yu-Chun Wang and Chan-Yun Yang **Abstract:** Improper watering is a major cause of indoor potted-plant failure. This paper presents a low-cost sensing and data pipeline for short-term soil moisture prediction in container cultivation. An ESP32 node with a soil moisture sensor and a DHT11 sensor uploads time-stamped data to a local server via HTTP, where measurements are stored in a MySQL database for long-term logging and offline analysis. To capture intrinsic drying behavior, data are collected under no-watering conditions. An ANN is trained to predict soil moisture change using only soil moisture, air temperature, and relative humidity, enabling stable short-term forecasting for future irrigation decision support.

51	**Title: & Authors:** Evaluating Topology Preservation in Dimensionality Reduction Methods for Metagenomic Data: A Comparative Analysis Chamuditha Jananga, Tharushika Prasadinie, Pasindu Malshan, Damayanthi Herath, Rajith Vidanaarachchi and Vijini Mallawaarachchi **Abstract:** Metagenomics employs high-throughput sequencing and computational methods to analyze microbial communities across diverse environments. This research comparatively evaluates dimensionality reduction (DR) methods for metagenomics by addressing the inherent computational challenges of high sparsity, compositionality, and dimensionality. We present a comparative study evaluating 8 DR techniques: Principal Component Analysis (PCA), Multidimensional Scaling (MDS), t-distributed Stochastic Neighbor Embedding (t-SNE), Uniform Manifold Approximation and Projection (UMAP), Potential of Heat-diffusion for Affinity-based Transition Embedding (PHATE), Self-Organizing Nebulous Growths (SONG), Pairwise Controlled Manifold Approximation Projection (PaCMAP), and Jaccard Principal Coordinates Analysis (PCoA). The data were processed via a robust preprocessing pipeline integrating non-zero Center Log-Ratio (nzCLR) transformation with iterative matrix completion. We utilize a comprehensive evaluation framework that incorporates both local and global topological preservation metrics: trustworthiness, continuity, normalized stress, k-nearest neighbor preservation. For non-Gaussian and sparse metagenomic data, we incorporated correlation metrics: Bray-Curtis dissimilarity, Aitchison distance, and Jaccard index. Our findings indicate that no single DR method is universally optimal; effectiveness depends on the specific scientific question and the type of biological distance being preserved for metagenomics data.
54	**Title: & Authors:** Development of a Concentration System for Oceanic Microplastic Monitoring Using Acoustic Radiation Force Yasuto Suzuki, Yoshikazu Koike, Takumi Ishiyama, Hirotaka Mine, Kousei Suzuki, Nobuyuki Futai and Hisayuki Arakawa **Abstract:** To enable in-situ monitoring of marine microplastics (MPs), a system integrating an autonomous ocean observation and concentration system and ultrasonic separation was developed. To reduce the cost and time of MP observation, it is important to extend the system by adding robotics and image-analysis techniques. In such a system, key components such as concentration, filtration, and separation play critical roles. A metal filter with an automated backwashing mechanism is utilized. This configuration enhances the concentration ratio. Furthermore, MPs are selectively isolated from biological impurities such as algae and zooplankton. Specifically, the feasibility of using a low frequency (47 kHz) Langevin transducer for high-power output was verified. Capturing an aluminum particle was successful. However, plastic particles (PE, PP) could not be trapped. This result was attributed to dominant acoustic streaming.Theoretical calculations indicate that increasing the frequency to approximately 1 MHz is necessary. This increase is required to overcome streaming effects and successfully capture MPs.

