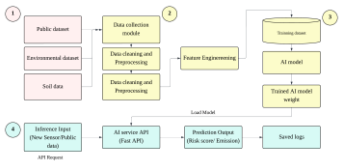
Abstract

PS Abstract (3)

PS1 Multimodal AI Framework for Urban Environmental Intelligence Integrating Hazard and Risk Prediction

Young-Im Cho (Gachon University, Republic of Korea)

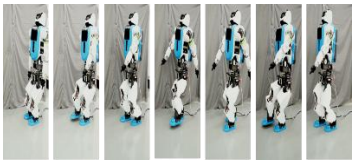
The study presents an integrated AI framework for environmental intelligence in smart cities, combining 3D ecological analysis with multivariate risk prediction. The proposed system unifies LiDAR-based tree-structure modeling with real-time underground hazard and carbon-emission forecasting. A PointNet++-based module extracts structural indicators from urban trees, while a Temporal Fusion Transformer (TFT) predicts emissions and facility risks using multimodal public and sensor data. To enhance interpretability, a SHAP-based cause-contribution layer quantifies feature influence, and a constraint-aware action model generates operational recommendations. Experimental evaluation demonstrates that multimodal integration improves predictive accuracy and provides interpretable decision support. The framework introduces a generalizable theoretical model for cross-domain urban environmental analytics.



PS2 AI Enabled Intelligent Robotics: Evolving Applications and Opportunities

Ren C. Luo (National Taiwan University, Taiwan)

Recently the development of AI enabled large-scale models has given robots the ability to be applied to more complex scenes. That is, the robot will rely on the large model to give embodied artificial intelligence, which means that the robot has intelligent behavior and adaptability, and it can interact with the environment and implement actions. It is estimated that the global market size of robots in the intelligent manufacturing automation and many services such as hospital, elder care, hotel, restaurant etc. will reach tens of billions of dollars per year after 2030. It is perceived that embodied intelligent robots consists of components such as sensors controllers, robotic arms, and dexterous hands to achieve perception and interaction with the environment. Enhanced by artificial intelligence, they have the capabilities of semantic understanding, human-computer interaction, and autonomous decision-making to achieve task understanding and response. The aforementioned issues, challenges and opportunities will be discussed including some research results on intelligent robotics control and manufacturing automation with video demo from our NTU intelligent robotics and automation (iCeiRA) Lab.



PS3

Multi-Agent Simulation of Influenza Epidemics and Evaluation of Infection Control Measures）

Saori Iwanaga (Japan Coast Guard Academy, Japan)

OS Abstract
OS1 Industrial Artificial Intelligence Robotics (11)
Chair Eiji Hayashi (Kyushu Institute of Technology, Japan)

OS1-1 Design and Development of a ROS2–Android Based Remote Control System for an Autonomous Beach Cleaning Robot

Weizheng Pan, Chi Jie Tan, Eiji Hayashi (Kyushu Institute of Technology, Japan)

This study presents a ROS2–Android based remote control framework for an autonomous beach cleaning robot. The system employs a FastAPI–Retrofit architecture to enable seamless bidirectional communication between the Android application and ROS2 nodes. High-level control functions—including robot startup, tracking, and camera streaming—are implemented via RESTful APIs, while real-time GPS and video feedback provide situational awareness. OpenStreetMap is integrated for intuitive path visualization and route planning. By combining modular ROS2 node design with lightweight network protocols, the proposed approach ensures robust connectivity, scalability, and user accessibility in outdoor environments. Experimental evaluation demonstrates reliable performance and responsiveness, confirming the system's effectiveness for remote operation and real-time monitoring of autonomous coastal cleaning robots.

OS1-2 Improved Multi-Object Tracking System Using 3D–2D Image Data Fusion for Beach Cleaning Robot

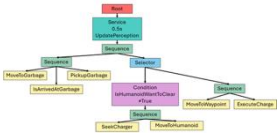
Rut Yatigul, Tan Chi Jie, M.A Munjer, Wisanu Jitviriya, Teppakorn Sittiwanchai, Watcharin Tangsuksant, Eiji Hayashi
(Kyushu Institute of Technology, Japan, King Mongkut's University of Technology Thailand)

This research introduces a 3D-2D image data fusion mechanism to enhance Multi-Object Tracking for marine debris detection. Traditional systems relying solely on 2D data cannot reidentify long-occluded objects that leave and re-enter the frame. The proposed system combines RGB and depth data from an RGBD camera on a Beach Cleaning Robot, registering each tracked object with 3D coordinates referenced to the robot's starting point for accurate ID reassignment. The system achieved 80.02% reidentification accuracy in simulation and 78.33% in real-world tests despite odometry drift. Results demonstrate that 3D-2D fusion provides robust tracking for long-occluded objects, offering practical value for Multi-Object Tracking across computer vision applications.

OS1-3 LLM-Supervised Genetic Programming for Multi-Robot Behavior Tree Evolution

Chi Jie Tan, M.A Munjer, Weizheng Pan, Eiji Hayashi, Way Soong Lim
(Kyushu Institute of Technology, Japan, Multimedia University, Malaysia)

A genetic programming framework supervised by large language models (LLMs) is presented for the evolution of multi-robot behavior trees. In this framework, LLMs are utilized as adaptive supervisors to regulate evolutionary processes. The method consists of two phases: (i) mutation rate adaptation, in which convergence patterns, diversity metrics, and fitness trajectories are evaluated at epoch boundaries to adjust evolutionary parameters; and (ii) diversity injection, in which targeted population seeding and intervention strategies are applied when premature convergence is detected. By incorporating context-aware parameter control and systematic diversity management, several limitations of traditional genetic programming are mitigated. Preliminary results indicate improvements in both convergence speed and solution quality under LLM-supervised guidance.



OS1-4 Tree Mapping in Forests with LiDAR–RGB Fusion

M.A Munjer, Tan Chi Jie, Boufaroua Vincent, Eiji Hayashi (Kyushu Institute of Technology, Japan)

This study presents a LiDAR–RGB fusion framework for automated tree stem detection and mapping, emphasizing Kalman filter–based estimation. YOLO detections are fused with LiDAR point clouds and accumulated in a global frame using odometry. The Kalman filter integrates sequential observations, suppresses noise, and ensures stable mapping. Field experiments show that predicted inter-tree distances align closely with laser-based ground truth, with minor deviations under partial visibility. Detection performance confirms robustness, achieving near-perfect Precision, 0.89 Recall, 0.91 Accuracy, and an F1-score of 0.94. Results demonstrate that Kalman filtering enables reliable tree position mapping, suitable for automated forest inventory and monitoring.

OS1-5 System development of autonomous mobile field robots - Feature Matching Method for Expanding Human Tracking Functions -

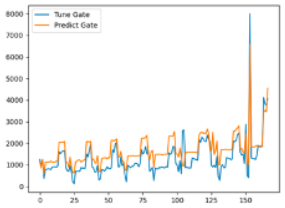
Satoshi Yamaguchi, Eiji Hayashi (Kyushu Institute of Technology, Japan)

In recent years, the increase in marine litter has become a serious environmental issue. To reduce the amount of debris washed ashore, coastal cleanup activities are being conducted nationwide. However, collecting large and heavy debris is extremely difficult in coastal areas with unstable footing. Therefore, we are developing an autonomous mobile field robot for collaborative tasks, in which humans collect debris and the robot transports it. In this study, we propose a method to re-identify the target person using AKAZE-based feature point matching, with the aim of enabling the robot's human-following function to automatically resume tracking when the target re-enters the frame after leaving it.

OS1-6 Support System for Editing Performance Information for an Automatic Piano -Construction of a System to Extract Elements from Score and Real Performance-

Ryuta Matsuda, Eiji Hayashi (Kyushu Institute of Technology, Japan)

This study developed a new element extraction system to create expressive MIDI data for an automatic piano, replacing a prior system that relied on outdated software. The system extracts parameters from MusicXML scores and real MIDI performances (e.g., from Ashkenazy's playing). The extraction component showed high precision, achieving up to 100% agreement with the score's note count, outperforming the previous study. However, when inputting the extracted data into the inference system, the prediction accuracy was low (e.g., Velo correlation 0.41, Step correlation 0.39). This is attributed to the inadequate matching system used to combine the score and performance elements. Future work will focus on improving the element matching system to enhance inference accuracy.



OS1-7 Enhancing Squeeze-and-Excitation Networks with Mixed Pooling for Image Classification

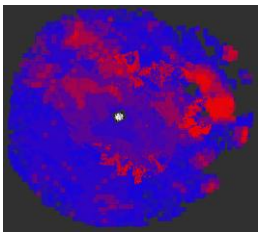
Rut Yatigul, Teppakorn Sittiwanchai, Aran Blattler, Eiji Hayashi, Wisanu Jitviriya
(King Mongkut's University of Technology Thailand, Kyushu Institute of Technology, Japan)

This research introduces a mixed pooling mechanism to improve Squeeze-and-Excitation Networks for image classification. Traditional Squeeze-and-Excitation Networks use average pooling for squeeze operations to extract feature information fed to fully connected layers for channel weight assignment. The proposed mixed pooling approach fuses max pooling and min pooling at equal ratios, replacing average pooling in the SE attention block. Evaluation on SE-VGG16 architecture using a five-class tomato ripeness dataset with 10-fold cross-validation shows superior performance, with VGG16+SE(Mixed Pool) achieving an average F1 score of 0.8562. Mixed pooling proves to be a robust strategy that improves feature representation in Squeeze-and-Excitation Networks.

OS1-8 Merging of Geometric and 3D Semantic Costmaps for Navigation in Complex Outdoor Environments

Boufaroua Vincent, Chi Jie Tan, Eiji Hayashi
(Kyushu Institute of Technology, Japan)

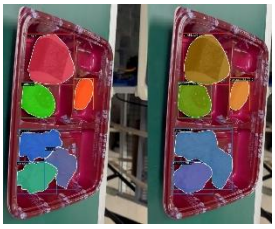
Outdoor autonomous navigation presents several challenges, including the nature and geometry of the terrain on which the robot evolves. These characteristics of the environment must be carefully considered to compute the safest and most efficient path towards the robot's goal, while avoiding obstacles or getting stuck. This study aims to integrate these terrain characteristics into the robot's path planning by generating and merging two complementary costmaps. The first costmap represents the terrain's geometry, computed from the slopes derived from the LiDAR point cloud projected to a 2D grid. The second costmap models the terrain's nature, obtained through semantic segmentation of RGB-D images, in combination with the RTAB-Map SLAM framework, to generate a semantically enriched map.



OS1-9 The research on food segmentation technology in the ready-to-eat food industry

Yamato Fukuiri, Gamolped Prem, Eiji Hayashi (Kyushu Institute of Technology, Japan)

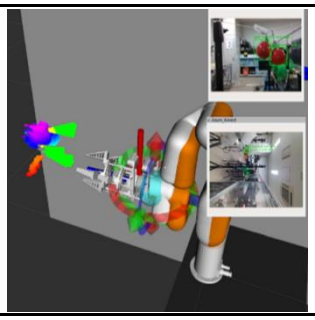
In recent years, the externalization of food has progressed in Japan, leading to increased demand in the ready-to-eat meal industry. Meanwhile, the decline in the labor force and the aging population have made improving labor productivity an urgent issue. Previous studies enabled the grasping of karaage(fried chicken) and onigiri(rice balls) using real-time object detection; however, challenges remain in the accuracy of instance segmentation and in handling high-demand foods such as tamagoyaki(rolled omelets) and hanba-gu(hamburgers). This study aims to identify the most suitable deep learning model for improving recognition accuracy and to construct a food dataset for bento meals that meets consumer needs.



OS1-10 Deep Reinforcement Learning with NVBlox TSDF Mapping for Grasp Optimization Using a Custom Force-Sensing Three-Finger Gripper

Yon Pang Ja Sin, Bytyqi Vjosa, Gamolped Prem, Eiji Hayashi (Kyushu Institute of Technology, Japan)

This study aims to develop a deep reinforcement learning (DRL) framework for optimizing grasping poses of an xArm7 robotic manipulator equipped with a custom three-finger gripper integrated with force sensors. The system focuses on combining YOLO-based tomato detection and NVBlox-generated TSDF and ESDF mapping with a Soft Actor-Critic (SAC) agent that outputs roll–pitch–yaw orientation and XYZ positional offsets for the gripper. Multi-point collision evaluation is performed using STL-sampled finger points with ESDF-based distance feedback and force-sensor responses for safe contact assessment. The framework is designed for real-time operation on ROS2 Humble with GPU acceleration, aiming for adaptive and robust online grasp learning in agricultural environments.



OS1-11 Robust round object occlusion identification and localization using an algebraic nine-field method for local exploitation

Anna Biedermann, Eiji Hayashi (Kyushu Institute of Technology, Japan)

Occlusions of fruit and vegetables in natural orchard environments diminish accurate harvesting success rates. The random distribution of fruit cluster growth and complexity in occlusion areas poses challenges in the identification of key points required for fully automated picking. This paper presents an algebra-based approach to occlusion detection and localization of round objects such as tomatoes seen in 2D planes. We have proposed an automated enrichment of 2D object relations by identification and localization of occlusion, which utilizes second order Polynomials fitted to nine zones of segmentation masks to determine the direction and area of occlusion.

OS2 Safety Intelligent Life Trend and Challenge (4)

Chair I-Hsien Liu (National Cheng Kung University, Taiwan)

Co-Chair Chu-Fen Li (National Formosa University, Taiwan)

OS2-1 A Dynamic Bayesian Game Model for Emergency Vehicle Evasive Decision-Making at Unsignalized Intersections

Zhi-Yuan Su, Wei-Xiang Li, Jung-Shain Li, I-Hsien Liu, Kuan-Ting Lee
(National Cheng Kung University, Taiwan)

This study addresses the complex challenge of decentralized decision-making for mixed-V2X and non-V2X-equipped vehicles at unsignalized intersections. We propose a Dynamic Bayesian Game framework where the game is re-evaluated at each simulation step based on the evolving traffic environment. To capture real-world uncertainty, we introduce incomplete information stemming from a detailed V2X communication simulation. This layer models physical-layer properties, including Signal-to-Noise Ratio based on path loss and AWGN, to determine packet reception success. The framework is validated in a MATLAB-SUMO co-simulation, demonstrating robust safety and efficiency under communication uncertainty. A key component of our framework is the decentralized process of belief formation. Each agent autonomously constructs a probabilistic belief over its opponents' unobserved types (e.g., driving styles). This belief is updated dynamically, using precise information from successfully received V2X messages or reverting to a shared prior distribution upon communication failure.

OS2-2 Challenges of Self-Driving Cars at Unsignalized Intersections

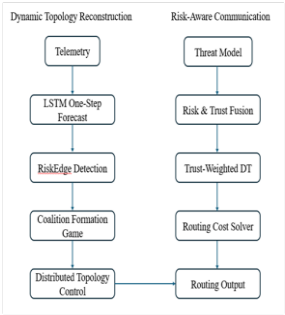
Kuan-Ting Lee, I-Hsien Liu, Wei-Xiang Li (National Cheng Kung University, Taiwan)
Chu-Fen Li (National Formosa University, Taiwan)

Autonomous driving in mixed traffic remains one of the most challenging topics in intelligent transportation systems (ITS). This study focuses on the interaction between autonomous vehicles (AVs) and human-driven vehicles (HVs) at unsignalized intersections, where right-of-way decisions are made without external coordination. A comprehensive set of microscopic simulation scenarios was constructed to analyze yielding and non-yielding behaviors under varying approach conditions, including combinations of straight, left-turn, and right-turn movements, as well as variations in approach speed and acceleration. The results show that, despite the high overlap among time-related features, the proposed analytical framework can still distinguish between behavioral outcomes, revealing the intrinsic uncertainty and variability of human–machine decision interactions. This work highlights the behavioral challenges faced by self-driving vehicles in complex urban environments and provides a reproducible foundation for future studies on intelligent transportation and vehicle-to-everything (V2X) systems in mixed traffic.

OS2-3 Endogenous Anti-Jamming Strategies for UAV Swarms: Dynamic Topology Reconstruction and Risk-Aware Communication

Ching-Fang Yang (Cheng Shiu University, Taiwan)
Kuan-Ting Lee (National Cheng Kung University, Taiwan)

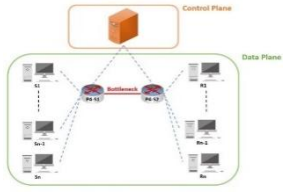
In adversarial environments, unmanned aerial vehicle (UAV) swarms require resilient communication to maintain coordinated operations. An endogenous anti-jamming framework is proposed that couples Dynamic Topology Reconstruction (DTR), driven by one-step link-quality forecasting and coalition formation, with Risk-Aware Communication (RAC), a trust-weighted decision tree classifier (TWDT) that steers routing away from compromised links and nodes. The system and threat models are formalized, per-link risk and trust fusion is derived, and distributed algorithms with complexity bounds are presented, covering barrage, reactive, and smart jamming. A reference implementation targets resource-constrained onboard processors and edge coordinators. The approach is designed to improve packet-delivery ratio, reduce outage time, and limit handover churn under strong interference, while keeping computation and signaling overhead bounded.



OS2-4 Lyapunov-Driven Adaptive Queue Management for P4-Programmable SDN: Stability-Guaranteed Low-Latency Control against Bufferbloat

Wei-Xiang Lin[1], Ming-Syuan Wu[1], Ya-Chen Li[1]*, Wen-Shyang Hwang[1], Cheng-Han Lin[2], Yu-Chi Lin[1]
[1](National Kaohsiung University of Science and Technology, Taiwan), [2](Fooyin University, Taiwan)

As Internet applications continue to expand, maintaining efficient network transmission has become increasingly challenging. Oversized router buffers often cause excessive queuing delays, a phenomenon known as bufferbloat. To address this problem, we propose a Lyapunov-based Adaptive Queue Management mechanism for Software-Defined Networking. The data plane utilizes P4-programmable switches for packet parsing and delay monitoring, enabling timely packet dropping during congestion. Meanwhile, the control plane dynamically adjusts queue thresholds to maintain stability under varying traffic conditions. Simulation results show that the proposed mechanism reduces queue length and latency compared with the CoDel algorithm, demonstrating its effectiveness in mitigating bufferbloat and improving network Quality of Service .



OS3 Trust and Innovation in AI-Driven Intelligent Living (4)

Chair: I-Hsien Liu (National Cheng Kung University, Taiwan)

Co-Chair: Jung-Shian Li (National Cheng Kung University, Taiwan)

OS3-1 Exploring the key factors of innovation in AI health management services using FAHP

Li-Min Chuang, Zong-Sheng Li (Chang Jung Christian University, Taiwan)

This study explores service innovation in AI-powered healthcare management, employing the four-facet theory (New service concept, new client interface, new service delivery system and technological options) combined with the Delphi method and the Fuzzy Analytic Hierarchy Process (FAHP) for analysis. The results indicate that the most critical indicators are cross-platform data integration, remote care and monitoring, AI algorithm accuracy, and data privacy and security. Experts emphasize that medical data standardization, remote application integration, algorithm reliability, and privacy protection will be core to the future development of AI-powered healthcare management.

OS3-2 Critical Success Factors of Taiwan's Multi-Level Marketing Industry in the AI-Driven Digital Era

Li-Min Chuang, Hsieh Tsung Hsien (Chang Jung Christian University, Taiwan)

In recent years, AI and digital technology have developed rapidly, becoming deeply integrated into people's daily lives. Various business models and consumer habits are increasingly influenced by digitalization. Traditional multi-level marketing (MLM) models, centered around person-to-person, face-to-face communication, face the risk of becoming obsolete if they fail to adapt to the AI-driven digital age through digital transformation. The findings of this study will help companies develop effective strategies to address the rapidly changing market environment and consumer demands during this digital transformation.This study aims to explore the strategies and sustainable development of Taiwan's MLM industry in the AI-driven digital age. First, based on relevant domestic and international literature, including research findings on the multi-level marketing industry and international marketing strategies in the digital age, this study employed a modified Delphi method, inviting eight scholars and experts to discuss and reach a consensus. They identified four primary dimensions: "cross-border feasibility," "internet reach," "shopping convenience," and "marketing innovation." These dimensions were further broken down into three secondary dimensions, for a total of twelve. A Fuzzy Analytic Hierarchy Process questionnaire was then developed, with 13 industry representatives extracting the weights and rankings of each primary and secondary dimension regarding the "Key Success Factors of Taiwan's Multi-Level Marketing Industry in the AI Digital Era." This research then summarized its conclusions and constructed five major propositions. It is hoped that these findings will provide concrete advice for Taiwanese multi-level marketing practitioners, helping them to continue to thrive in the AI digital age

OS3-3 Exploring the Relationship Between Moral Development and Internet-Triggered Academic Dishonesty Behavior among Cadets in Taiwan

Shu-Hua Huang (Air Force Institute of Technology, Taiwan)
I-Hsien Liu (National Cheng Kung University, Taiwan)

This study investigated the relationship between moral development and Internet-Triggered Academic Dishonesty (ITAD) behavior among military cadets in Taiwan. A mixed-methods design was employed, gathering data from 161 cadets who using a standardized moral development scale and a structured questionnaire assessing ITAD attitudes and behaviors. Quantitative analysis indicated that while cadets generally reported high levels of moral development, binary logistic regression revealed that higher moral maturity significantly predicted a reduced likelihood of engaging in ITAD. However, the overall explanatory power of this model was limited. Qualitative data analysis provided crucial context for this finding, revealing that cadets often held lenient moral judgments toward ITAD. Participants frequently rationalized these behaviors, indicating a belief that such actions do not necessarily constitute a fundamental moral defect. These findings highlight a complex interplay, and a potential disconnect, between cadets' moral reasoning and their situational ethics regarding academic integrity in the era of artificial intelligence.

Summary of Binary Logistic Regression Analysis Predicting

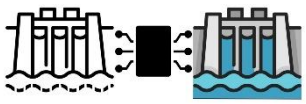
	B	SE	Wald	OR	Coefficient of Determination
Moral Justice	0.325	0.138	5.516*	1.384	Cox-Snell R^2=.084
Moral Cognition	0.048	0.136	0.124	1.049	Nagelkerke R^2=.13
Moral Behavior	0.036	0.156	0.053	1.037	
Moral Concern	-0.172	0.265	0.422	0.842	
Constant	-6.633	1.798	13.611***	0.001	
	χ^2=14.200** Hosmer-Lemeshow χ^2=12.941 n.s.				

P.S.: *p<.05 **p<.01 ***p<.001 n.s. p>.05

OS3-4 A Novel Digital Twin Framework for Industrial Control System: Cybersecurity Testbed Trends and Challenges

Han-Yang Yu, Jung-Shain Li, I-Hsien Liu (National Cheng Kung University, Taiwan)

Conducting practical experimentation on live Industrial Control Systems is exceptionally difficult due to the significant risk of operational disruption. However, much cybersecurity research, relying on simplified simulations, is often challenged for its significant gap with real-world scenarios. Digital Twin technology is widely regarded as a key solution to this challenge, providing a safe virtual environment for testing and analysis. This study develops the CySEC-vRT virtualized testbed, integrating both IT and OT components within a segmented network architecture composed of a virtual firewall and dual Network Intrusion Detection Systems to achieve comprehensive observation and traffic monitoring. This study compares CySEC-vRT with representative Digital Twin solutions to analyze the trends and challenges of existing frameworks in ICS applications. It demonstrates how CySEC-vRT implements the core concepts of Digital Twin to enhance model observability and reproducibility, providing a feasible experimental foundation for subsequent application and validation in the ICS domain.



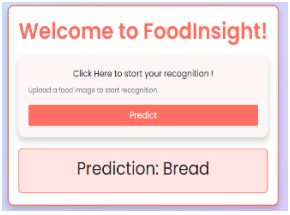
OS4 Applied Machine Learning and Intelligent Systems (10) on line presentation

Chair Kasthuri Subaramaniam (Universiti Malaya, Malaysia)
Co-Chair Abdul Samad Bin Shibghatullah (Universiti Tenaga Nasional, Malaysia)

OS4-1 Comparative Performance Analysis of Random Forest and SVM Classifiers in Food Image Recognition

Eason Yan Yi Chen[1], Kasthuri Subaramaniam[2], Shayla Islam[3], Oras Baker[4], Raenu Kolandaisamy[5]
([1,3,5]UCSI University, Malaysia, [2]Universiti Malaya, Malaysia, [4]Ravensbourne University London, UK)

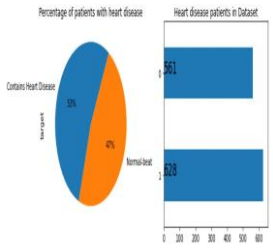
This research presents the design and implementation of an AI-based Food Recognition System capable of classifying food items from images to support dietary monitoring, health assessment, and automated meal tracking. The system employs machine learning algorithms trained on an extensive food image dataset, with Random Forest (RF) and Support Vector Machine (SVM) models evaluated for classification accuracy and robustness. Performance metrics, including accuracy, precision, recall, and F1-score, were computed to assess model effectiveness. A web-based interface was integrated to enable real-time image classification and user feedback, demonstrating the system's practicality and usability.



OS4-2 Optimized Ensemble Learning Framework for Early Cardiac Risk Prediction Using Random Forest and XGBoost

Oras Baker[1], Kasthuri Subaramaniam[2], Sellappan Palaniapan[3], Abdul Samad Bin Shibghatullah[4]
([1]Ravensbourne University London, UK, [2]Universiti Malaya, Malaysia,
[3]Help University, Malaysia, [4]Universiti Tenaga Nasional, Malaysia)

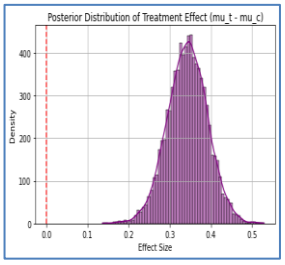
Cardiovascular disease remains a leading global cause of mortality, underscoring the urgent need for accurate, early-stage diagnostic systems that can reduce the burden on healthcare infrastructure. This study develops an autonomous machine learning framework for early cardiac risk detection using ensemble-based predictive modelling. This research employs a rigorous multi-phase methodology encompassing comprehensive literature analysis, data engineering, feature extraction, and algorithmic optimisation using Kaggle-sourced clinical datasets. Among the models evaluated, Random Forest (RF) and XGBoost. The study's significance lies in demonstrating that an optimised hybrid ensemble can achieve near real-time, high-fidelity cardiac risk prediction, offering a robust alternative to conventional diagnostic practices.



OS4-3 A Bayesian Approach to Pilot Trial Inference in Rare Disease Research: Application to Spinal Muscular Atrophy

Sellappan Palaniapan[1], Kasthuri Subaramaniam[2], Oras Baker[3]
([1]Help University, Malaysia, [2]Universiti Malaya, Malaysia, [3]Ravensbourne University London, UK)

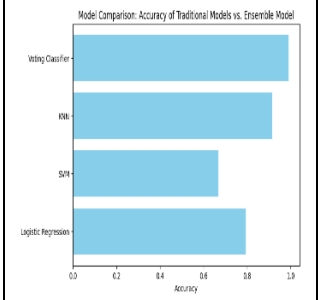
This study investigates a Bayesian framework for extrapolating evidence from limited pilot data to support the design of larger clinical trials, using spinal muscular atrophy as a representative case. Simulated pilot data were analysed through Bayesian linear regression. Posterior distributions were generated using Markov Chain Monte Carlo (MCMC) sampling, with diagnostic checks confirming convergence and credible posterior estimates. The results revealed a positive treatment effect with a 95% Highest Density Interval excluding zero, indicating strong evidence of efficacy even under data scarcity. The significance of this study lies in demonstrating that Bayesian modelling can enhance transparency, reproducibility, and regulatory readiness in rare disease trials.



OS4-4 Ensemble Learning Framework for Robust Malware Classification: Integrating Feature-Optimized Voting Classifiers

Oras Baker[1], Kasthuri Subaramaniam[2], Sellappan Palaniapan[3], Abdul Samad Bin Shibghatullah[4], Chit Su Mon[5]
([1]Ravensbourne University London, UK, [2]Universiti Malaya, Malaysia,
[3]Help University, Malaysia, [4]Universiti Tenaga Nasional, Malaysia
[5]Heriot-Watt University Malaysia, Malaysia)

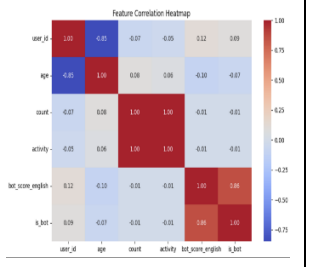
This study presents a novel ensemble learning framework that integrates Random Forest, Gradient Boosting, and a meta-level Voting Classifier to enhance malware detection performance. The methodology incorporates advanced feature engineering techniques, including entropy-based feature selection and structural byte analysis, using the ClaMP Integrated-5184 dataset. Experimental evaluation demonstrates that the proposed ensemble model significantly outperforms conventional classifiers such as Logistic Regression, Support Vector Machines, and K-Nearest Neighbours across all major metrics. The significance of this research lies in establishing classifier fusion as an effective paradigm for next-generation cybersecurity systems, providing a balanced solution to the persistent accuracy-adaptability trade-off in malware detection.



OS4-5 Behavioural Analysis and Machine Learning for Social Media Bot Detection: A Comparative Study of Random Forest, SVC, and Decision Trees

Kasthuri Subaramaniam[1], Oras Baker[2], Sellappan Palaniapan[3], Umm E Mariya Shah[4], Chit Su Mon[5]
([1]Universiti Malaya, Malaysia, [2]Ravensbourne University London, UK,
[3]Help University, Malaysia, [4]International Islamic University Malaysia, Malaysia,
[5]Heriot-Watt University Malaysia, Malaysia)

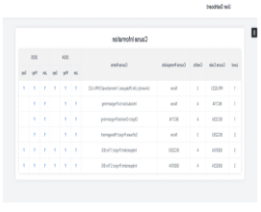
This study investigates the application of behavioural analytics and machine learning to the detection of social media bots, employing a quantitative research design implemented in Python. A labelled dataset of user activity was used to train and evaluate multiple models, including Random Forest, Support Vector Classifier, and Decision Tree algorithms. Model performance was assessed through cross-validation using accuracy, precision, recall, and F1-score metrics. The findings demonstrate that traditional machine learning models, when supported by robust feature engineering, can equal or surpass more complex approaches such as deep learning. The study's significance lies in advancing scalable, transparent, and computationally efficient frameworks for combating malicious automation on social platforms.



OS4-6 Design and Development of a Web-Based Enrichment Management System with Academic Progress (EMSAP)

Tee Wen Jun[1], Kasthuri Subaramaniam[2], Saleh Abdulalem Ali Mohammed[3], Oras Baker[4], Abdurrahman Bin Jalil[5]
([1,3]UCSI University, Malaysia, [2]Universiti Malaya, Malaysia,
[4]Ravensbourne University London, UK, [5]Universiti Teknologi Mara, Malaysia)

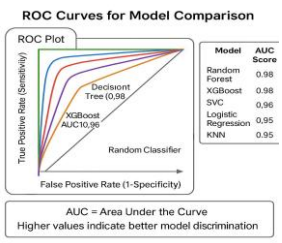
This study presents the design and development of the Enrichment Management System with Academic Progress (EMSAP), a web-based prototype aimed at enhancing workflow efficiency, reducing administrative delays, and improving user experience for students, event organisers, and administrators. A user requirement analysis was conducted using survey questionnaires. The prototype was implemented using HTML, CSS, JavaScript, PHP, and MySQL. Results indicated high user satisfaction, improved time management, and system efficiency. Future enhancements involve analytics dashboards, automated certificate generation, and mobile application integration to extend accessibility and performance.



OS4-7 High-Accuracy Machine Learning Models for Cervical Cancer Prediction Using Ensemble Techniques and Class Imbalance Correction

Oras Baker[1], Kasthuri Subaramaniam[2], Sellappan Palaniapan[3], Umm E Mariya Shah[4]
([1]Ravensbourne University London, UK, [2]Universiti Malaya, Malaysia,
[3]Help University, Malaysia, [4]International Islamic University Malaysia, Malaysia)

This study develops a machine learning-based predictive model for cervical cancer detection using a dataset of 835 patient records encompassing 36 clinical and demographic features. A systematic methodology was employed, including mean imputation for missing data, StandardScaler for feature normalisation, and the Synthetic Minority Oversampling Technique (SMOTE) to address class imbalance. Multiple algorithms, Decision Tree, Random Forest, XGBoost, Support Vector Machine, Logistic Regression, and K-Nearest Neighbours, were trained and evaluated using an 80/20 train-test split. The results confirm the feasibility of using ensemble-based models as reliable clinical decision-support tools for early cancer screening.



OS4-8 Machine Learning-Based Detection of Cyberbullying in Social Media Texts: A New Zealand Contextual Study

Oras Baker[1], Kasthuri Subaramaniam[2], Sellappan Palaniapan[3], Dobrila Lopez[4], Abdurrahman Bin Jalil[5]
([1]Ravensbourne University London, UK, [2]Universiti Malaya, Malaysia,
[3]Help University, Malaysia, [4]Eastern Institute of Technology, New Zealand,
[5]Universiti Teknologi Mara, Malaysia)

This study investigates the use of machine learning approaches to identify cyberbullying within social media text, focusing on New Zealand. The research develops and evaluates supervised machine learning models trained on a labelled dataset of X (Twitter) posts obtained from Kaggle. Text preprocessing involved data cleaning, tokenisation, lemmatisation using WordNetLemmatizer, and vectorisation through Term Frequency–Inverse Document Frequency (TF–IDF). Several algorithms, including Support Vector Machine (SVM), Naïve Bayes, Logistic Regression, and Random Forest, were implemented and compared using performance metrics. A Streamlit-based web application was developed to operationalise the most effective model, allowing users to detect cyberbullying in real time.

OS4-9 On a Hybrid Modeling of Specific Biohydrodynamic Phenomena

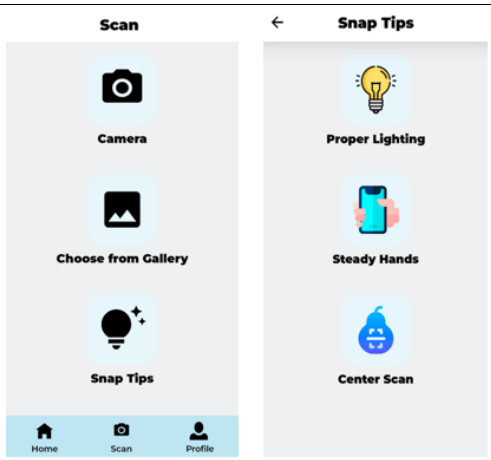
Asiya Zhumanazarova[1] and Tabiga Zhumanazarova[2]
([1]Almaty Technological University, Kazakhstan and [2]Independent Researcher, Kazakhstan)

This paper investigates modeling approaches for specific biohydrodynamic processes associated with impaired vascular elasticity and other pathological blood flow conditions. It considers the potential generalization of mathematical models and their integration with machine learning techniques to enhance the accuracy of analysis and prediction. The theoretical foundations and conceptual structure of a proposed hybrid approach are presented, highlighting its scientific and practical relevance as a promising direction in applied mathematics and biomedical modeling.

OS4-10 FruitSense: An Android-Based Fruit Quality Detection Mobile Application Using Machine Learning and Image Processing

Evelyn Levina Diva (UCSI University, Malaysia), Umm E Mariya Shah (International Islamic University, Malaysia), Samar Ghazal Mohammed Abdullah (UCSI University, Malaysia), Heshalini Rajagopal (MILA University, Malaysia), Kasthuri Subaramaniam (Universiti Malaya, Malaysia), Yasir Mehmood (Syslab Technologies Sdn Bhd, Malaysia), Atif Mahmood (INTI International University, Malaysia)

Fruit quality is crucial for human nutrition and health, however, traditional visual inspection for fruit freshness is time-consuming and inconsistent. The growing adoption of AI offers new possibilities for improving traditional methods. Accordingly, FruitSense was developed to classify the ripeness of bananas, apples, and tomatoes using machine learning techniques. Implemented with TensorFlow Lite and Google Teachable Machine, it analyzes color, defects, and size. A diverse dataset of fruit images representing various ripeness stages was obtained from Kaggle to train separate models for each fruit. The models were integrated into an Android app for real-time ripeness detection. Evaluation of the application through system, usability, and performance testing revealed that it meets the project objectives and was positively received.