55	**Title: & Authors:** Performance Evaluation of Person Detection Using Scanless 3D Time of Flight Sensor Hyo Okawa, Masaya Kawamata, Tetsuya Ito, Tomonori Nakamura, Tatsutoshi Shioda and Tetsuya Manabe **Abstract:** This paper quantitatively clarifies the performance of scanless 3D Time-of-Flight (ToF) sensor for person detection, aiming to enhance the quality of location-based services. The experiments compare scanless 3D ToF sensor with cameras and scanning Light Detection And Ranging (LiDAR), both widely utilized for person detection, evaluating their performance in detecting two stationary persons under identical conditions. The experimental results demonstrate that the person detection performance of the scanless 3D ToF sensor is equivalent to that of the camera and, on average, 53% superior to that of the scanning LiDAR. Consequently, by investigating the characteristics of cameras, scanning LiDAR, and scanless 3D ToF sensor, insights contributing to the improvement of location-based service quality have been acquired, as this research contributes to determining the appropriate utilization environment for these devices.
97	**Title: & Authors:** Human Presence Detection from Hyperspectral Data Using PCA–Max-Pooling Integrated Dimensionality Reduction and Lightweight 3D CNNs Dulaj Umansha, Chinthaka Premachandra, Lasith Gunawardena, Hiroharu Kawanaka and Tomotaka Kimura **Abstract:** Hyperspectral imaging (HSI) provides rich spectral information that is well-suited for human detection in complex environments such as disaster sites, intelligent surveillance and autonomous systems. However, the high dimensionality of HSI data imposes computational challenges. This paper proposes a novel dimensionality reduction framework that integrates Spectral Pooling, Principal Component Analysis (PCA), and Spectral Embedding to aggressively compress hyperspectral data while preserving discriminative manifold structures. We further introduce EfficientHumanPresence, a lightweight 3D Convolutional Neural Network (CNN) utilizing depthwise separable convolutions to process this reduced representation. The proposed method is validated on a custom dataset of 1,000 hyperspectral images captured with a Cubert Ultris 5 camera across diverse lighting conditions. Experimental results demonstrate that the system achieves a classification accuracy of 69.33% and an ROC AUC of 0.77 on independent test data. These findings confirm the feasibility of using extreme spectral compression for real-time human sensing on edge devices.
99	**Title: & Authors:** Helmet Detection in Automated Teller Machine Surveillance Using Machine Learning Udara Aththanayaka, Thushari Silva and Waruna Premachandra **Abstract:** In Sri Lanka, ATMs and CDMs are indispensable for banking, especially in far-flung rural areas and bustling urban markets where human oversight is often minimal. Yet, these machines are frequent targets for crime, with culprits usually donning helmets to dodge identification by standard front-facing CCTV cameras. Drawing on this challenge, our study introduces a helmet detection system explicitly designed for Sri Lankan ATMs, using top-down camera views that capture headgear more effectively. We combined YOLO's fast object detection with MobileNetV2's efficient classification to create a system that runs smoothly on low-cost devices like Raspberry Pi, which is ideal for resource-scarce settings. Collaborating with Sri

	Lankan banks, we compiled a specialized dataset of ATM footage over three months, tackling challenges like inconsistent lighting and diverse camera angles to prepare our model for real-world conditions. Our system reliably detects helmet-wearing individuals and promptly notifies bank personnel, achieving a precision of 0.889, though its recall is somewhat limited. This solution provides an affordable means to strengthen ATM security across Sri Lanka's varied settings.
102	**Title: & Authors:** Investigating the Influence of Social Media Health Communities on Treatment Adherence and Patient Empowerment in Diabetes Vedamurthy Gejjegondanahalli Yogeshappa, Rajiv Avacharmal, Mukesh Soni, Durgesh Nandan, Rajit Nair and M. W. P. Maduranga **Abstract:** The rise of chronic disease patients' social media health communities has changed chronic disease patients' interactions with treatments, information, and peer support. This study employs an interdisciplinary approach that combines linguistic, behavioural, temporal, and social features, and, for the first time, analyses the impact of diabetes-focused online health communities on the adherence to and the empowerment of patients in their diabetes. We systematically analyse patient-generated data to derive metrics on adherence, consistent engagement, emotional engagement, and the informational value of contributions. We capture the treatment adherence behavioural model using the temporal engagement model, state change model, and peer dynamics model, embodying the dual behavioural approach theory. We derive the empowerment metric from a trilateral index on the sentiment, the information variance, and the extent of contribution, which would embody the confidence, information grandness, and the activation of the system. The experimental assessment indicates concerning adherence, empowerment, and literacy and engagement participation, an approach that outperforms the system generated from the social media data, traditional surveys, and some clinical surveillance approach. The emotional and clinical outcomes, the quality of the life indicators, the information reliability of the clinical outcomes, and peer-driven chronic disease digital ecosystems demonstrate a drastic improvement and mark the importance of these systems. Integrating the social, emotional, and behavioural aspects of analysis, the research illustrates the mechanisms by which online communities promote sustainable commitment and self-management. The research confirms that, properly analysed by social media analytics, online social communities of patients can enhance empowerment and improve health outcomes through more effective self-management and engagement in their diabetes care
103	**Title: & Authors:** Shape-Constrained Segmentation of Anatomical Structures Using Graph-Based Deep Learning in Low-Contrast CT Images Rajib Guha Thakurta, Anitha Christy Angelin P., Mukesh Soni, Durgesh Nandan, Rajit Nair and M. W. P. Maduranga **Abstract:** Weak boundaries, intensity ambiguity, and structural noise make accurate segmentation of anatomical structures in low-contrast CT images challenging. This paper describes a shape-prior-constrained, graph-based deep learning framework that utilizes a unique combination of convolutional feature extraction, graph neural network (GNN) relational reasoning, and spectral graph filtering with statistical shape anatomical templates. This framework is proposed to tackle a variety of segmentation conditions and achieve anatomically-prior-consistent segmentation. We consider CT volumes as weighted graphs, which allows us to perform feature propagation by neighborhood and model long-range dependencies. We encapsulate shape priors from eigen-shape representation in energy-based optimization to promote the anatomical plausibility of a segmentation while preserving variability across different patients. Anisotropic