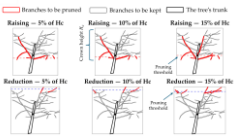
OS5 Advances in Field Robotics and Their Applications (16)

Chair Shinsuke Yasukawa (Kyushu Institute of Technology, Japan)
Co-Chair Kazuo Ishii (Kyushu Institute of Technology, Japan)

OS5-1 Semi-Automated Urban Tree Pruning Using a Rule-Based 2D Vision Approach

Mohammad Albaroudi, Abdullah Alraee, Raji Alahmad, Hussam Alraie, Kazuo Ishii
(Kyushu Institute of Technology, Japan)

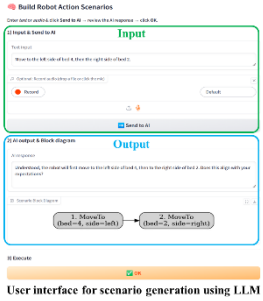
Urban trees require regular pruning to ensure infrastructure safety. Manual pruning is labor-intensive and risky, whereas 3D-based approaches require high computational power. This study presents a semi-automated 2D vision method that combines machine learning with safety thresholds. Branch positions were derived from the YOLO-OBB detection outputs trained on diverse urban tree data. Branches for pruning are selected based on position and safety thresholds using raising and reduction methods. The framework balances automation and expert oversight, thereby enabling efficient and consistent urban tree management.



OS5-2 Automatic Scenario Generation for Agricultural robots Using Natural Language Instructions

Takuya Fujinaga (Osaka Metropolitan University, Japan)

Foundation models have advanced rapidly. However, their applications in outdoor environments remain limited. This study aims to develop a large language models (LLMs)-based framework for automatic scenario generation in agricultural robots. The framework interprets natural language instructions and generates executable scenarios. Experiments in a virtual environment demonstrated that the framework achieved comparable accuracy to a menu-based approach while exhibiting superior operational efficiency and linguistic flexibility. Furthermore, the framework effectively handled ambiguous instructions through interactive clarification with the user. However, the response time of the LLM increased with scenario complexity. Future work will focus on improving processing speed and integrating real-robot experiments.

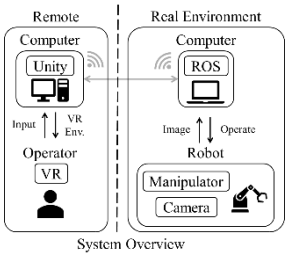


User interface for scenario generation using LLM

OS5-3 Development of a Tele-Operation Control System for a Tomato-Harvesting Robot Using VR Interfaces

Takuma Ushiroji, Takuya Fujinaga (Osaka Metropolitan University, Japan)

Agricultural robots are used to automate and improve the efficiency of farming tasks. In particular, tele-operation of robots is an efficient approach to managing large farm areas, especially for tasks such as monitoring, planting, and harvesting. This study aims to develop a tele-operation control system for a tomato-harvesting robot using VR interface. The camera view of the actual robot is displayed in a virtual environment by this system. The operator uses the VR interface to control the arm of the robot more intuitively than with conventional screen-based operation. The system is evaluated for harvest success rate, harvesting speed, and operability through real-world experiments. This study contributes to improving harvesting efficiency and usability in the tele-operation of agricultural robots.

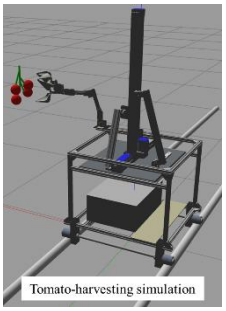


System Overview

OS5-4 Evaluation of an Optimal Approach Direction for a Tomato-Harvesting Robot Using a Digital Twin

Kouya Taitou, Takuya Fujinaga (Osaka Metropolitan University, Japan)

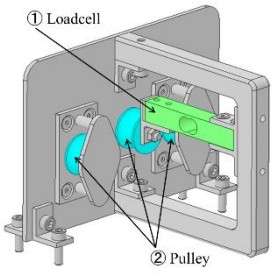
This study aims to optimize the approach direction of a tomato-harvesting robot using a digital twin. The success of tomato harvesting depends on various factors, one of which is the approach direction of the end effector. To examine the effect of the approach direction, a digital twin environment of the robot was constructed using Gazebo and ROS. Tomato models were then generated in the environment to simulate the harvesting motions. Several approach directions were tested and evaluated based on whether the gripper could properly grasp the fruit while avoiding the peduncle. The optimal direction was determined through simulation experiments, and field tests were subsequently conducted based on the obtained results. The experiments demonstrated the effectiveness of the optimized approach direction using the developed digital twin.


Tomato-harvesting simulation

OS5-5 Tension Measurement Sensor for a Surface Vehicle Equipped with an Underwater Vehicle

Naoto Shirahama, Takuya Fujinaga (Osaka Metropolitan University, Japan)

Tethered underwater robots are widely used for underwater inspection, mapping, and observation because they can operate efficiently in complex environments. However, managing the tether cable remains a critical challenge, as fluctuating tether tension can affect the maneuverability, stability, and safety of the robot. This study aims to develop a tension measurement sensor mounted on a surface vehicle that assists an underwater vehicle. The developed sensor mainly consists of a load cell and pulleys to measure tether tension. The measured data can be used to analyze variations in tether tension caused by the motion of the underwater robot. The proposed sensor is expected to contribute to safer and more efficient cooperative operations between surface and underwater vehicles through improved tether management.

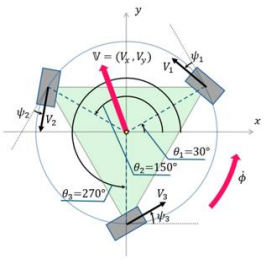


Tension measurement sensor

OS5-6 Proposal of New Kinematics for Mobile Robots adapted Three-Rollers

[1]Kenji Kimura, [2]Kazuki Nakayama, [3]Katsuaki Suzuki, [4]Kazuo Ishii,
([1]National Institute of Technology, Matsue College, Japan, [2] Toyohashi University of Technology, Japan,[3]Kumamoto Industrial Research Institute, Japan, [4]Kyushu Institute of Technology, Japan)

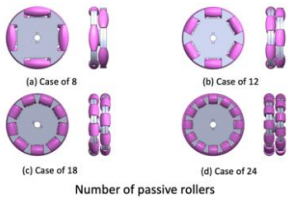
Mobile robots can be used in a variety of fields, including the logistics industry. The wheels used in these mobile robots are primarily omni-directional wheels and are commonly called omni-rollers. Omni-rollers have countless passive wheels attached to the rotating wheel, allowing them to move passively in directions perpendicular to the direction of rotation. Previous research has derived the kinematics of mobile mechanisms equipped with these three omni-rollers. This was done using a geometric method, clarifying the relationship between roller placement position and roller speed. In this study, we propose an algebraic derivation method that focuses on the speed and contact points of each roller.



OS5-7 A Study on the Number of Passive Rollers and Trajectory of Omni-Roller in Mobile Robot

[1]Kenji Kimura, [2]Katsuaki Suzuki, [3]Kazuo Ishii,
([1]National Institute of Technology, Matsue College, Japan,[2]Kumamoto Industrial Research Institute, Japan
[3]Kyushu Institute of Technology, Japan)

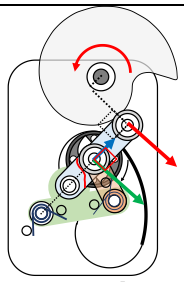
Mobile robots come in a variety of configurations with three or four rollers, and these mobile mechanisms are used in a wide range of fields, including the logistics industry. Mobile robots use omni-roller or Mecanum roller wheels. These allow for omnidirectional movement thanks to multiple passive wheels positioned along the direction of roller rotation. Previous research has determined the number of passive rollers and verified the kinematics of the trajectory and movement speed of a mobile mechanism equipped with rollers for a given number of passive wheels. In this study, we investigate the behavior of the mobile robot's running trajectory and vertical displacement when the passive wheels of the omni-roller are changed.



OS5-8 Development of a Self-Locking Cam Mechanism for Spring Compression

[1]Katsuaki Suzuki, [2]Yuya Nishida, [3]Kenji Kimura, [2]Kazuo Ishii
([1]Kumamoto Industrial Research Institute, Japan, [2]Kyushu Institute of Technology, Japan, [3]National Institute of Technology, Matsue College, Japan)

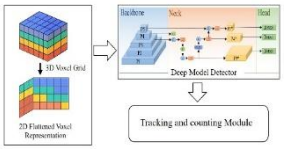
In production equipment, achieving both energy efficiency and cost reduction is a key requirement. One effective approach is to develop a mechanism that restrains rotation of the output shaft without relying on an electromagnetic brake. This study focuses on a cam mechanism that achieves an optimal reduction ratio depending on the applied load via its contour design, thereby improving energy efficiency through efficient power transmission. Furthermore, targeting spring-compression applications, we propose a novel mechanism with a self-locking function that generates frictional resistance only during backdriving by integrating a one-way bearing and other mechanical elements with the cam mechanism.



OS5-9 Voxel-Grid Based Deep Learning for Robust People Counting and Tracking with Event-Based Vision Sensors

Raji Alahmad, Zitong Zhou, Mohammad Albaroudi, Abdullah Alraee, Hussam Alraie, Shinsuke Yasukawa
(Kyushu Institute of Technology, Japan)

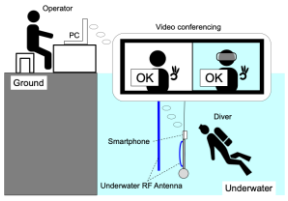
Abstract: Accurate people counting in crowded or low-light environments remains challenging for conventional cameras due to limited dynamic range, poor contrast sensitivity, and privacy concerns. Event-based vision sensors (EVS) address these issues by asynchronously capturing brightness changes with microsecond temporal resolution. This work introduces a voxel-grid deep learning framework that converts EVS event streams into spatial-temporal tensors, enabling lightweight detection and Byte Track-based tracking for reliable counting. The proposed system delivers real-time, privacy-preserving performance on embedded platforms, achieving high accuracy and efficiency under extreme illumination, fast motion, and densely populated scenes.



OS5-10 An Underwater Operation Method for a Diver Using Underwater Radio Frequency Communication and a Smartphone

Daigo Katayama[*,**], Raji Alahmad[*], Kazuhiro Eguchi[*], Toshiyuki Wakisaka[***], Tohlu Matsushima[*], Yuki Fukumoto[*], Kazuo Ishii[*] ([*]Kyushu Institute of Technology, [**]Kobe City College of Technology, [***]Panasonic Holdings Co., Ltd. , Japan)

For safety reasons, the time available for diving operations is limited, so improving efficiency is necessary. Effective coordination with shore-based operators is essential. However, current voice communication methods can only convey a limited amount of information, meaning more information needs to be transmitted and received to ensure that operations run smoothly. We propose a communication system that uses underwater radio frequency technology and smartphones to facilitate communication between divers performing underwater operations and operators on land. To verify the usefulness of this system, we conducted tests in freshwater tanks and real sea environments. This paper describes the outline of operation methods, and presents the results of the verification experiments.



OS5-11 Computer Vision-Based Monitoring of Feeding Consistency in Aquaculture

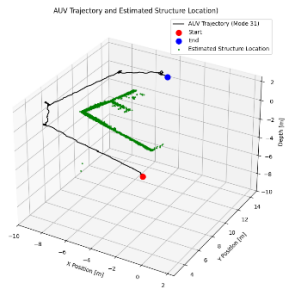
Abdullah Alraee, Mohammad Albaroudi, Hussam Alraie, Raji Alahmad, Irmiya R Inniyaka ,Kazuo Ishii
(Kyushu Institute of Technology, Japan)

Automatic feeding in aquaculture optimizes feed and reduces labor; however, reliability is crucial because malfunctions cause economic losses. In this study, we proposed a computer vision framework to monitor feeder performance by analyzing real-time fish movement patterns using three metrics: fish count, density, and group disorder. Each successful feeding showed a distinct behavioral signature, a simultaneous spike in all three metrics, the absence of which signals feeder malfunction. This approach ensures reliable automation and improves efficiency.

OS5-12 The processing of acoustic sonar data for the underwater robot self-localization

Ryo Miyakawa, Kazuo Ishii, Yuya Nishida (Kyushu Institute of Technology, Japan)

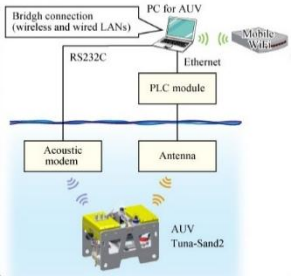
To improve the inspection efficiency of underwater structures, there is a demand for the development of inspection methods that utilize underwater robots. The employment of autonomous underwater vehicles (AUV), which are not constrained by cables, is of paramount importance. To achieve automated inspection by AUV, it is imperative that these vehicles maintain a constant position relative to underwater structures. Acoustic sonar, which is less susceptible to environmental light and suspended particles, is useful for this purpose. However, the integrity of sonar data is compromised by significant noise due to echoes and scattering, which complicates the estimation of the structure's position. The present study proposes a method for developing a filter to reduce noise in sonar data and estimate the position of structures.



OS5-13 Remote Operation of an Underwater Vehicle equipped with a Radio communication

Yuya Nishida, Ryo Miyakawa, Kazuhiro Eguchi,
Tohlu Matsushima, Yuki Fukumoto (Kyushu Institute of Technology, Japan)

In recent years, considerable expectations have been placed on the utilization of untethered, remotely operated UUVs for marine resource surveys and underwater structure inspections. Consequently, various research institutes are developing high-speed underwater communication devices essential for UUVs. The authors have developed an underwater radio communication device capable of high-speed communication within a range of 20m x 15m x 2m, demonstrating communication speeds of approximately 1Mbps within this area. This paper reports on remote operation experiments conducted using the developed radio communication device mounted on an AUV.



OS5-14 Multimodal RF-Enabled iPhone-Based Diver-in-the-Loop strategy for Underwater communication and UUV control

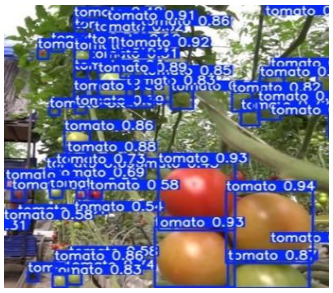
Irmiya R. Inniyaka, Kazuhiro Eguchi, Toshiyuki Wakisaka, Yuya Nishida, Kazuo Ishii
(Kyushu Institute of Technology, Japan)

Signal attenuation and multipath effects remain key barriers to underwater communication. A novel RF-enabled strategy supports Operator–Diver communication over Zoom/OBS but lacks Diver–Diver communication and diver-initiated UUV control. This limitation is due to restricted touchscreen access in a sealed housing. We present a multimodal RF-enabled iOS framework that supports three modes: Operator–Diver communication, Diver–Diver communication, and Diver–UUV control. System concept and RF pathway are described, demonstrating how the proposed architecture overcomes the current constraints.

OS5-15 Comparative Performance Analysis of YOLOv5 and YOLOv8 for Tomato Detection in Agricultural Robotics.

Eslem Kıvrak, Orhun Erke Simav, Arda Şahin (Middle East Technical University, Türkiye),
Abdullah Alraee, Mohammad Albaroudi, Raji Alahmad (Kyushu Institute of Technology, Japan),
Hussam Alraie, Tayfun Nesimoğlu (Middle East Technical University, Türkiye).

The research aimed to develop a precise and dependable program that can accurately recognize tomatoes in photos and label them clearly. The goal was to help farmers automate picking by saving time. Modern farms increasingly rely on cameras and computers. Tomatoes are tricky: they come in different shades of red, sizes, and ripeness levels. We picked tomatoes to test whether AI could handle these real-world variations. By using YOLOv5 on a comparison analysis of our project with YOLOv8, this project experiments with different real-time object detection algorithms. In the tests, the software correctly finds nearly every tomato, making the project feasible. The tomato detector proves that machine learning can make farm work faster and smarter.



OS5-16 Resolving Object Overlap in Agricultural Imagery Using a Modified Watershed Transform

Oğuzhan Çalışkan, Naime Ayça Sezginer, Elifnaz Bilgili, Mustafa Eray Erdoğan,
(Middle East Technical University, Türkiye),
Abdullah Alraee, Mohammad Albaroudi, Raji Alahmad (Kyushu Institute of Technology, Japan),
Hussam Alraie, Tayfun Nesimoğlu (Middle East Technical University, Türkiye).

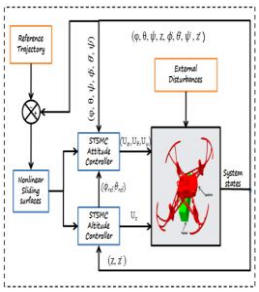
Agriculture is losing its popularity in Türkiye because of outdated techniques. Object detection is essential for enhancing productivity, harvesting, and yield estimation for farmers. In this study, an autonomous tomato detector utilizing an image processing approach in Python is developed, leveraging a dataset comprising diverse tomato types under various environmental and lighting conditions to enhance the application. This approach utilized some traditional image processing techniques, such as masking and filtering. To overcome the overlap problem that occurred in crowded tomato images, the watershed split algorithm was used to separate overlapping tomatoes to improve detection precision. The application can effectively distinguish tomatoes in the field to be harvested. Removing the overlap problem significantly raises the detection performance. The outcome of this study let it be said that computer-based techniques can help agriculture while lowering labor costs.

OS6 Advanced Techniques for UAVs and Structural Heritage (7)
Chair Hazry Desa (Universiti Malaysia Perlis (UniMAP), Malaysia)
Co-Chair M. Azizi Azizan (Universiti Malaysia Perlis (UniMAP), Malaysia)

OS6-1 Variants of Robust Sliding Mode Control for Quadrotor UAVs under Parametric Uncertainties

Hazry Desa[1], Azmat Saeed[2], M. Azizi Azizan[1], S. B. Yaakob[1], Abadal-Salam T. Hussain[3], Taha Almulaisi[4], M. Hassan Tanveer[5]
([1]UniMAP, Malaysia; [2]NUST, Pakistan; [3]Al-Kitab University, Iraq; [4]Northern Technical University, Iraq; [5]Kennesaw State University, USA)

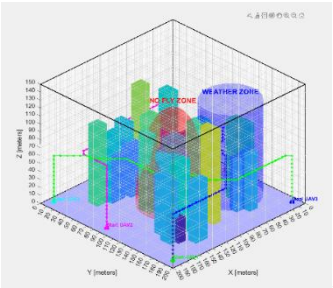
Super-Twisting Sliding Mode Control has emerged as a robust and efficient strategy for flight control system design, providing strong resilience against model uncertainties while effectively mitigating the chattering phenomenon inherent in conventional Sliding Mode Control (CSMC) schemes. This paper presents a Nonlinear Surface–Based Super Twisting Sliding Mode Control (NSTSMC) scheme for the attitude and altitude control of a quadrotor. The performance of the NSTSMC is evaluated through numerical simulations under parameter variations and benchmarked against the CSMC and Nonlinear Sliding Mode Control (NSMC) schemes. Results demonstrate that NSTSMC improves rise time by 25 to 56% over CSMC and 32 to 47% over NSMC, chattering index by 94 to 95% and integral absolute error by 34 to 56% for both attitude and altitude.



OS6-2 Unmanned Aerial Vehicle Fleet Management and Control System

Thines Vasanthan[1], Hazry Desa[1], Azmat Saeed[2], M. Azizi Azizan[1], S. B. Yaakob[1], Abadal-Salam T. Hussain[3], Taha Almulaisi[4], M. Hassan Tanveer[5]
([1]UniMAP, Malaysia; [2]NUST, Pakistan; [3]Al-Kitab University, Iraq; [4]Northern Technical University, Iraq; [5]Kennesaw State University, USA)

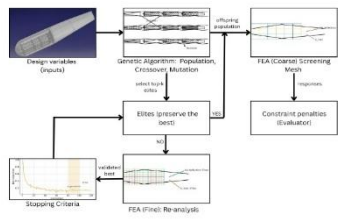
The Unmanned Fleet Management and Control System (UFMC) uses pathfinding algorithms and simulated IoT sensors to safely manage and scale high-density UAV traffic in cities. A core component is its grid-based airspace model, which was tested comparing an A* algorithm against a Perimeter (Shortest Boundary) method. Simulation results for a test mission showed the A* algorithm's path was 8.54% more efficient (shorter) than the Perimeter path, also completing the mission 8.75% faster. IoT sensors track key metrics like path length and time, feeding data into the robust simulation platform to validate performance under various conditions. The UFMC sets a new standard for urban UAV management, enabling efficient and safe drone operations for smart city applications.



OS6-3 AI-Driven Structural Optimization of a Fixed Wing UAV Composite Airframe

Afnan Nazmy[1], Hazry Desa[1], M. Azizi Azizan[1], S. B. Yaakob[1], Abadal-Salam T. Hussain[3], Taha Almulaisi[4], M. Hassan Tanveer[5]
([1]UniMAP, Malaysia; [2]NUST, Pakistan; [3]Al-Kitab University, Iraq; [4]Northern Technical University, Iraq; [5]Kennesaw State University, USA)

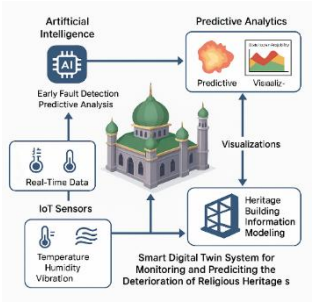
AI-assisted workflow to lighten the Fixed Wing UAV airframe using sandwich-composite structures. Finite-element analyses under cruise, manoeuvre, and gust loads are coupled with a genetic algorithm to minimize mass while enforcing strength, stiffness, and modal limits. With manufacturable layups, graded cores, and verification via mesh convergence, the optimized design achieves ~24–25% structural mass reduction and raises f_1 to ≥30–35 Hz. These gains increase payload capacity and endurance without compromising safety or durability. The workflow is reproducible, implementation-ready, reliable, and enables rapid iteration for robotics and aerospace teams moving from digital preliminary sizing to buildable composite structures.



OS6-4 Smart Digital Twin System for Monitoring and Predicting the Deterioration of Religious Heritage Structure

Ainur Fariha Mahhassan[1], M. Azizi Azizan[1], Hazry Desa[1]
([1]UniMAP, Malaysia)

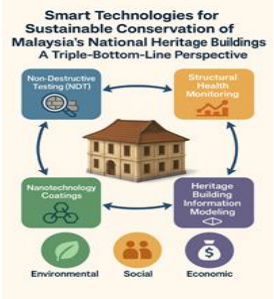
A Smart Digital Twin System is proposed to enhance the monitoring and preservation of Malaysia's religious heritage structures. The system integrates IoT sensors, Artificial Intelligence (AI), and Heritage Building Information Modelling (HBIM) to provide real-time data acquisition and predictive condition assessment. IoT sensors record key environmental and structural parameters, while AI algorithms analyse these inputs to detect early deterioration and forecast potential damage. The processed data are visualized within an HBIM-based 3D model, enabling clearer interpretation of structural risks and maintenance needs. This integrated approach supports proactive, data-driven conservation, reduces restoration costs, and strengthens the long-term sustainability of historic religious monuments.



OS6-5 Smart Technologies for Sustainable Conservation of Malaysia's National Heritage Buildings: A Triple-Bottom-Line Perspective

Muhammad Nazrul Naim Md Zain[1], M. Azizi Azizan[1], Hazry Desa[1]
([1]UniMAP, Malaysia)

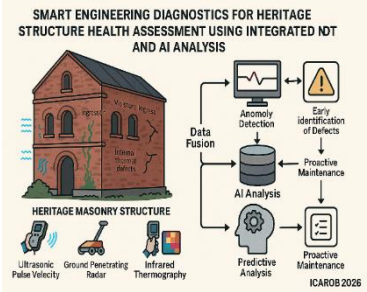
The application of smart technologies to promote sustainable conservation of Malaysia's heritage buildings. By integrating Non-Destructive Testing (NDT), Structural Health Monitoring (SHM), nanotechnology coatings, and Heritage Building Information Modelling (HBIM), the framework supports preventive and data-driven maintenance. Guided by the Triple-Bottom-Line approach, it advances environmental protection, cultural preservation, and economic resilience. The adoption of intelligent diagnostics and digital management enhances structural safety, reduces restoration costs, and extends the life of historic assets. This strategy reflects Malaysia's commitment to sustainable heritage conservation through innovation and technology.



OS6-6 Smart Engineering Diagnostics for Heritage Structure Health Assessment Using Integrated NDT and AI Analysis

Muhammad Adib Syahmi Muhammad[1], M.Azizi Azizan[1], Hazry Desa[1]
([1]UniMAP, Malaysia)

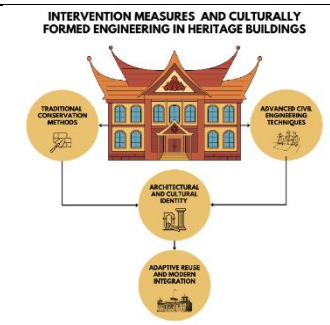
Heritage masonry structures in Malaysia face progressive deterioration caused by moisture ingress, biological decay, and internal cracking that often go undetected through conventional visual inspection. This research presents an intelligent diagnostic framework that integrates non-destructive testing methods including ultrasonic pulse velocity, ground penetrating radar, and infrared thermography with artificial intelligence for data fusion, anomaly detection, and predictive analysis. The framework enables early identification of hidden defects and supports proactive maintenance through data-driven decision making, contributing to sustainable and reliable conservation of heritage structures.



OS6-7 Intervention Measures and Culturally Formed Engineering in Heritage Buildings

Mimi Natasha Jamal[1], M. Azizi Azizan[1], Hazry Desa[1]
([1]UniMAP, Malaysia)

This study focused on the Chow Kit Mansion and the Floral Tea Mansion to explore the integration of traditional and modern engineering methods in heritage preservation. A quantitative survey of fifty-two heritage experts and users evaluated architectural influences, preservation techniques, and heritage elements relevant to contemporary design. Findings showed that modern technologies improved efficiency, while traditional methods-maintained authenticity. Architectural style, structure, and ornamentation were key to cultural identity, and adaptive reuse enhanced aesthetics. The study emphasized the need for tailored strategies, resources, and expert support for sustainable preservation.



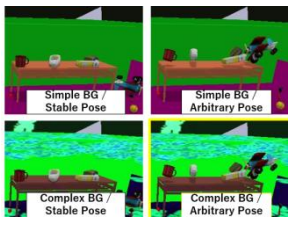
OS7 AI System and Space Design Toward Co-Existence of Humans and Robots (9)

Chair Yuichiro Tanaka (Kyushu Institute of Technology, Japan)
Co-Chair Hakaru Tamukoh (Kyushu Institute of Technology, Japan)

OS7-1 Pose Diversity Improves Object Detection Generalization

Tomoya Shiba, Akihiro Suzuki, Naoki Yamaguchi, Ryoga Maruno, and Hakaru Tamukoh
(Kyushu Institute of Technology, Japan)

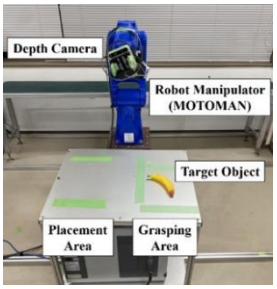
The performance of object detection models strongly depends on the distribution of object poses in training data. While previous studies have focused on dataset size and background diversity, the effect of pose variation remains unclear. This study investigates how pose diversity influences detection generalization. We generated synthetic datasets with controlled pose ranges using a 3D simulator and trained detectors under different pose conditions. Experiments on the YOLO-Video dataset show that models trained with wider pose distributions achieved higher accuracy on unseen poses. These results indicate that designing pose diversity in training datasets is essential for improving the robustness and generalization of object detection models.



OS7-2 A Robot Grasping Framework for Flexible and Amorphous Objects Using Skeleton Estimation

Ryoga Maruno, Naoki Yamaguchi, Akihiro Suzuki, Tomoya Shiba, and Hakaru Tamukoh
(Kyushu Institute of Technology, Japan)

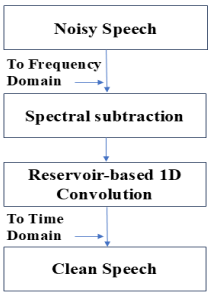
This paper proposes a framework for the flexible and amorphous object grasping of robots. In prior work, we developed methods for automatically assigning skeletons that faithfully reproduce object shape without excess or deficiency. This study builds on the previous research by applying it to grasp point estimation and implementing it on the robot manipulator. A skeleton estimation model was trained on automatically assigned skeletons, and the inference results were obtained. Then, the results were combined with the object's mask image and depth measurements from the robot-mounted camera to determine the grasp point and gripper angle. The experimental results confirmed that the proposed framework can achieve high-precision grasping of target objects.



OS7-3 Preliminary Study of Speech Denoising Using One-Dimensional Convolutional Reservoir Computing

Digisha, Rohan Saini, Aryan Rakheja, Hakaru Tamukoh, and Yuichiro Tanaka
(Kyushu Institute of Technology, Japan)

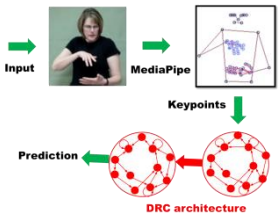
This study presents an efficient speech denoising framework based on one-dimensional convolutional reservoir computing (1D-CRC). Deep-learning approaches for speech enhancement require high computation, whereas the proposed 1D-CRC provides a low-cost, adaptive alternative. The framework integrates a reservoir-based convolution mechanism to extract local spectro-temporal features and capture recurrent temporal dependencies in speech. A comparative analysis with the conventional spectral subtraction method was conducted using the VoiceBank-DEMAND dataset. Experimental results show that the proposed model effectively suppresses background noise and reconstructs smoother, more natural waveforms, achieving an average signal-to-noise ratio improvement of 5.6 dB, compared to 3.5 dB for spectral subtraction.



OS7-4 Deep Reservoir Computing Based Lightweight Model for Isolated Sign Language Recognition

Nitin Kumar Singh, Arie Rachmad Syulistyo, Yuichiro Tanaka, and Hakaru Tamukoh
(Kyushu Institute of Technology, Japan)

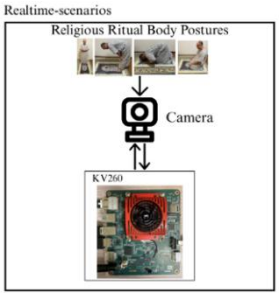
Sign language recognition (SLR) is an emerging technology that enhances communication between hearing and hearing-impaired individuals. Deep learning is widely used for SLR, however, its suitability for edge devices is limited due to computational constraints. To address this issue, we propose an approach to SLR that combines MediaPipe with deep reservoir computing (DRC). MediaPipe extracts key points from sign language videos, which are further processed through DRC to class labels using ridge regression. This method offers low computational cost and faster training, suitable for edge devices. Our proposed method achieves a competitive accuracy on the Word-Level American Sign Language (WLASL) dataset with a shorter training time than deep learning-based SLR systems.



OS7-5 Real-Time Religious Ritual Body Recognition Using an FPGA System

Dinda Pramanta (Kyushu Institute of Information Sciences, Japan) and Hakaru Tamukoh (Kyushu Institute of Technology, Japan)

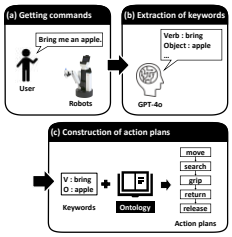
This study proposes a real-time recognition system for religious ritual body movements. The system focuses on structured movements from Islamic prayer, including raising, bowing, sitting, and sujud, aiming to support educational and assistive applications in Edge-AI platforms such as Field-Programmable Gate Arrays (FPGA). A machine learning model, Faster Objects, More Objects (FOMO), was trained and deployed on the KV260 board. Using 94×94 images, the system was trained for 0.33 hours over 50 epochs. The system achieves a total inference latency of 5 ms, with 1 ms used for image processing and 4 ms for detection, enabling practical real-time operation. Despite modest accuracy performance, this work demonstrates the feasibility of implementing a real-time recognition system on FPGA.



OS7-6 Development of an Action Planning System using Explainable AI for Home Service Robots

Takashi Akamatsu and Yuma Yoshimoto (National Institute of Technology, Kitakyushu College, Japan)

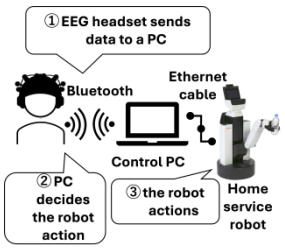
When home service robots are deployed into home environment, robots must perform “Command Understanding Tasks (CUT)” to execute commands given by users. Robots need to construct action plans—combinations of predefined actions such as going to the kitchen and grabbing an object—, to perform CUT from the commands. In recent years, methods using large language models (LLMs) have become mainstream due to their high flexibility. However, LLMs lack of explainability, when accidents or malfunctions occur and cannot explain the cause. In this research, we use Ontology, an explainable AI, to provide explainability to the construction of action plans in CUT.



OS7-7 The Development of a Control System for Robot Operation Using EEG

Haruki Miura and Yuma Yoshimoto (National Institute of Technology, Kitakyushu College, Japan)

Home service robots, capable of performing a wide range of tasks in homes and stores, must be controlled by anyone through simple procedures. As the operating procedures that robots understand use buttons, remote controls, and voice commands, these methods have shortcomings. And, it is difficult to verify the command. Therefore, this study proposes a method for commanding the robots using only motor imagery via electroencephalography (EEG). EEG is a method that measures the electrical activity within the brain using small electrodes attached to the scalp. In the proposed system, (1) the EEG headset sends data to a PC, (2) the PC decides the robot action, and (3) the robot actions. In the experiments, the robot reached a destination room using the EEG headset.



OS7-8 Application and Impression Evaluation of AI Robot Technology in Biophilic Design

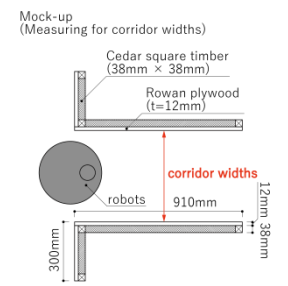
Kairi Manabe, Hiroaki Miyauchi, Keitaro Ito, Tomomi Sudo, Naoto Ishizuka, Akinobu Mizutani, Hakaru Tamukoh, Yuichiro Tanaka, Leon Furuya, Kei Wakabayashi, and Hirofumi Tanaka (Kyushu Institute of Technology, Japan)

In recent years, biophilic design has received increased attention for enhancing human well-being. This study presents a system in which robots autonomously relocate plants to optimal positions based on illuminance, temperature, and humidity, while examining psychological effects of this movement on humans. Environmental gradient maps generated by sensors determine relocation destinations, showing distinct spatial differences between conditions with and without human presence. Heart rate variability and subjective impressions are measured at varying distances as the plant-carrying robot moves around participants. Results suggest that integrating robotic movement and environmental sensing can create dynamic, responsive spaces bridging human–nature interaction, providing new insights into biophilic design applications.

OS7-9 Basic Research on Movement Failure Condition for Home Service Robots — Mock-up Evaluation of Step Heights, Corridor Widths, and Under-Furniture Clearances —

Suzuka Tachibana, Ren Matsuoka, Naoto Ishizuka, Akinobu Mizutani, Tomomi Sudo, Keitaro Ito, Hakaru Tamukoh, and Hirofumi Tanaka (Kyushu Institute of Technology, Japan)

As home service robots become more common, design standards for their smooth operation in typical residences remain insufficient. In this study, as basic research to understand performance tendencies, we conducted experiments using 12 cleaning robots, 1 pet-type robot, and 1 small transport robot, totaling 14 devices. We employed a mock-up that replicated a range of residential conditions—including typical step heights, corridor widths, and under-furniture clearances—to measure mobility limits and compare them with housing conditions. The results showed that common step heights posed only minor issues, whereas large robot body size significantly limited mobility, particularly for clearances and corridor widths. These findings are expected to inform future spatial standards for home robot integration.



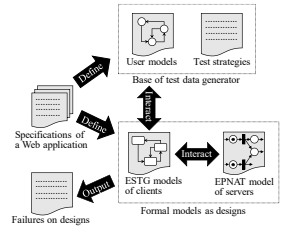
OS8 Software Development Support Method (3)

Chair Tetsuro Katayama (University of Miyazaki, Japan)
Co-Chair Tomohiko Takagi (Kagawa University, Japan)

OS8-1 A Design Testing Method Using Formal Models Based on EPNAT and ESTG for Web Applications

Takeru Amo[1], Tetsuro Katayama[2], Tomohiko Takagi[1]
[1] Kagawa University, Japan, [2] University of Miyazaki, Japan

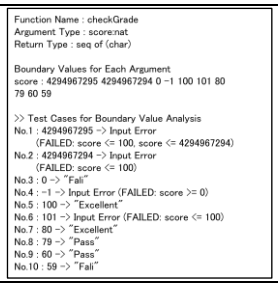
This study shows a method to test designs of Web applications using formal models. In the method, designs of servers and clients of a Web application are defined as EPNAT and Extended Screen Transition Graph (ESTG) models, respectively. The EPNAT model represents concurrent distributed behavior to provide services to the clients, and the ESTG model represents behavior to request and receive the services through a Web browser. A test data generator based on user models and testing strategies interacts with the ESTG models, and the ESTG models interact with the EPNAT model. The EPNAT and ESTG models contain assertions that detect failures on the designs, that is, detect violations of constraints derived from specifications. The procedure, effectiveness, and future work will be discussed in this paper.