	spectral filtering on the graph Laplacian is used to enhance the coherence of boundaries and to attenuate high-frequency noise, especially in low-contrast areas. With the introduction of viable alternatives to U-Net, Attention U-Net, nnU-Net, Swin-UNet, and GNN-only models, the proposed method, through thorough and extensive experimentation, has continued to show consistent success. Achieving a Dice similarity coefficient of 0.825, Jaccard index of 0.702, and boundary F1-score of 0.768, the method outperformed the previous best baseline (nnU-Net) by about 0.8-1.4% on most of the metrics. The average symmetric surface distance (ASSD) and 95% Hausdorff distance (HD) also reflect surface accuracy, which was previously (and consistently) underreported, at 1.62 mm and 8.9 mm respectively. Its robustness is demonstrated through a volumetric overlap error of 0.298 with corroborating true positive and true negative rate values of 0.851 and 0.932 respectively. A sensitivity score of 0.851 reinforces the explanation of this method showing the highest clinical acceptability score of 3.9 The attributed boundary realism, shape plausibility, and radiologist confidence, reflect increasing clinical acceptability attributed to even limited soft signage. These results confirm the highly clinically relavent segmentation combined the explicit shape constraints and graph based learning for low-contrast CT imaging.
78	**Title: & Authors:** Machine Learning Based Hybrid RF–VLC Modulation Classification with RIS-Assisted Channels Pasan Maduranga, Durgesh Nandan, Chamodya Nirmal and Isuru Lakmal **Abstract:** This work targets Machine Learning based modulation classification system in a hybrid Radio Frequency (RF) and Visible Light Communication (VLC) environment. The setup was also supported with Reconfigurable Intelligent Surfaces (RIS). An indoor space of dimensions a 5 m × 5 m × 3 m was simulated and it contained a ceiling mounted LED, an RF transmitter and several of RIS panels which help generate additional VLC paths by reflection. Five modulation formats were produced under AWGN over SNR levels ranging from 0 to 30 dB. Each sequence received was represented through time-domain statistics, selected FFT components, and I/Q-based features. A total of four ML classifiers, SVM, Random Forest, KNN and XGBoost were trained to identify the type of modulation. The classification accuracy increasing with SNR is shown by the results, with ensemble models achieving the highest accuracies. XGBoost shows an accuracy of 53% at 30 dB. RIS reflections provided a clear benefit at low SNR as it boosted received optical power, while causing minor degradation at high SNR due to small waveform distortions. With these findings, it is clear that unified RF–VLC modulation recognition is feasible and also shows the disadvantages introduced by RIS.

12.00-13.15 Lunch Break

Day 02 : March 08, 2026 (13.15~15.00)

Session 05: - Computer vision & Image processing 2-(Oral session) Chairs: Dr. Kohei Shimasaki, Dr. Upeksha Ganegoda	
Paper ID	Title, Authors and Abstract
104	**Title: & Authors:** Development of a speech reconstruction system using image vibration analysis with a high-speed camera Yuya Hamano and Kohei Shimasaki **Abstract:** Sound induces micro-vibrations in everyday objects, enabling non-contact sound reconstruction. This study explores full-field vibration measurement using a high-speed camera as an alternative to accelerometers and laser Doppler vibrometers. A 0–500 Hz sweep was applied to tissue, paper, and aluminum to evaluate their frequency responses. All mate- rials showed high-frequency attenuation, but tissue exhibited the most favorable response. A male voice was then played onto the tissue and recorded by the camera. The reconstructed audio contained noise and high-frequency loss, which were improved using spectral subtraction and the AI model VoiceFixer. Evaluation confirmed enhanced audio quality.
37	**Title: & Authors:** Parameter-Efficient Fine-Tuning for Vision-Language Models: The Post-Transformer Evolution Patalee Narasinghe and B.H. Sudantha **Abstract:** The rapid proliferation of large-scale Vision-Language Models (VLMs) has revolutionized multimodal artificial intelligence, enabling unprecedented capabilities in cross-modal understanding and generation. However, the substantial computational and memory requirements for fine-tuning these billion-parameter models present significant deployment challenges, particularly for resource constrained environments like mobile robots and edge devices. This survey provides a comprehensive analysis of Parameter-Efficient Fine-Tuning (PEFT) techniques tailored for VLMs in the post-Transformer era (2021-2025). PEFT methods are systematically categorized into three mechanistic paradigms: input-level adaptation (prompting), feature-level adaptation (adapters), and weight-level adaptation (reparameterization). Representative techniques, including CoOp, CoCoOp, MaPLe, CLIP-Adapter, Tip-Adapter, LoRA, DoRA, and PiSSA, are analyzed. These methods are critically evaluated regarding parameter efficiency, convergence, latency, catastrophic forgetting, and alignment preservation. Comparative benchmarking on ImageNet, VQAv2, and MMBench is used to isolate optimal strategies for distinct application needs. This analysis extends into specialized fields, critically examining adaptations for medical imaging, remote sensing, and video understanding, alongside privacy preserving federated learning. It is concluded that while competitive performance is offered by methods like DoRA and Tip-Adapter-F, the optimal strategy is critically dependent on the specific architecture, task complexity, and deployment constraints.

38	**Title: & Authors:** Three-Dimensional Motion Capture of Flying-Object Groups Using Event Cameras with Dynamic Features Makoto Kawae, Kouhei Shimasaki and Idaku Ishii **Abstract:**Three-dimensional analysis of multiple flying objects in flocks, such as birds and insects, is an important technology in biology and robotics. From a biological perspective, understanding three-dimensional flight trajectories contributes to mitigating societal challenges, including increasing agricultural damage caused by birds, bird-strike accidents, and insect pest control under recent environmental changes. However, the practical deployment of such analysis techniques has been limited by insufficient accuracy and high sensitivity to environmental conditions. To address these challenges, this study focuses on event cameras, which have not been widely used for three-dimensional analysis despite their robustness to environmental variations and their capability for high-speed, high-precision sensing. Leveraging the unique characteristics of event cameras, dynamic features such as velocity vectors and temporal area variations are extracted to establish robust stereo correspondences among individuals. These correspondences are then used to reconstruct three-dimensional trajectories through triangulation based on visible-light camera calibration. Finally, the reconstructed trajectories are mapped onto a pre-acquired three-dimensional environmental model, enabling accurate three-dimensional motion capture.
80	**Title: & Authors:** An Autonomous Advance-Scout Platform for Vision-Based Railway Obstacle Detection and Driver Assistance Supun Chandra Ampe Mohottalage, Nilupul Senevirathna, Chinthaka Premachandra and H. Waruna H. Premachandra **Abstract:**Train–wildlife and train–obstacle collisions present a serious safety challenge for railway operations in Sri Lanka, particularly due to elephant intrusions along railway tracks. This paper proposes a vision-based railway obstacle detection and driver assistance system that provides early warnings for hazards ahead of moving trains. The system consists of a Mobile Railway Monitoring and Transmission Unit (MRMTU) operating ahead of the train and a Train-Mounted Driver Assistance Unit (TMDAU) responsible for image processing and alert generation. The MRMTU captures real-time visual data and transmits it via a low-latency RF link, while the TMDAU performs railway track detection, object detection, and depth estimation to assess obstacle risk using a region-based safety framework. Experimental results show that the system reliably detects multiple obstacle types under varying speeds and generates timely visual warnings, demonstrating its potential to improve railway safety in wildlife-prone environments.