OS8-2 Extension to Support Multi-Class Specification in BWDM that Generates Test Cases from VDM++ Specification

Tomohiro Takahashi*, Nobuya Takahashi*, Tetsuro Katayama*, Yoshihiro Kita†
*University of Miyazaki, Japan, †University of Nagasaki, Japan

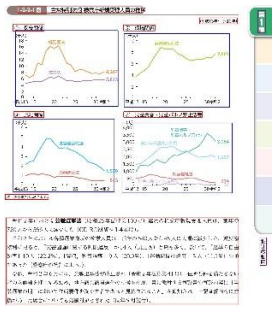
Writing test cases from the formal specification description VDM++, which is a method for eliminating ambiguity in software specification, is time-consuming and labor-intensive. Therefore, our laboratory has developed BWDM, a tool that automatically generates test cases from VDM++ specification. However, the existing BWDM has a problem in that it cannot generate test cases from VDM++ specification having multiple classes. Therefore, in order to improve the usefulness of BWDM, this study extends BWDM to solve the above problem. Consequently, it has confirmed that the extended BWDM can reduce the test case generation time compared to manual test case generation for VDM++ specification having multiple classes.



OS8-3 Extension of ASLA Which Is a Segmentation and Labeling Tool for Application to New Document Formats and Improvement of Label Generation Accuracy

Chihaya Takuma*, Nobuya Takahashi*, Tetsuro Katayama*, and Yoshihiro Kita†
*University of Miyazaki, Japan, †University of Nagasaki, Japan

We have developed ASLA (Automatic Segmentation and Labeling tool using AI) to divide electronic documents into elements and generate labels for new applications. However, the existing ASLA has two problems: (1) low segmentation accuracy for document formats other than scientific papers, and (2) occasionally generating incorrect labels. This study generates a new document image dataset with three additional formats, generates a segmentation model, and extends ASLA to use a multimodal LLM for label generation. Evaluation results have shown that the generated segmentation model achieved a score of at least 0.78 in mAP@[0.75] for each of the four format types in the test data. Additionally, it has confirmed that the multimodal LLM generates correct labels with higher accuracy than the existing ASLA method.



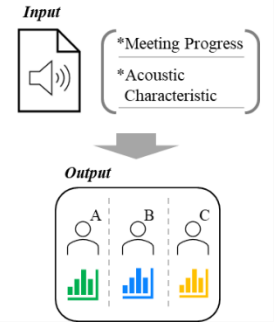
OS9 Biological and Intelligent Information System (7)

Chair Masayuki Fujiwara (Komatsu University, Japan)
Co-Chair Kazuma Sakamoto (Komatsu University, Japan)
Co-Chair Masaya Nakahara (Osaka Electro-Communication University, Japan)

OS9-1 Speaker Identification Method Using Textual Data and Acoustic Features in Multi-Speaker Meetings with Focus on Meeting Progress

Teruya Minakuchi, Kazuma Sakamoto, Iori Iwata, Yoshihiro Ueda (Komatsu University, Japan)

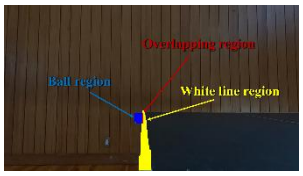
Recent advancements in speech recognition technologies have expanded the potential applications of speaker identification. Conventional approaches generally fall into two categories: models trained to learn acoustic characteristics using artificial intelligence, and text-based methods that infer speakers solely from linguistic information. However, the former is highly dependent on acoustic features, resulting in high training costs and sensitivity to recording conditions, whereas the latter is strongly affected by automatic speech recognition errors and inconsistencies in punctuation insertion, and thus depends heavily on transcription accuracy.
In this research, we propose a novel method that integrates both textual data and acoustic characteristics for identifying speakers in multi-speaker turn-taking settings with a focus on meeting progress.



OS9-2 Basic Research on Automating Edge and Side Determination in Table Tennis

Reo Ishii, Kazuma Sakamoto, Iori Iwata, Riku Kaiba, Yoshihiro Ueda (Komatsu University, Japan

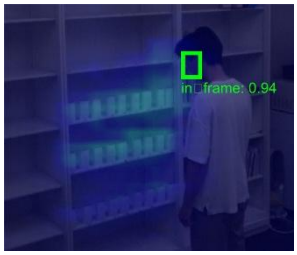
Accurate judgment in sports is difficult to achieve solely with the human eye. Consequently, judgment support systems that utilize deep learning are gaining attention. According to extant research, judgments have been made indirectly on the basis of trajectories subsequent to ball contact. This research proposes a method to automate edge and side judgments in table tennis. Specifically, it directly determines contact by extracting the “ball region” and “white line region” using instance segmentation and analyzing their overlap. This approach enables concise and intuitive judgment without trajectory estimation, reducing analytical complexity and computational processing. The efficacy of the proposed method in automating edge and side judgments is demonstrated by the results obtained from experiments utilizing experimentally captured footage. These results suggest the potential for fair and consistent support for table tennis judgment.



OS9-3 Basis Research on Attended Objects Estimation Using Gaze Information and Object

Hiroto Kawabe, Kazuma Sakamoto, Tomoya Senda, Yoshihiro Ueda (Komatsu University, Japan)

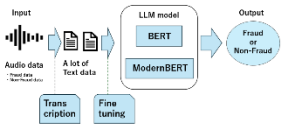
Appropriate product placement in stores is directly linked to reducing lost sales opportunities. Therefore, it is imperative to understand the differences in attention levels that arise from product and display positions is essential. While online shops can estimate popularity through browsing time, in physical stores making it difficult to directly observe customer attention comparable to viewing time. The present research proposes a methodology for addressing this issue. The methodology utilizes a single image and to calculate the attention duration toward that object from camera footage. The proposed method enables quantification of product and layout-specific attention levels all by utilizing existing cameras. Ultimately, the goal of this study is to present a data-driven guideline for designing new product layouts.



OS9-4 Research on Supporting Detection of Communication Fraud Using BERT

Ryuta Okabe, Kazuma Sakamoto, Iori Iwata, Yoshihiro Ueda (Komatsu University, Japan)

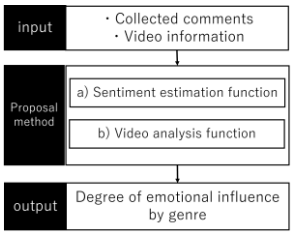
Communications fraud has become a serious social problem in Japan, with 13,213 reported cases and total damage amounting to 59.7 billion yen in the first half of 2025, marking record highs. Implementation of awareness campaigns, the number of victims continues to increase, suggesting that the sophistication of fraudulent techniques may be a contributing factor. The mitigation of such damages is contingent upon the early detection of communications fraud, a strategy that has been demonstrated to be effective. In this research, we conducted token prediction related to communications fraud using Large Language Models. The prediction accuracy of BERT and ModernBERT was compared, with a focus on the differences in the maximum input sequence length that each model can process. The objective of this research is to provide a foundation for the prevention of communications fraud.



OS9-5 Influence of Comment Sentiment on YouTube Subscribers and View Counts by Genre

Kyoya TAKIGUCHI, Masaya NAKAHARA (Osaka Electro Communication University, Japan)
Kazuma SAKAMOTO (Komatsu University, Japan)

With the spread of video platforms such as YouTube, viewers have more opportunities to express their opinions and emotions through comments. These comments complement qualitative responses that are difficult to capture through viewing history and rating numbers alone, making them an important form of feedback for video creators. Emotional expressions in comments, in particular, can potentially affect a video's view count and popularity, but systematic verification of this effect has yet to be conducted. Previous research has confirmed that videos with more subscribers and views tend to have more "strongly emotional" comments, and has also shown that the distribution of emotions varies by video genre. Therefore, this study compares and examines the impact of comment emotions on subscriber counts and view counts by genre. Specifically, we index the intensity and polarity of emotions for each genre and use regression analysis to evaluate their relationship with viewing indicators (subscribers and views).



OS9-6 Evaluation of the Effectiveness of a Voice-Based Special Fraud Experience System Using Generative AI

Masaya Nakahara, Kyoya Takiguchi, Taketo Ueno, Yuya Doi, Ryusei Noguchi, Tenma Matsumoto, Ryotaro Teranishi (Osaka Electro Communication University, Japan)

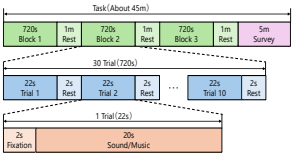
In recent years, losses from specialized fraud schemes have been expanding worldwide, both domestically and internationally. As countermeasures, methods such as publicizing fraud cases through media and developing AI to detect specialized fraud have been implemented. However, actual specialized fraud attempts deceive victims using various patterns, lacking fixed formulas, and losses among the elderly continue unabated. Furthermore, monitoring every call using detection AI is impractical. Therefore, there is a need for technology that enables people to experience various actual fraud scenarios. This research developed a fraud experience system capable of video calls. It utilizes an LLM model pre-trained on fraud scenarios and avatars that generate human-like speech using generative AI. Through proof-of-concept experiments, the effectiveness of experiential learning using this system was confirmed.

Image of the developed system

OS9-7 Electroencephalographic Responses to Three Types of Auditory Stimuli

Akihiro Matsumoto[1], Koushi Nishioka[1], Hironari Machida[1] and Masayuki Fujiwara[1,2]
([1]Komatsu University, Japan), ([2]Japan Advanced Institute of Science and Technology, Japan)

Sounds and music are known to influence human psychological and physiological states, potentially modulating emotion and behavior. Previous electroencephalography (EEG) studies have mainly focused on event-related potentials (ERPs), but oscillatory brain activity across different types of auditory stimuli and under repeated listening conditions may provide additional insights. In this study, EEG recordings were conducted while participants listened to three types of auditory stimuli: classical music, natural sounds (flowing water), and environmental noise (classroom chatter). Time–frequency analysis was applied to examine oscillatory brain activity across conditions. As a result, characteristic neural activity was observed in response to the three types of auditory stimuli, and significant differences were found.



OS10 Robotics and Intelligent Systems (9)

Chair Kuo-Hsien Hsia (National Yunlin University of Science and Technology, Taiwan)

Co-Chair Jr-Hung Guo (National Yunlin University of Science and Technology, Taiwan)

OS10-1 Design and Implementation of a Four-Wheel Steering Mechanism for Educational Demonstration

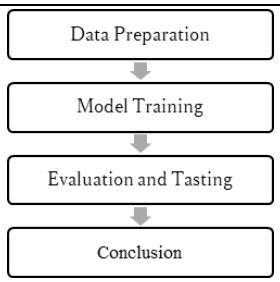
Kuo-Hsien Hsia, Chun-Chi Lai, Yi-Ting Liu (National Yunlin University of Science and Technology, Taiwan)

With the advancement of autonomous driving and intelligent vehicle technologies, the demand for enhanced maneuverability and stability is increasing. This study presents the design and implementation of a four-wheel steering mechanism intended for educational demonstration. The platform enables independent directional control of each wheel, supporting multiple steering modes such as front-wheel, rear-wheel, same-direction, and opposite-direction configurations. Ackermann steering geometry was applied to ensure all wheels align toward a common turning center, reducing sideslip and improving accuracy. The mechanism provides a tangible tool for exploring vehicle dynamics and steering behavior in a controlled, observable setting.

OS10-2 Comparative Analysis of Speech Recognition Training Using Real and Synthetic Data

Chung-Yu Li, Kuo-Hsien Hsia (National Yunlin University of Science and Technology, Taiwan)

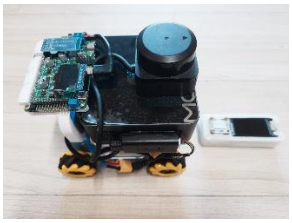
Speech recognition, as one of the most commonly used methods in language models, has always been a focus in terms of accuracy and latency. The appropriate standards vary depending on the application scenario. Traditional real-recorded speech data is commonly used in model training. However, the emergence of artificial intelligence synthesized speech has provided new options for training methods. This study will compare the training results of speech recognition using traditional real-recorded speech data and artificial intelligence synthesized speech data, analyze whether there are significant differences in accuracy, latency, and overall model performance, and explore the reasons for these differences.



OS10-3 Development of a Flexible ROS-based Robot Architecture

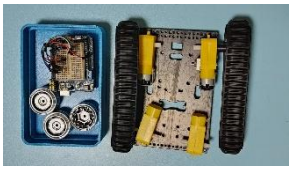
Jr-Hung Guo, Kuo-Hsien Hsia (National Yunlin University of Science and Technology, Taiwan)

The Robot Operating System (ROS) is widely adopted in robotics development due to its modular and open architecture, which supports diverse robotic platforms. However, its reliance on Linux limits its applicability to smaller robots or systems unable to run Linux environments. This paper proposes a universal architecture that leverages ROS's openness to bridge non-ROS-capable robots and peripheral devices with ROS-based systems. By integrating core ROS components—such as nodes, topics, and messages—this design enables external systems to interact with ROS functionalities, facilitating broader compatibility and extending ROS's utility beyond native Linux platforms.



OS10-4 Implementation of Water-Washing Blackboard Cleaning Mobile Robot

Jia-Ming Hsiao, Shao-I Hsiao, Yu-En Tien (National Yunlin University of Science and Technology, Taiwan)

This device was originally designed to help students and teachers clean the blackboard. Although it's designed for water-washing blackboards, the robot uses a tracked and magnetic design for movement, making it suitable for regular blackboards with magnetic attachment. The combination of a single-board computer and a motor driver is utilized as the robot control core, and the motor and magnetic tracks allow it to adhere to the blackboard and move. A cleaning cloth is placed around the bottom perimeter to ensure the corners of the blackboard are reached. A water sprayer is located inside the robot, and the robot cleans the blackboard by moving. Considering safety, a safety rope is placed near the blackboard to prevent damage to the machine and personal injury.	

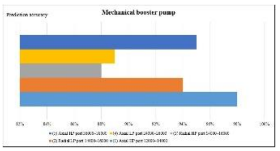
OS10-5 Image Recognition of UAV Photographed Ground Targets

Kuo-Da Chou, Huang-Li Wang (National Formosa University, Taiwan)

This study uses the Jetson Nano development board and a camera serial interface camera to build a test environment. Using a unmanned aerial vehicle (UAV) to capture images, this study compares two neural networks, YOLOv5 and SSD-Net, to evaluate the performance of object detection. Evaluation metrics include mean average precision (mAP) and frames per second (FPS). By incorporating object recognition and edge computing, YOLOv5 performs better on key performance metrics such as mAP, FPS, precision, and recall, with mAP outperforming SSD-Net. Test results demonstrate that the system can accurately identify a car at a range of 120 meters and an altitude of 60 meters, with a confidence score exceeding 82%.	

OS10-6 A Fault Prediction Method for Electron Beam Welding Equipment

Kuo-Da Chou, Huang-Li Wang (National Formosa University, Taiwan)

In electron beam welding, the process has to be carried out in vacuum to prevent gases in the air from scattering high-energy electrons. Therefore, the vacuum pump acts as a very important role in the process, and its feature parameters are the critical factors in the fault prediction of a vacuum pump in the electron beam welding equipment. This study adopts neural network to calculate the weight of individual features, to help establish a vacuum pump fault diagnosis model. And thereby increasing available maintenance time for equipment engineers to reduce losses caused by unexpected downtime. Through experiment verification results, it shows that the accuracy of the prediction model is 92%, proving the effectiveness of the method proposed in this study and can be used to improve the reliability of the welding process.	

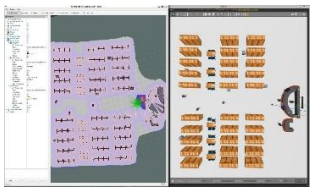
OS10-7 Concept Design of Foot Massager

Yuting Hsiao, Dengchuan Cai, Chung-Wen Hung, Chen-Wei Tu, Zi-Jie Xu
(Nation Yunlin University of Science and Technology, Taiwan)

In Taiwan, there is a shortage of skilled personnel for foot reflexology. To make this method more widely available, this study aims to automate the technique and develop a new foot massage product. This study measured the foot dimensions of 40 Taiwanese adults and photographed their soles. Professional foot therapists marked key areas to create a massage program, which was automated through a machine learning system and integrated into the product design, resulting in a unique foot massager. The features of this design include: 1) adjustable footrest size according to the user's foot size; 2) selectable massage speed; 3) selectable number of massages; 4) voice prompts for easy operation; and 5) safety considerations.	

OS10-8 Preliminary Design and Simulation Verification of an Autonomous Book Returning System Based on Navigation and Visual Recognition

Chun-Chieh Wang*, Chung-Wen Hung, Chun-Lung Hsiao, Kuo-Hsien Hsia, Chian-Cheng Ho
(National Yunlin University of Science and Technology, Taiwan)

This study aims to develop an autonomous book returning system with navigation and visual recognition capabilities. A mobile robot platform was built in the Gazebo simulation environment, achieving single-point navigation and obstacle avoidance as a foundation for integrating book recognition and slot localization modules. The system supports a complete workflow in a smart library, from autonomous positioning and navigation to precise book shelving. Future work will incorporate image recognition and deep learning techniques to enhance the automation and intelligence of library management.	

OS10-9 Development of a SOTIF-Based Safety Evaluation Platform for Lane Keeping Assist (LKA) Systems

Chien-An Chen, Yan-Hua Chen, Yi-Feng Tsou
(National Kaohsiung University of Science and Technology, Taiwan)

To reduce unexpected incidents involving vehicles equipped with autonomous driving (assistance) systems on real roads and to examine the operational range and limitations of such systems, this study focuses on the image perception module of the lane detection function within a Lane Keeping Assist (LKA) system. A test platform based on Safety of the Intended Functionality (SOTIF) is established to identify functional shortcomings and performance limits. The results can serve as references for defining the system's Operational Design Domain (ODD) and for proposing functional improvements, thereby assisting system developers in completing verification and solutions for known unsafe scenarios defined in SOTIF.	

OS11 Intelligent Control (8)

Chair Ching Ju Chen (National Yunlin University of Science and Technology, Taiwan)
Co-Chair Chun-Chieh Wang (National Yunlin University of Science and Technology, Taiwan)

OS11-1 Development of a Flight-Path Planning and AprilTag-based Landing System for Drone Logistics

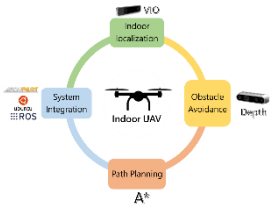
Yu-Ming Li, Jia-Ming Xu, Jia-Wen He, and Chau-Chung Song
(National Formosa University, Taiwan)

This research integrates multiple subsystems to achieve safe, reliable, and fully autonomous UAV flight in urban areas. Real-time traffic data are collected through the Google API, while cost maps generated from OpenStreetMap (OSM) illustrate congestion levels, obstacles, and no-fly zones. The A* algorithm is employed to calculate the optimal flight path, minimizing travel cost and improving route efficiency. For landing, AprilTags are detected by an onboard camera to perform accurate position estimation and autonomous descent. By combining these techniques, the proposed system enables UAVs to plan intelligent routes, avoid dangerous regions, and complete missions with high precision.	

OS11-2 Development of an Indoor VIO-Based Navigation System for Unmanned Vehicles

Chih-Hao Chen, Lin, Jian Jhih, Li-Hao Chen and Chau-Chung Song
(National Formosa University, Taiwan)

The widespread lack of stable GPS signals in indoor environments poses a critical challenge to autonomous UAV operation. To overcome this core limitation, our study is motivated to design and implement a highly robust, infrastructure-free navigation system. This novel solution integrates the RealSense T265 (VIO) for high-accuracy localization and the D435i for environment perception. All processing is efficiently executed on the Jetson Orin NX platform. The deployed system enables the unmanned vehicle to achieve precise localization, efficient path planning, and robust real-time obstacle avoidance. Ultimately, this work verifies the feasibility of VIO and depth sensing solutions in GPS-denied environments.



OS11-3 YOLOv11 Wormhole Detection System based on ESRT and EGA Enhancements

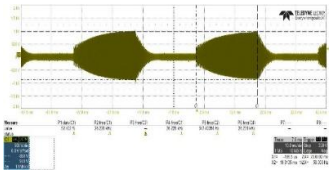
Jun-Lin WU, Chung-Wen HUNG*
(Nation Yunlin University of Science and Technology, Taiwan)

A YOLOv11(You Only Look Once) wormhole detection system based on ESRT (Efficient Transformer for Single Image Super-Resolution) and EGA (Edge–Gaussian Aggregation) enhancements is proposed in this paper. The detection of tiny wormholes embedded in richly textured carved wood surfaces is a challenge, due to an extreme small-object. To improve performance, one lightweight model and one module are introduced: the ESRT model to boost pixel resolution; and the EGA module to enhance shallow edge features and suppress deep noise. All components are integrated with SAHI (Slicing Aided Hyper Inference). Based on the method proposed in this paper, the parameters were increased from 2.6M to 2.7M, mAP was increased from 0.796 to 0.859, and F1 from 0.779 to 0.829.

OS11-4 Modulation Control Strategies for Ultrasonic Transducers

Chi-Wei Li, Chung-Wen HUNG*, Chun-Chieh Wang
(Nation Yunlin University of Science and Technology, Taiwan)

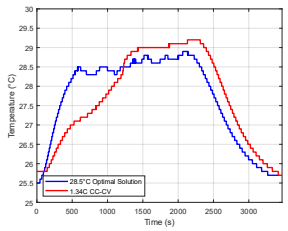
The modulation control strategies for ultrasonic transducer are discussed in this paper. In liquid atomization process, the output power needs to be modulated to control the particles and their distribution. The pulse width modulation（PWM）is used to adjust the amplitude of an ultrasonic oscillator, which is driven by an LC resonant circuit with automatic power point tracking to maintain stable oscillation. Three modulation methods: sinusoidal-, trapezoidal-, and intermittent on–off modulations are implemented and compared in this paper. The experimental results shows that the intermittent start-up and cut-off is the most suitable method for power point tracking and meeting the atomization requirements.



OS11-5 Temperature-Controlled Multi-Segment Constant Current Charging Technique Based on PSO Algorithm

Chun-Liang Liu, Guan Jhu Chen, Ching Ju Chen*, Ting-An Chang, Jin-Chen Zhuo
(National Yunlin University of Science and Technology, Taiwan)

This paper introduces an optimized Constant Temperature-Constant Voltage (CT-CV) charging method with three stages. The initial stage uses a high current to quickly raise the battery temperature to a target level. The second stage maintains a stable temperature using twenty Constant Current segments optimized through Particle Swarm Optimization (PSO). The final stage applies a fixed voltage until the current reaches a cutoff. Experimental results at 28.5 °C demonstrate a 1.12% reduction in charging time, 1.73% in average temperature, and 1.08% in maximum temperature compared to other methods.



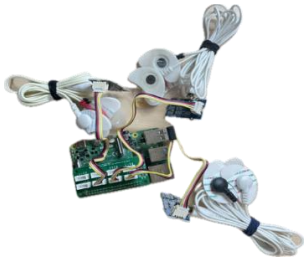
OS11-6 AIoT-Driven Smart Ecological Restoration of Sasakia Charonda Habitat

Ching-Ju Chen*, Zhao-Sheng Chen, Chun-Liang Liu, Candera Wijaya
(National Yunlin University of Science and Technology, Taiwan)

This study presents a smart ecological monitoring system for the Purple Emperor butterfly (Sasakia Charonda), an indicator species in Taiwan. Integrating NB-IoT and MQTT technologies, the system establishes a microclimate network for real-time environmental data collection. Combined with AI modeling, remote sensing, and GIS analysis, it evaluates the growth and distribution of Chinese hackberry (Celtis sinensis) and examines environmental effects on habitat restoration. Results demonstrate improved monitoring accuracy and management efficiency, supporting sustainable ecological conservation.	

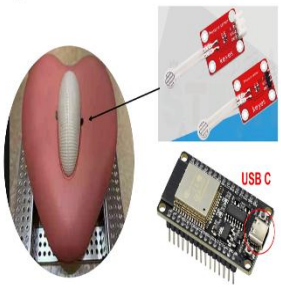
OS11-7 Swallowing Training Monitor

Nai-Hui Chien, Po-Ting Wang (Chang Gung University of Science and Technology, Taiwan)

Dysphagia affects about 8% of the global population, leading to aspiration pneumonia, and reduced quality of life. Current rehabilitation depends on medical professionals, yet resources are limited and existing devices are costly. To address this, we developed a wearable AI-powered swallowing training device integrating Raspberry Pi and electromyography sensors. The system features real-time monitoring, voice guidance, vibration feedback, and cloud-based tracking via LINE. It analyzes muscle activity and adaptively adjusts training intensity, enabling caregivers and physicians to monitor rehabilitation progress remotely. The device provides a comfortable, cost-effective solution for dysphagia management. Future developments include AI optimization, VR/APP-based training, and clinical validation to improve patients' quality of life.	

OS11-8 Assisted Pelvic Floor Muscle Training Device

Nai-Hui Chien, Tsai-Er Ho, Po-Ting Wang (Chang Gung University of Science and Technology, Taiwan)

Urinary incontinence (UI) affects ~20% of adults, with prevalence in older women up to 50–70%, causing physical discomfort, anxiety, depression, and social isolation. Pelvic floor muscle training (PFMT), such as Kegel exercises, is recommended but verbal instruction often fails to ensure correct activation, with ~40% of patients using compensatory muscles and adherence declining over time. To address this, we developed the Smart Pelvic Trainer, integrating AI, thin-film pressure sensors, and a mobile app. It provides guidance, real-time feedback, long-term data analysis, and gamified motivation, ensuring accurate muscle activation, improving PFMT effectiveness, supporting clinical practice, and enhancing patient quality of life and healthcare outcomes.	

OS12 Mathematical Informatics (11)

Chair Amane Takei (University of Miyazaki, Japan)
Co-Chair Ryuusuke Kawamura (University of Miyazaki, Japan)

OS12-1 Broadening Access to Creative Experiences with MR 3D Painting

Takumi Ishimaru, Yu Oshikawa, Shizuki Nokura, Satoshi Ikeda, Kenji Aoki, Kaoru Ohe,
Amane Takei, Ryuusuke Kawamura, Makoto Sakamoto
(University of Miyazaki, Japan)

Access to arts experiences varies by income and locality, creating an experience divide. We present a low-barrier mixed-reality (MR) 3D-painting system that anchors strokes to real surfaces on a desk. At a university festival with local children, we used a within-participant, counterbalanced protocol (2-min 2D task, 2-min MR task, 4-min free MR creation). After each condition, participants rated five items—immersion, accomplishment, perceived creativity, self-efficacy, and intention to continue—on a 5-point Likert scale. We summarize condition-wise medians and within-participant differences. Findings will indicate whether MR can deliver meaningful creative experiences with minimal setup in everyday spaces, suggesting a practical path to broadening access irrespective of place or household income.

OS12-2 Proposal of a Muscle Training Method using EMG Visualization via Machine Learning

Yu Oshikawa, Takumi Ishimaru, Shizuki Nokura, Satoshi Ikeda, Kenji Aoki, Kaoru Ohe,
Amane Takei, Ryuusuke Kawamura, Makoto Sakamoto
(University of Miyazaki, Japan)

Strength training is essential for maintaining health and building an attractive physique, yet many people struggle to stick with it. One reason for this is that they fail to feel the effects of strength training. To maximize the effects of strength training, mastering proper form is essential. Therefore, I embarked on this research to reduce the number of people who quit strength training by visualizing muscle load in real time during workouts.We are developing a system that uses machine learning to visualize muscle load from user form, enabling muscle load visualization without requiring electromyography. At present, it is possible to estimate muscle load, but the accuracy of this estimation is low. Therefore, we are currently experimenting to improve the accuracy of muscle load estimation.

OS12-3 Unsupervised Defect Detection for Automatic Shiitake Sorting

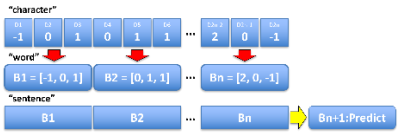
Shizuki Nokura[1], Leona Kimura[1], Takumi Ishimaru[1], Yu Oshikawa[1], Satoshi Ikeda[1], Kenji Aoki[1],
Kaoru Ohe[1], Amane Takei[1], Ryuusuke Kawamura[1], Makoto Sakamoto[1], Kazuhide Sugimoto[2]
([1]University of Miyazaki, Japan), ([2]SUGIMOTO Co., Ltd., Japan)

Automated shiitake sorting faces data imbalance and annotation difficulties. We compared data augmentation and unsupervised detection. First, augmenting scarce defective data with GANs failed; models either lost subtle defect features (e.g., discoloration) during pre-processing or overfit to augmentation patterns, proving label-less augmentation difficult. We then shifted to unsupervised anomaly detection (VAE+OC-SVM) trained only on good data. This model achieved perfect Recall (100%) for the defective class, identifying all bad items without a single miss. This "zero-miss" capability demonstrates its high practical utility as a primary screening tool for quality control.

OS12-4 Language Modeling of Discretized Numerical Time Series: An Empirical Study Using Transformers

Daiya Matsuyo[1], Makoto Sakamoto[1], Takao Ito[2], Satoshi Ikeda[1]
([1]University of Miyazaki, Japan), ([2]Hiroshima University, Japan)

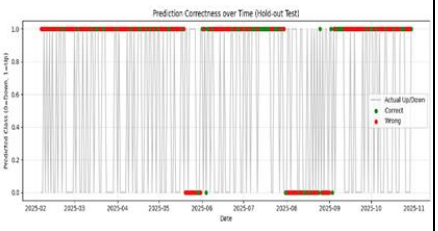
By discretizing daily stock price changes into five categories {−2, −1, 0, 1, 2}, the time series can be represented as a sequence over a five-symbol alphabet (e.g., [−1, 0, 2, 1, …]). By grouping every three consecutive days into a single token, the series can be viewed as a compact “language” with a 125-word vocabulary defined over these symbols. In this study, we apply a Transformer-based language model to learn patterns in this symbolic representation of stock movements. Using this approach, we evaluate the feasibility and effectiveness of treating financial time series as natural language and explore the affinity between such discrete temporal data and Transformer architectures.



OS12-5 Raising Issues with Evaluation Metrics for Predicting Highly Volatile Cryptocurrencies

Hyuma Kai[1], Makoto Sakamoto[1], Takao Ito[2], Satoshi Ikeda[1]
([1]University of Miyazaki, Japan), ([2]Hiroshima University, Japan)

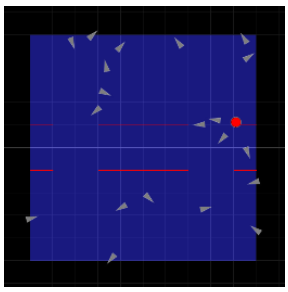
Cryptocurrencies exhibit substantial price volatility, and commonly used error metrics such as RMSE and MAPE do not necessarily reflect performance in ways that align with practical investment decisions. In particular, for Ethereum (ETH), which is the focus of this study, there are instances where numerical prediction errors remain small despite low directional accuracy, revealing inherent limitations in these metrics. This study systematically investigates this discrepancy by comparing regression and binary classification models within systems that incorporate algorithms suited to ETH price behavior as well as external factors. Furthermore, it proposes a new evaluation framework tailored to the unique characteristics of cryptocurrency markets.



OS12-6 Development of a Crisis-Avoidance Simulator Based on the Boids Model

Taiyo Hidaka, Makoto Sakamoto, Kenji Aoki
(University of Miyazaki, Japan)

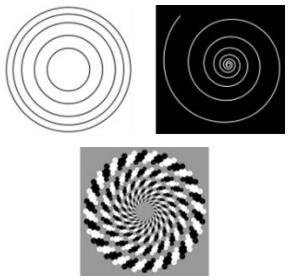
This study presented the development of a crisis avoidance simulator based on Reynolds' Boids model, designed to replicate crowd escape behavior in two-dimensional environments under attack scenarios. The simulator incorporated structural elements such as walls with openings, wall-induced reflection and repulsion, and line-of-sight occlusion. It featured a single attacker who pursued the nearest visible agent and multiple agents who attempted to flee. Simulation experiments conducted across various room configurations revealed that spatial structure and inter-agent attraction significantly influenced escape dynamics. These findings suggested that the proposed simulator could serve as a valuable tool for optimizing evacuation route design and emergency behavior planning.



OS12-7 Investigating Fraser's Spiral Illusion in Vision Transformer Models

Eisuke Fujita, Makoto Sakamoto, Kenji Aoki
(University of Miyazaki, Japan)

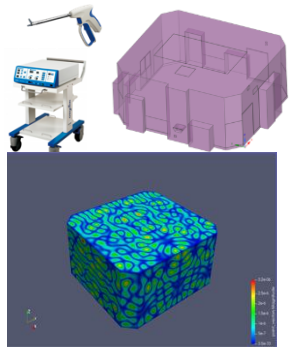
This study investigated whether Vision Transformer (ViT) models exhibited perceptual responses to Fraser's spiral illusion similar to those observed in humans. Fraser's illusion presents images that appear spiral-like to human observers, despite being composed of concentric circles. To explore this phenomenon, we constructed a ViT model and trained it to distinguish between spiral and concentric circle patterns using a custom-designed dataset. We then evaluated the trained model on Fraser's illusion images to determine whether it classified them as spirals or concentric circles. The results provided new insights into how neural networks processed visual information and suggested that such models may replicate perceptual phenomena typically associated with human vision.



OS12-8 Microwave Parallel FEM based on Iterative Domain Decomposition Method

Amane Takei, Makoto Sakamoto
(University of Miyazaki, Japan)

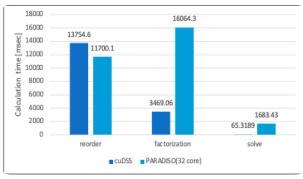
This paper describes large-scale parallel microwave numerical calculations based on the finite element method (FEM) with an iterative domain decomposition method. A stationary vector wave equation for the high-frequency electromagnetic field analyses is solved taking an electric field as an unknown function. Although this solver is capable of detailed, fast and efficient FEM of large-scale high-frequency electromagnetic problems using the iterative domain decomposition method (IDDM) and the corresponding parallel distributed processing environment, it still requires a large number of iterative computation trials and computation time. In this study, we found that increasing the size of the subdomain in the IDDM improves the convergence of the accuracy of the iterative method and reduces the computation time. We are also considering replacing the solver with a subdomain solver that can handle larger subdomains.



OS12-9 Study on GPGPU Computing of Subdomain Solver in High-Frequency Electromagnetic Field Analysis

Biki Bidish Biswas[1], Kento Ohnaka[1], Makoto Sakamoto[1], Amane Takei[1], Sota Goto[2]
([1]University of Miyazaki, Japan), ([2]University of Tokyo, Japan)

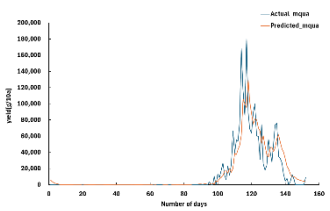
This study presents GPU acceleration of a subdomain solver for high-frequency electromagnetic field analysis using the finite element method (FEM). The solver is a direct sparse solver based on a parallel multi frontal algorithm implemented using NVIDIA's cuDSS library for sparse matrix factorization and solution. Implemented within the ADVENTURE_FullWave framework, the approach achieves efficient parallel computation of subdomain problems on GPGPU platforms. Benchmark results demonstrate significant speedup compared with CPU execution, confirming the effectiveness of cuDSS-based GPGPU computing for large-scale electromagnetic simulations.



OS12-10 Investigation of Features for Mango Yield Prediction using Long Short-Term Memory Networks

Hiroshi Kurita[1], Ryuusuke Kawamura[1], Kazunori Yamaguchi[2], Makoto Sakamoto[1]
([1]University of Miyazaki, Japan), ([2]Miyazaki Agricultural Experiment Station)

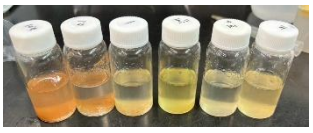
In mango cultivation in Miyazaki Prefecture, much of the production management relies on the empirical rules and intuitive judgments of agricultural workers. This study predicts mango yield using a Long Short-Term Memory (LSTM) model and investigates the impact of explanatory variables on prediction accuracy. A model developed using weather and harvest data from 2017 to 2024 demonstrated an approximate one-day error in predicting the peak harvest date; however, the overall trend in predicted yield closely aligned with the observed data. Through a comparison of feature selection, excluding unnecessary variables resulted in the highest prediction accuracy, demonstrating the importance of appropriate variable selection.