96	**Title: & Authors:** RGB - Thermal Fusion Techniques for Edge Detection in Low-Visibility Environments Ilsara Malavi Pathirage, K.B.N Lakmali, Sudantha B.H and B. H. N. Sudila **Abstract:** Edge detection is an important part of computer vision because it lets you accurately extract object boundaries for higher level tasks like object recognition, autonomous navigation, surveillance, and scene understanding. But traditional RGB-based edge detection techniques like Sobel, Prewitt, and Canny operators don't work as well in low light situations like nighttime scenes, fog, smoke, and low light conditions because they are sensitive to noise, have low contrast, and lose structural details. To overcome these limitations, recent studies have increasingly investigated the fusion of thermal imaging with RGB data, utilising the synergistic advantages of both modalities. In this review, RGB thermal multimodal approaches for edge detection and related vision tasks in visually impaired environments are thoroughly analysed. It thoroughly investigates recent multimodal fusion frameworks that were initially created for object detection and semantic segmentation, deep learning-based single modality approaches, and traditional edge detection techniques. Lastly, future research directions are described and open challenges are identified, such as cross-modal misalignment, thermal noise, limited edge-specific datasets, and computational constraints. For researchers and practitioners looking to create reliable multimodal edge detection systems for low-visibility and safety-critical applications, this review attempts to offer an organised reference.
100	**Title: & Authors:** Human Proximity Detection Using the Properties of Equirectangular Transformation of Omnidirectional Images and Object Tracking Y Shimbo, H.A. Harindu Y. Sarathchandra and Chinthaka Premachandra **Abstract:** With the increase in the elderly population, wheelchairs have become essential for transportation among older adults. Although many see wheelchairs as victims in traffic accidents, electric wheelchairs are more often the cause of collisions with pedestrians due to their greater mass and difficulty in quick operation. Since electric wheelchairs are classified as pedestrians, accidents involving them are usually treated as pedestrian-on-pedestrian incidents rather than traffic crashes, complicating efforts to address the problem. Existing proximity detection systems typically measure distances in real time or detect nearby objects; however, they do not specifically identify people. Traditional sensors like LiDAR have not been used to distinguish between dangerous approaches, such as a person or object approaching a wheelchair, and non-threatening crossings. In this study, we introduce a new method that uses images from an omnidirectional camera, which captures all directions, combined with distance calculations based on the properties of equidistant cylindrical projection to differentiate between approaching and crossing situations. By integrating these images with an object-tracking system, our approach can detect approaching objects from all directions in real time, automatically assess their potential threat, and determine whether they pose a danger. Evaluation results show that this system can detect approaching objects with over 95% accuracy at a minimum of 15 frames per second, offering a promising new solution for proximity detection.

101	**Title: & Authors:** Interpretable Predictive Maintenance Frameworks for High-Frequency IIoT Streams Using Sparse Transformer Attention Jyoti Devi, Rajiv Avacharmal, Mukesh Soni, Durgesh Nandan, Preeti Sharma Nair and M. W. P. Maduranga **Abstract:** This paper presents a framework for predictive maintenance with the ability to interpret high-frequency IIoT data streams using sparse transformer attention. The proposed architecture combines predictive maintenance with pre-processing, sparse temporal-sensor attention, and multi-step refinement. The refinement step increases the reliability of the decision further by using temporal embeddings, cross-time fusion, multi-scale state fusion, and attention based reconstruction. The proposed method was experimentally and empirically validated and it was found that pseudocode and statistical benchmarks, LSTM models, CNN-RNN models, and other current versions of transformers were less successful than the proposed method on 12 metrics. The most important results included a prediction accuracy of 93.6, F1 score of 91.8, Mean Absolute Error of 0.062, a Root Mean Square Error of 0.074, 185 MegaBytes of memory usage and 10.2 Joules of energy usage. The most important results included a predictive accuracy of 93.6, an F1 score of 91.8, a Mean Absolute Error (MAE) of 0.062, a Root Mean Square Error (RMSE) of 0.074, a memory usage of 185 MegaBytes. The energy usage was 10.2 Joules. The latency for detecting fault is at least 87 milliseconds, which is a confirmation that the application is suitable for real time use in the industry. The interpretability score of the model was 0.91 which is an indication that it is capable of producing relevant insights that is actionable and aligned with the discipline.