OS12-11 Comparative Study of Metal-Ion Adsorption and Gold Reduction by Crosslinked and non-crosslinked Sericin

Kaoru Ohe[1], Yudai Yamaguchi[1], Tatsuya Oshima[1]
([1]University of Miyazaki, Japan)

Sericin is an underutilized biomass of hydrophilic protein removal during the refining process of silk yarn. Processing abundant functional groups such as hydroxyl, carboxyl, amide, and amino groups, sericin exhibits affinity for metal ions, making it a promising biosorbent. This study investigated the adsorption behavior of metal ions using sericin and glutaldehyde-crosslinked sericin(Glu-sericin). Glu-sericin selectively adsorbed precious metals over Cu(II) in 0.01 M HCl. In contrast, sericin showed a red color change after Au(III) adsorption from 0.01 M and 0.1 M HCl, indicating the reduction of Au(III) to Au(0). These results show that sericin non-crosslinked treatment, both adsorption and reduction functions, making it a unique biomass material for gold recovery.



Fig,1 Photos of samples after Au(III) adsorption from 0.01M-HCl solutions using sericin

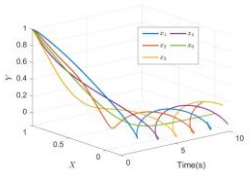
OS13 Intelligent Control (5) no presentation

Chair Yingmin Jia (Beihang University, P.R.China)
Co-Chair Weicun Zhang (University of Science and Technology Beijing, P.R.China)
Co-Chair Lixia Yan (Tsinghua University, P.R.China)

OS13-1 Observer-Based Adaptive Prescribed-Performance Formation Control for Fully Actuated Multi-Agent Systems

Jiaming Zhang[1], Yang Liu[1], Yulin Duan[2]
([1]Beihang University (BUAA), P.R.China), ([2]Southern University of Science and Technology, P.R.China)

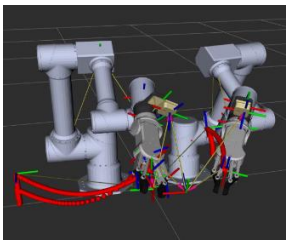
This article explores the adaptive distributed prescribed performance formation control problem for nonlinear high-order fully actuated multi-agent systems (HOFA-MASs). Firstly, we employ the prescribed-time control technology to implement the observer design for the desired leader trajectory. Then, for each follower, a funnel controller is designed by using the prescribed performance funnel method and the HOFA control method, where the effect of uncertain parameter vector is eliminated by using adaptive control method. With the aid of barrier function, it can ensure that the formation errors are restricted by arbitrary accuracy at any prescribed time and realize the asymptotic formation control ultimately. Finally, the simulation studies on Unmanned Ground Vehicles (UGVs) demonstrate the effectiveness of the proposed schemes.



OS13-2 Coordinated Hybrid Visual/Force Servo Approach-Based Peg-in-Hole Assembly for a Master-Slave Dual-Arm Robot

Xuewen Zhang, Yingmin Jia, Yang Liu
(Beihang University (BUAA), P.R.China)

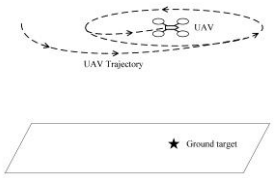
This paper proposes an efficient architecture for collaborative peg-in-hole assembly operation based on coordinated hybrid visual/force servo approach for a master-slave dual-arm robot. Equipped with an RGB camera for AprilTag identification, the master arm is responsible for grasping and screwing operations based on the visual servo algorithm. A force/torque sensor is mounted on the end of the slave arm to measure contact wrench, granting it the ability to regulate internal wrench while clamping the target. The control system is built based on ROS2, wherein the dual-arm robot is driven under the framework of Moveit! Servo, a software facilitating real-time robot control. Simulations in Gazebo are conducted, followed by experiments on a real dual-arm robot to validate the efficacy of the proposed architecture.



OS13-3 Range-Only Target Searching for Unmanned Aerial Vehicles in GPS-Denied Environments

Xuancheng You, Baoli Ma, Yue He (Beihang University (BUAA), P.R.China)

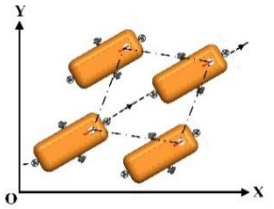
This paper proposes a UAV target searching method for GPS-denied environments relying solely on range measurements. To resolve the relative position ambiguity inherent in range-only data during linear motion, we first employ a range-based target circumnavigation control law, guiding the UAV to circle the target at a fixed distance. A designed observer then estimates the relative position, enabling the UAV to accurately move to and hover directly above the target. The method's effectiveness and feasibility are validated through numerical simulations and field experiments.



OS13-4 Formation Tracking Control of Multiple Underactuated Autonomous Underwater Vehicles

Lixia Yan, Qingqi Zhang, Yue Ma, Shiji Song (Tsinghua University, China)

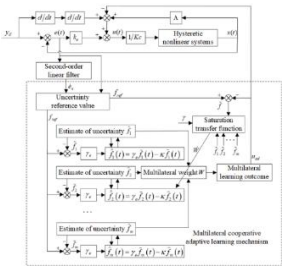
This paper investigates the formation tracking control for a group of underactuated autonomous underwater vehicles (AUVs). First, we simplify the AUV model into linear integrators by shifting the coordinated position from the center to a point in front of the AUV body. Second, the new coordinates, which incorporate neighboring communication, are utilized to derive the saturated formation tracking control law. It is proven that the formation tracking errors are convergent to zero asymptotically, and the moving directions of all AUVs are to the tangential direction of the position trajectory. Numerical simulations are carried out to validate the theoretical results.



OS13-5 A Multilateral Cooperative Adaptive Learning Control Scheme for Hysteretic Nonlinear Systems

Yao Wang[1], Qunpo Liu[1,2], En-guang Yang[1], Guotai Li[1]
([1]Henan Polytechnic University, China)
([2]Henan International Joint Laboratory of Direct Drive and Control of Intelligent Equipment, China)

For a class of single-input single-output nonlinear systems with Backlash-like hysteresis and external disturbance, a multilateral cooperative adaptive learning controller is proposed to improve the response speed and tracking accuracy of the system trajectory tracking. The adaptive update rate is designed for the uncertainty estimate of the multilateral branch to complete the local update iteration. The multilateral learning result is exported by weighted fusion, and the uncertainty in the system is compensated. The differential of the error signal is obtained by a second-order linear filter, and the saturation conversion function is introduced to deal with the challenge caused by the rapid parameter change, and then the adaptive update rate of multilateral weight parameters is designed completely. The performance of PD controller and sliding mode neural network controller is compared to verify the effectiveness of the proposed control scheme.



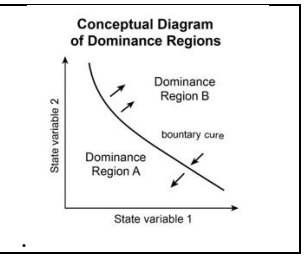
OS14 Natural Computing (3)

Chair Marion Oswald (TU Wien, Austria)
Co-Chair Yasuhiro Yasuhiro Suzuki (Nagoya University, Japan)

OS14-1 Dominance Regions: Geometric Framework for Multi-Component Dynamical Systems

Yasuhiro Suzuki (Nagoya University, Japan)

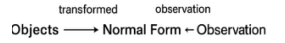
I introduce the concept of *dominance regions* as a new geometric framework for describing multi-component dynamical systems. A dominance region specifies where the influence of one component locally exceeds that of all others, producing a natural partition of state space through relative-rate comparisons. This structure reveals directional biases, highlights transition boundaries, and exposes latent organizing principles that govern system trajectories. It provides a minimal yet broadly applicable tool for analyzing the internal structure of high-dimensional interacting systems.



OS14-2 Algorithmic Observation and the Reconstruction of Scientific Rationality

Yasuhiro Suzuki (Nagoya University, Japan)

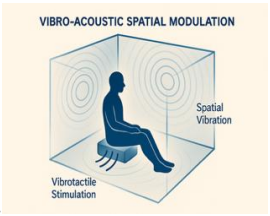
This paper develops an algorithmic account of observation by treating Minakata Kumagusu's "koto" as a natural process generated through the observer's transformation. Subjectivity is defined as a non-formalizable algorithmic operation that produces observation rather than preceding it. Observation is thus a computational event linking natural and formal systems. This framework clarifies the structural limits of modern objectivist science and outlines a post-objective model in which observer and world co-evolve.



OS14-3 Vibro-Acoustic Spatial Modulation for Enhancing Environmental Experience in Interior Spaces

Yasuhiro Suzuki (Nagoya University, Japan)

Vibro-Acoustic Spatial Modulation for Enhancing Environmental Experience — [Your Name], Nagoya University, Japan — This study introduces a vibro-acoustic spatial modulation method that integrates controlled spatial vibration with gentle tactile stimulation to create a coherent multisensory field without audible cues; objective measurements showed reproducible changes in acoustic structure and spatial coherence, and pilot demonstrations indicated enhanced calmness, natural presence, and environmental comfort, suggesting applicability to wellbeing-oriented spatial design while technical details remain proprietary.



OS15 Human Machine Interface I (4) online presentation

Chair Norrima Mokhtar (Universiti Malaya, Malaysia)
Co-chair Siti Sendari (Universitas Negeri Malang, Indonesia)

OS15-1 Engineering Design and Numerical Simulations of Upper Limb Exoskeleton for Rehabilitation

Pringgo Widyo Laksono[1], Eko Wahyu Abryandoko[1], Lobes Herdiman[1], Norrima Mokhtar[2]
([1]Universitas Sebelas Maret, Indonesia), ([2]Universiti Malaya, Malaysia)

This study presents a 4-DoF upper-arm exoskeleton for post stroke rehabilitation using integrated kinematic, dynamic, and FEA analysis. The system includes three active actuators (ball-screw linear translation, shoulder–elbow flexion–extension, and supination–pronation) and one passive spring-based wrist joint. Kinematic simulations show accurate reproduction of physiological motion. Dynamic analysis indicates a torque requirement of 22.76 Nm, and a minimum linear torque of 0.0278 Nm for actuator specification. The supination–pronation module achieved a safety factor >2. FEA results show maximum stress of 9.09×10^5 N/m², deformation of 1.96×10^{-2} mm, and a structural safety factor of 4.56×10^{11}. Overall, the design demonstrates high structural integrity and strong potential for safe, adaptive stroke rehabilitation.

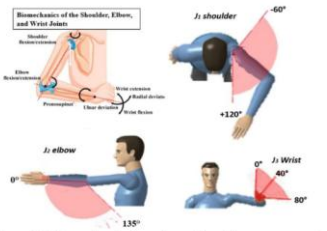


Figure 1. Biomechanical configuration of arm movement

OS15-2 Performance Evaluation of Deep Learning-Based Resnet, MobileNetV2 and DenseNet Models for Road Lane Detection

Joko Slamet Saputro[1], Ananda Putra Kanieza[1], Pringgo Widyo Laksono[1], Norrima Mokhtar[2]
([1]Universitas Sebelas Maret, Indonesia), ([2]Universiti Malaya, Malaysia)

This study presents a performance comparison of three backbone architectures—MobileNetV2, ResNet, and DenseNet—for road lane detection using Mask R-CNN. The evaluation employs three key metrics: loss function, mean Intersection over Union (mIoU), and pixel accuracy, supplemented by inference time testing. Experimental results demonstrate that DenseNet achieves the highest segmentation accuracy, with the lowest training loss and mIoU exceeding 0.95. ResNet strikes a balance between accuracy and efficiency, while MobileNetV2 excels in training and inference speed, making it ideal for real-time applications. Tests were conducted on Google Colab using a Tesla T4 GPU, confirming the relevance of these findings for cloud-based computing environments with limited resources.

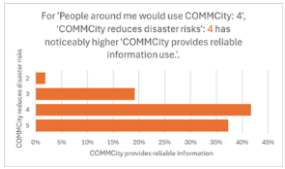

Table 2 Variety of road conditions

Road Condition	Description
	Road with optimal lighting
	Road with shadow noise
	Road with low lighting

OS15-3 CommCity: An Integrated Multi-Modal Platform for Urban Disaster Resilience through Hybrid Route Optimization and AI-Driven Community Intelligence

Mohd Heikal Husin[1], Azleena Mohd Kassim[1], Nor Shamira Sabri[1], Noor Farizah Ibrahim[1]
Siti Rahyla Rahmat[2]
([1] Universiti Sains Malaysia, Malaysia), ([2] Universiti Sains Malaysia, Malaysia)

This study presents the CommCity Platform, an integrated System-of-Systems (SoS) designed to enhance urban resilience. CommCity covers the dynamic evacuation routing for citizens using Hybrid Genetic Algorithm and Simulated Annealing (GA-SA), the AI-driven community intelligence using Natural Language Processing approach for situational awareness derived from crowdsourced public data, as well as community-centric vehicle and asset safety management. CommCity demonstrates a paradigm for urban disaster management, shifting from isolated applications to an interconnected, multi-stakeholder platform. The results show that the hybrid GA-SA achieves strong performance, and integrating AI with validated community input is feasible and valued by potential users.



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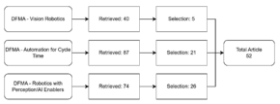
OS15-4 Bridging Design for Manufacturing and Assembly (DFMA) with High-Speed Vision - Robotics: Toward Integrated Design and Cycle Time Reduction in High-Mix Low-Volume Production

Hendi Herlambang[1], Pringgo Widyo Laksono[1], Ilham Priadythana[1], Norrima Mokhtar[2]
([1]Universitas Sebelas Maret, Indonesia), ([2]Universiti Malaya, Malaysia)

This paper reviews how Design for Manufacturing and Assembly (DFMA) can be integrated with Vision-Guided Robotics to improve High Mix Low Volume (HMLV) production. Using publications from 2015–2025, the review analyzes trends in DFMA, robotic vision, and automation through bibliometric mapping and thematic synthesis. Three key research themes emerge: cycle time reduction, real-time adaptability, and design for perception. While many studies highlight DFMA features that improve detection and robotic grasping, there is still a lack of quantitative models linking DFMA parameters to robotic performance. The review identifies future opportunities such as design-for-perception guidelines, digital twin–based design and scheduling analysis, and transferable perception systems for highly variable environments. These directions strengthen DFMA–robotics integration and support significant improvements in automation efficiency.



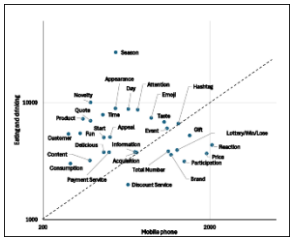
OS16 Narrative, Sensibility, and Cognition: Post-narratological Discussion for Humans and Robots (12)

Cair Jumpei Ono (Aomori University, Japan)
Co-Chair Hiroki Fxyma (Kobe University, Japan)
Co-Chair Yukiko Furuya (Chiba University, Japan)
Co-Chair Takashi Ogata (Yamato University, Japan)

OS16-1 An Analysis of Post Content and Like Ratings - Differences by Product Category and Media –

Yoji Kawamura (Kindai University, Japan)

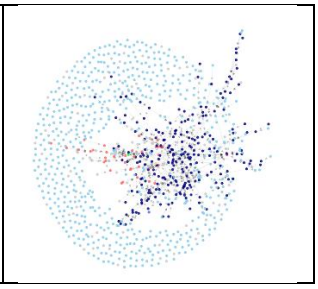
The purpose of this study is to analyze "like" ratings for posts made by official social media accounts, and to clarify trends in post content and "like" ratings, as well as differences between product categories and media.
First, the content of official account posts and ratings (number of "likes," "retweets," and "replies") over a one-year period were collected from database services such as social media. Next, morphological analysis software was used to extract keywords from the posts, and similar keywords were grouped together and classified into hypernyms. The classified hypernyms were then compared by product brand and media.



OS16-2 Disinformation Narrative Distribution and Generation Using Generative AI

Jumpei Ono (Aomori University, Japan), Takashi Ogata (Yamato University, Japan)

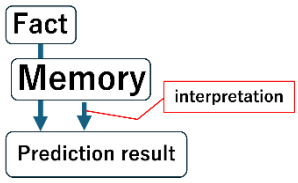
In recent years, concepts such as cognitive security and cognitive warfare have attracted increasing attention, and the mechanisms by which disinformation distorts the cognition of societies and individuals are being actively studied. Although this issue has become an urgent topic in Japan, research in this field remains in its developmental stage. This study aims to simulate the distribution process of disinformation in a virtual scenario where a group targets an individual on social media, based on real-world data, and to analyze the generation of disinformation narratives using generative AI. The results of this research are expected to contribute to the development of systems for detecting and countering disinformation narratives.



OS16-3 Graph-Based Next-Event Prediction Methods Considering the Interrelationships among Game Players' Memories: Focusing on a Card Game

Koki Nishiyama (Yamato University, Japan), Hiroki fxyma (Kobe University, Japan)
Takashi Ogata (Yamato University, Japan)

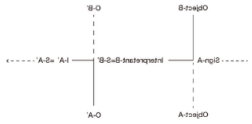
The aim of this study is to understand the process by which humans form a hierarchy of predictions when anticipating future developments of events and taking actions accordingly. Predictions are not necessarily based on probabilistic judgments; rather, even in situations where probabilities cannot be quantitatively assessed, people make guesses by referring to memory and constructing their own theories in relation to the current situation. In this paper, we compare and examine three computational models that represent "relational values" to investigate how experience-based theory construction contributes to predicting future developments.



OS16-4 Category-Theoretic View of Social Repair: Minimal Supplementation in Human Dialogue

Yukiko Furuya, Akinori Abe (Chiba University, Japan)

This study proposes a framework for how humans detect and repair interpretation gaps in dialogue and collaborative narrative construction. We argue that repair is not a full stop-and-explain move, but a “minimal supplementation”: supplying only the missing assumption, using previously shared relational or situational patterns, to restore continuity and mutual understanding. We reinterpret this as on-the-spot interpersonal regulation, consistent with abductive and analogical accounts of filling missing knowledge (Abe, 1999). Drawing on 5 dyadic improvisations and 10 post-performance interviews, we code where gaps are perceived and what assumption is said to have been inserted. We further model repair as a minimal structural completion of the interaction between conversational states — treating dialogue states as objects and role-relational links as morphisms — thereby situating repair in a category-theoretic, compositional view of interaction. We suggest that this principle can inform socially responsive robot behavior that maintains rapport without intrusive overcorrection.