Tea Break : 15.00~ 15.15

Day 02 : March 08, 2026 (15.15~16.45)

Session 06: - Security, UAV and automation-(Oral session)

Chairs: Prof. Hiroharu Kawanaka, Mr. B. H. Sudantha

Paper ID	Title, Authors and Abstract
7	**Title: & Authors:** Real-Time Path Planning For Unmanned Surface Vehicles In Flooded Cityscape Yohantha D. Alwis and Buddhika Jayasekara **Abstract:** Due to human activities flooding becomes a faster growing natural disaster of the world. Even though many research has been done regarding rescue operation using robot systems but less research has been carryout regarding Unmanned Surface Vehicle (USV) in flood relief operations. This research presents a real-time path-planning system for USV utilizing aerial imagery from UAV to construct a real-time ground map and generate near-optimal navigation paths in flooded cityscapes. The system integrates map building, path planning, and decision-feedback algorithms to enhance rescue boat maneuverability, ensuring safe and responsive navigation in dynamic environments. A key contribution of this study is the development of an adaptive, real-time path-planning approach, incorporating clustering algorithms for waypoint optimization and obstacle detection techniques. The system combines LiDAR's 360-degree environmental awareness with stereo vision's depth perception to improve obstacle recognition, mitigating the limitations of individual sensors. For multi-waypoint navigation, the research evaluated three clustering algorithms, Genetic Algorithm (GA), Minimum Spanning Tree (MST) and Nearest Neighbor Algorithm (NNA), to determine the most effective method for real-time flood navigation. The study further compared three path-planning algorithms, A-Star (A*), Probabilistic Roadmap Method (PRM), and K-Nearest Neighbor (KNN) evaluating their performance in real-world flood scenarios. Final experiments demonstrated that the Modified Algorithm achieved shorter travel distances as the number of waypoints increased, highlighting its scalability and efficiency.
28	**Title: & Authors:** Simulating Dynamic Formation Flying for Enhanced Satellite Communication Dinith Madushan, Susara Thenuwara and H. Waruna H Premachandra **Abstract:** Dynamic flying formations clusters of satellites that autonomously reconfigure in real time offer transformative gains in coverage agility, latency resilience, and mission adaptability for next-gen satellite networks. Unlike static constellations, they enable rapid response to traffic surges, disruptions, mobility, and threats, supporting critical applications from disaster recovery to secure sensing. Realizing them requires multidisciplinary simulation frameworks integrating orbital dynamics, time-varying networking, stochastic channels, AI-driven control, and security. This paper surveys state of the art simulation methodologies, covering reinforcement learning for formation control, stochastic geometry for scalability, chaos-based encryption for secure imaging, and robotic testbed validation (e.g., Starlink Robot). We review tools from GMAT/STK (orbit), ns-3 (networking), and Gym-SatEnv (AI), assessing performance across rural, maritime, and tactical scenarios. Key challenges scalability, real-time adaptation, security–performance trade-offs, and standardization are identified. We conclude with a roadmap advocating IEEE-led benchmarking,

	open datasets, and co-simulation standards to advance autonomous satellite swarms from theory to practice.
52	**Title: & Authors:** Benchmarking CNN and Transformer-Based Object Detectors for UAV Solar Panel Inspection Ashen Rodrigo, Isuru Munasinghe, Asanka Perera and Pubudu Sanjeewani **Abstract:** Timely and accurate detection of defects and contaminants in solar panels is critical for maintaining the efficiency and reliability of photovoltaic (PV) systems. While recent studies have applied deep learning to PV inspection, fair benchmarking across detector architectures and unbiased handling of class imbalance remain limited. This work presents a comprehensive benchmark of convolutional and transformer-based object detectors on UAV-captured RGB imagery of solar panels. It introduces a class-targeted augmentation strategy applied exclusively to the training split to mitigate imbalance without compromising evaluation integrity. Faster R-CNN with ResNet50 and MobileNetV3 backbones, RetinaNet with ResNet50, YOLOv5, YOLOv8, and Swin Transformer backbones integrated with Faster R-CNN (Tiny, Small, and Base variants) are evaluated. Performance is assessed using mean Average Precision (mAP) across multiple IoU thresholds, precision, recall, F1 score, and inference throughput to enable accuracy-throughput tradeoff analysis relevant to UAV deployment. Experimental results show that Faster R-CNN with a ResNet50 backbone achieves the highest localization accuracy, with mAP@0.5 of 0.893 and mAP@0.5:0.95 of 0.759, whereas the MobileNetV3 variant provides the best overall reliability balance, achieving recall of 0.745, F1-score of 0.809, and accuracy of 0.679 on the test set.
57	**Title: & Authors:** Automated Intelligent Fall Detection and Alert System for Elders Pavithra Shantha and Susantha Wijesinghe **Abstract:** Falling is among the significant sources of injury in elderly persons, usually resulting in serious health aftermaths and long-term disability. Existing fall detection systems typically do not find a balance between accuracy, real-time response, and privacy for the user. An Automated Intelligent Fall Detection and Alert System (AIFDAS) is introduced in this work, which attempts to overcome these shortcomings. The system uses a wearable gyroscope-accelerometer sensor and an ESP32 microcontroller, collecting motion data from various activities and simulated falls. Data is preprocessed through noise filtering, normalizing, and segmenting into time windows, which is fed to a Python-developed machine learning-based algorithm. This premium artificial intelligence model, distilled for low-processor consumption, is deployed directly onto the ESP32, enabling quick, on-device fall detection and reducing the necessity for cloud connectivity. Upon detection of a fall, the system logs the incident immediately on a Firebase database and also sends real-time notifications to caregivers via a dedicated web application and mobile application. Controlled trials have demonstrated the system performing well with an accuracy exceeding ninety-two percent and a minimal false positive rate, enabling interventions at suitable moments. The AIFDAS is a low-cost, portable, real-time solution and a significant advance in monitoring the elderly for safety.

73	**Title: & Authors:** A Topic Centric Communication Architecture for Drone Swarms: Zenoh-based drone network over an Optimized BATMAN-adv Mesh Arockia Doss, Jeevesh Somasundaram and Chinthaka Premachandra **Abstract:** Autonomous drone swarms operating in mixed BVLOS and LOS environments demand a communication architecture that delivers both low latency and high bandwidth efficiency. Current solutions, however, force an unacceptable trade-off: robust mesh protocols such as BATMAN-adv provide the needed resilience but incur high baseline latency—typically around 300 ms in our measurements—while lighter, toic-centric framework preserve low latency at the expense of resilience and impose considerable overhead. This paper proposes a unified communication stack that eliminates this compromise. We first reduce BATMAN-adv's latency for real-time traffic through targeted optimization of its hop penalty and routing metrics. On this strengthened mesh foundation, we replace MAVLink's traditional polling model with the data-centric Zenoh protocol, exploiting its efficient publish-subscribe semantics and queryable callbacks to minimize network load. Validation is performed using a MAVSDK–Zenoh bridge, which—despite constituting a transient serial bottleneck—reduces end-to-end latency by more than 80 %, from 300 ms to 58 ms.
82	**Title: & Authors:** Reinforcement Learning-Based Autonomous UAV Navigation in Indoor Environments Towards Human Detection Vishwani Geeganage, Chinthaka Premachandra, Sudantha B.H, Lakmina Gamage and Haritha Weerathunga **Abstract:** Unmanned Aerial Vehicles (UAVs) have become indispensable in search and rescue (SAR) missions by enabling rapid aerial reconnaissance in unstructured and GPS denied environments that are inaccessible to ground teams. Conventional autonomous navigation systems typically depend on heavy sensor suites such as LiDAR or reliable GPS signals, which are often impractical for lightweight and low-cost rescue drones operating in cluttered indoor spaces, including partially collapsed buildings in disaster zones. To address this limitation, this paper introduces a cost-effective, fully autonomous UAV navigation framework that leverages Deep Reinforcement Learning (DRL) to replace brittle rule-based decision logic with adaptive policy learning. The framework integrates real-time human detection using a monocular RGB camera and YOLOv8, and evaluates two DRL strategies for autonomous indoor maneuvering toward detected humans, specifically Deep Q-Network (DQN) and Proximal Policy Optimization (PPO). Simulation results indicate that rule-based navigation fails to generalize to dynamic and unstructured conditions. Although DQN shows limited reliability, the PPO based agent achieves substantially higher navigation success rates and more stable decision policies. The proposed system is further validated through Sim to Real transfer using a DJI Tello drone on indoor flight tasks, demonstrating practical deployment without expensive sensing hardware. The results confirm the feasibility of lightweight, low-cost, vision based autonomous UAV agents capable of adaptive indoor navigation toward detected humans.

Day 02 : March 08, 2026 (16.45~17.00)

Award Ceremony : 16.45~17.00 By Award Chairs **Vote of Thanks:**
End of Day 02