OS16-5 Toward a Multi-layered Computational Model of Structure and Meaning in *Onna Koroshi Abura no Jigoku* for AI-based Narrative Generation

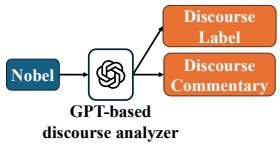
Sakura Kawai, Takashi Ogata (Yamato University, Japan)

The authors have conducted research aimed at confirming and extending the characteristics of an author’s (S. Kawai) literary and artistic “empathy.” In particular, we surveyed papers and books related to human sympathy and empathy, and analyzed the author’s cognitive characteristics based on her reading and writing tendencies. Moreover, we intentionally selected a famous narrative work, *Onna Koroshi Abura no Jigoku* by Chikamatsu Monzaemon, which has a strong storyline that does not easily attract a reader’s sympathy. Through the above research process, we recognized the necessity of a detailed narrative analysis of this work. In this paper, we report on a concept of narrative analysis that includes both structural and semantic levels for a detailed examination of the narrative. The structural level deals with the discoursal process, repetition and tension-building mechanisms, and narration methods used in actual performances. In contrast, the semantic level corresponds to a set of events involving mainly characters, places, times, and objects.

OS16-6 Toward Computational Narrative Discourse Analysis with Large Language Models: A Case Study on a Japanese Short Novel

Riku Takahashi, Ayahiko Niimi (Future University Hakodate, Japan)

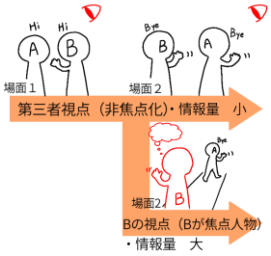
This study investigates the role of large language models (LLMs) in facilitating narrative discourse analysis for computational comprehension of narratives and robotic cognition. Narrative discourse pertains to the aspects of who narrates, what is narrated, when it occurs, and from whose perspective. The field of narrative discourse remains underexplored in computational linguistics, as traditional narrative analysis frameworks encounter challenges in modeling the perspective, temporal, and interpretive dimensions emphasized in Gérard Genette’s discourse theory. To address these challenges, this study explores the potential of LLMs as an innovative approach to narrative discourse analysis. We conducted prompt-based discourse analyses of a Japanese short novel using the GPT-5, GPT-5-mini, and GPT-4o models. The findings indicate that GPT-5 demonstrates stable labeling and generates commentaries that effectively capture discourse structures, such as focalization and narrative distance.



S16-7 Blending a Visual Novel and Narrative Discourse Theories Using Generative AI

Yuka Okayama (Yamato University, Japan), Jumpei Ono (Aomori University, Japan)
Takashi Ogata (Yamato University, Japan)

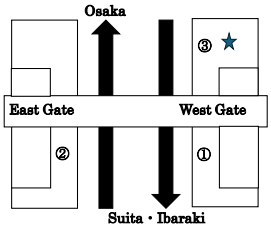
The framework of a “visual novel” on a computer allows for diverse story lines based on a single narrative world. This research aims to implement organized and systematic mechanisms for narrative representation within visual novels to enable diverse narrations. While the narrative discourse theory by Gerard Genette is an analytical framework that systematically studies narrative works, Ogata reorganized the theory from a constructive viewpoint for application in computer-based narrative generation systems. The basic idea of this paper is to use narrative discourse techniques for the visual novel to flexibly, automatically, and in real time create diverse narrative representations at various points in the user's reading. In this paper, we present our visual novel work, “Slime Cat,” as a template for future integration with diverse narrative discourse mechanisms.



OS16-8 Acquiring Creative Narrative Generation Techniques from the Behaviors and Cognition of Individuals with Autism Spectrum Disorder

Misao Ichio (Yamato University, Japan), Jumpei Ono (Aomori University, Japan),
Shin’ichiro Aoki (Iwate Prefectural University, Japan), Takashi Ogata (Yamato University, Japan)

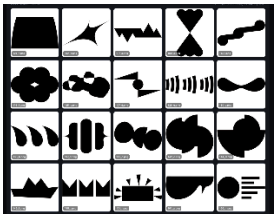
This study aims to identify and systematize creative and rhetorical narrative generation techniques inspired by the behaviors and cognition of individuals with Autism Spectrum Disorder (ASD). In our previous study, we analyzed several narratives created by people with ASD and extracted distinctive narrative generation techniques from their storytelling processes. We then conducted simulations applying these techniques to narrative generation tasks. Based on that foundation, this paper categorizes the previously acquired techniques into two hierarchical levels: macro-level and micro-level narrative techniques. We present the detailed structure and characteristics of each level and discuss how they can be applied to create novel and engaging narratives.



OS16-9 Developing a Shape Dataset for Multimodal Evaluation of Taste and Flavor

Hiroki Fxyma (Kobe University, Japan)

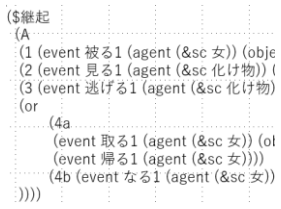
This study aims to develop a standardized set of abstract shapes for evaluating the subjective impressions of taste and aroma. To construct a perceptually diverse and experimentally usable stimulus set, I compiled a dataset of 750 abstract images and extracted 126-dimensional morphological features using WinROOF. Based on these high-dimensional shape descriptors, we performed clustering to organize the images into structurally coherent groups. The analysis yielded 48 clusters, each representing a distinct pattern of geometric and morphological characteristics. For each cluster, I examined its internal feature distribution and selected a representative image that best captured the cluster’s central properties. The resulting set of 48 representative shapes provides a manageable and interpretable subset of the broader 750-image space, enabling controlled presentation in sensory and psychophysical experiments. This study establishes a quantitative foundation for nonverbal evaluation of taste and aroma and offers a systematically constructed visual stimulus set for subsequent multimodal research linking flavor perception and shape representation.



OS16-10 Toward AI-based Narrative Generation Techniques Based on the Narrative Structures of Japanese Folktales

Jumpei Ono (Aomori University, Japan), Takashi Ogata (Yamato University, Japan)

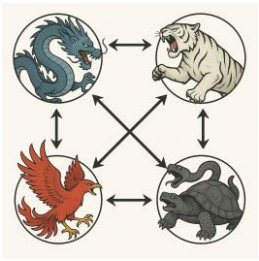
This study explores a method for generating new narrative structures by integrating structural analysis of Japanese folktales with artificial intelligence techniques. Based on *Nihon Mukashi Banashi Taisei* (*The Complete Collection of Japanese Folktales*) compiled by Keigo Seki and et, al, the authors represent Japanese folktales as hierarchical tree structures extracted from events within the text. By manipulating these tree structures through evolutionary computation and generative adversarial networks, the study attempts to edit structural features of the original folktales and merge multiple folktales, thereby generating novel and coherent narratives.



OS16-11 Design and Development of a Narrative World for a Multi-agent-based Narrative Generation Role-Playing Game

Hikaru Sugizawa (Yamato University, Japan), Ono Jumpei (Aomori University, Japan)
Takashi Ogata (Yamato University, Japan)

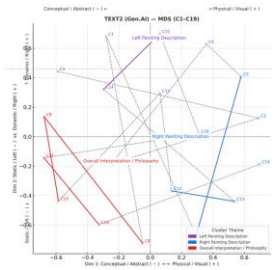
The goal of this research is to develop a novel type of role-playing game that automatically generates narratives through multi-agent simulations of diverse characters' events. In our previous study, we designed a narrative world consisting of four countries and multiple types of characters as a fundamental framework for this developmental research. In this paper, we describe the overall structure of the narrative world and the development of a prototype system based on this structure, which includes various elements, such as countries, characters, and events. Furthermore, we present several results from event simulations and narrative generation experiments to identify current challenges and future directions.



OS16-12 The Aesthetic Mindscape: Visualizing Human and AI Narratives in Abstract Art

Jun Nakamura (Chuo University, Japan), Sanetane Nagayoshi (Shizuoka University, Japan)

Recent advances in generative AI have allowed machines to produce narrative-like interpretations of artworks that evoke a sense of human reflection. This study investigates how sensibility emerges differently in human and AI cognition through the interpretation of an abstract painting by Pablo Picasso. Using multidimensional scaling (MDS), we visualize semantic structures within human and AI-generated texts to reveal their narrative tendencies. Human interpretation demonstrates a fluid interplay between perception and introspection, seamlessly shifting between physical observation and conceptual imagination. In contrast, AI constructs a coherent yet detached narrative, systematically organizing visual information into an analytical sequence. By positioning these differences along cognitive axes of conceptual–physical and static–dynamic expression, the study illuminates how narrative structure embodies distinct modes of sensibility. These findings contribute to post-narratological discussion by exploring how the act of description itself becomes a mirror of cognition for both humans and machines.

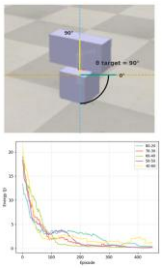


OS17 Human Machine Interface II (4) **online presentation**
Chair Norrima Mokhtar (Universiti Malaya, Malaysia)
Co-Chair Pringgo Widyo Laksono (Universitas Sebelas Maret, Indonesia)

OS17-1 Experimental Analysis of Energy-Aware Reward Function for Q-Learning in Single-Joint Robotic Manipulator

Giri Wahyu Wiriasto[1,2], Dyah Lestari[1], Muhamad Syamsu Iqbal[2], Siti Sendari[1*] Norrima Mokhtar[3]
([1] Universitas Negeri Malang, Indonesia) ([2] Universitas Mataram, Indonesia)
([3] Universiti Malaya, Malaysia)

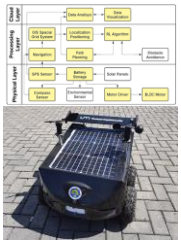
This study proposes an Energy-Aware Q-Learning framework for a single-joint robotic manipulator to explicitly balance energy consumption and motion performance. By testing various reward weight configurations (Energy: Performance), the research found that excessive energy weighting (e.g., 70:30) results in lower minimum energy but conservative behaviour. The 60:40 configuration provided the optimal trade-off, achieving the highest efficiency score (662.25 J^{-1}), highest average reward, and a 100% success rate. The results demonstrate that integrating energy-aware reward shaping creates more adaptive, stable, and energy-efficient robotic control policies.



OS17-2 IoT-Based Autonomous Mobile Robot Navigation Using GPS with GIS Integration

Siti Sendari[1*], Danang Arengga[1], Farhan Nafis Dermawan[1], Vita A. K. Dewi[1], Tibyani Tibyani[2], Norrima Mokhtar[3]
([1] Universitas Negeri Malang, Indonesia), ([2] Universitas Brawijaya, Indonesia)
([3] Universiti Malaya, Malaysia)

This study addresses the difficulty of autonomous mobile robot navigation in challenging outdoor terrains (like landfills). The solution involves an IoT framework that integrates GIS (for path planning) and GPS (for localization) to facilitate real-time environmental mapping. Tested at a landfill in Indonesia, the system was evaluated on localization accuracy, path completion time, and communication reliability. The robot demonstrated satisfactory performance, validating the method as a scalable and practical approach for intelligent mobile robot navigation and mapping in variable environments.



OS17-3 Bearing Fault Identification System of Three-Phase Induction Motor Using Vibration Signal-based Backpropagation Neural Network

Dwiky F. Syahbana[1], Muhammad Shandar F. Faseh[1], Fauzi I. Adhim[1], Norrima Mokhtar[2]
([1] Institut Teknologi Sepuluh Nopember, Indonesia), ([2] Universiti Malaya, Malaysia)

This study proposes a Backpropagation Neural Network (BPNN) approach for classifying the condition of three-phase induction motor bearings using vibration data, a critical factor in industrial reliability. The BPNN achieved the highest accuracy on the standard SUBF v1.0 dataset, and its performance was further evaluated on a real-world conveyor prototype. While the model demonstrated highly accurate and stable detection for the normal and outer fault classes in the prototype, it showed high precision but low recall for the inner fault class, indicating frequent failures to detect actual inner race faults. Overall, the research validates the BPNN as a promising solution for vibration-based fault diagnosis in both controlled and real-world settings, but highlights the necessity of further optimization to overcome practical challenges in reliably detecting inner race faults.

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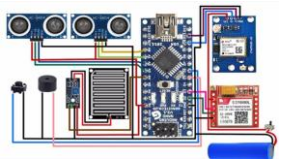
OS17-4 Assistive Navigation Stick for the Blind

Norul Ashikin Norzain, Mohd Azwan Ramlan, Hanisah Mohd Zali, Nik Nur Zuliyana Binti Mohd Rajdi, Maisarah Binti Lutfi
(MAHSA University, Malaysia)

This paper describes the design and evaluation of a low-cost, multi-sensor Assistive Stick for the Blind developed to improve navigation safety and independence for visually impaired users. The embedded system integrates dual ultrasonic sensors for short-range obstacle detection, a water sensor for identifying slippery surfaces, a GPS module for outdoor localization, and a buzzer for real-time acoustic alerts. Experimental results confirmed the system's reliability: the ultrasonic sensors consistently detected obstacles within 30 cm, the water sensor provided rapid hazard warnings for wet surfaces, and the GPS achieved location accuracy of within 5-10 meters outdoors. The study successfully validates this compact, user-oriented device as a practical tool that combines essential environmental sensing and location tracking, offering a scalable platform for future integration of advanced features like GSM and AI



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OS18 Human Machine Interface III (4) online presentation

Chair Norrima Mokhtar (Universiti Malaya, Malaysia)
Co-Chair Heshalini Rajagopal (MILA University, Malaysia)

OS18-1 Ensemble of Convolutional Neural Networks (CNN) to classify different classes of demented Alzheimer's disease patients

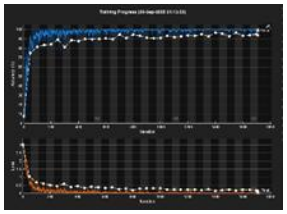
Amutha S[1], Nitish Menon[1], Dhanush R[1*], Heshalini Rajagopal[2]
([1]Vellore Institute of Technology Chennai, India), ([2]MILA University, Malaysia)

Automated Alzheimer's disease detection marks a major improvement in the effectiveness and early diagnosis of the illness compared to older techniques. Conventional approaches frequently depend on laborious and error-prone subjective clinical evaluations, cognitive testing, and manual interpretation of medical imaging. This article recommends a better AD classifier from MRI (Magnetic Resonance Image) brain images, exploring the weighted ensemble of different Convolutional Neural Networks (CNNs) with multiple layered architecture. The proposed Ensemble Models perform much better than the candidate models, such as InceptionV3, VGG-19, LeNet and MobileNet. The findings show increased diagnostic accuracy, providing a possible path for the early identification and categorization of AD using neuroimaging data.

S18-2 Transfer Learning for Chinese Herbal Leaves Recognition: A Comparative Study of ResNet-50, DarkNet-53, SqueezeNet, EfficientNet-B0, and GoogLeNet

Lyu SiQian[1], Heshalini Rajagopal[1*], Zaris Izzati Mohd Yassin[1], Peng Lean Chong[1], Norrima Mokhtar[2]
([1] University, Malaysia), ([2] Universiti Malaya, Malaysia)

Chinese herbal leaves identification is critical for traditional medicine, quality control, and biodiversity conservation. However, manual identification is time-consuming and error-prone, while existing automated methods struggle with complex leaf morphologies. Therefore, this study investigates the performance of five pre-trained convolutional neural network (CNN) models, namely DarkNet-53, EfficientNet-B0, GoogLeNet, ResNet-50 and SqueezeNet in recognizing 20 species of Chinese herbal leaves using transfer learning. The results demonstrated that EfficientNet-B0 and ResNet-50 outperformed the other three models. The proposed system aims to achieve real-time recognition with higher accuracy, providing a scalable solution for herbalists and pharmaceutical industries.



OS18-3 Deep Learning for Paddy Leaf Disease Segmentation: An Exploratory Study

Muhammad Amirul Aiman Asri[1], Wenjunliang Zhang[1], Norrima Mokhtar[1*], Raza Ali[2], Takao Ito[3], M. Aziz Muslim[4], Siti Sendari[5], Pringgo Widyo Laksono[6], Tsutomu Ito[7]
([1] Universiti Malaya, Malaysia), ([2]Balochistan University of Information Technology, Pakistan), ([3]Hiroshima University, Japan), ([4]Universitas Brawijaya, Indonesia), ([5]Universitas Negeri Malang, Indonesia), ([6] Universitas Sebelas Maret, Indonesia), ([7]Ube National College of Technology, Japan)

The study established a unified benchmark for the pixel-accurate segmentation of paddy leaf lesions using the 2,444 image, manually annotated Kaggle New Paddy Doctor dataset, which covers Bacterial Leaf Blight, Brown Spot, and Hispa. The research evaluated U-Net, U-Net++, and DeepLabV3 (with a ResNet-50 backbone) under both per-disease and pooled training protocols. DeepLabV3 achieved the best average Dice score (approx. 0.70), though performance varied significantly, with Brown Spot proving the most challenging. The key finding was that training a single pooled model resulted in slightly lower performance than training models specific to each disease. This work provides critical baselines and practical guidance on optimal architecture and training strategies for field deployment.

a. Original Image b. Disease Masks

Figure 1 Mask for diseases

OS18-4 Performance Analysis of Paddy Disease Classification Using Multiple Yolo Models

Wenjunliang Zhang[1], Shunta Kimura[2], Muhammad Amirul Aiman Asri[1], Norrima Mokhtar[1*], Heshalini Rajagopal[3], Ryosuke Harakawa[2], Masahiro Iwahashi[2], Rahmadwati[4], Takao Ito[5], Siti Sendari[6], Pringgo Widyo Laksono[7]
([1] Universiti Malaya, Malaysia), ([2]Nagaoka University of Technology, Japan), ([3] MILA University, Malaysia), ([4]Universitas Brawijaya, Indonesia), ([5]Hiroshima University, Japan), ([6]Universitas Negeri Malang, Indonesia), ([7] Universitas Sebelas Maret, Indonesia)

This study benchmarked the classification heads of YOLOv5, YOLOv8, and YOLOv11 (nano and medium variants) for fast, field-ready rice-disease recognition using the New Paddy Doctor dataset. An eight-class leaf subset (6,627 images) was curated and evaluated under a unified 224×224 training protocol. Metrics include accuracy, Macro-F1, Weighted-F1, confusion matrices, and model complexity (parameters and FLOPs). YOLOv8-m achieves the highest accuracy for 99.9%, followed by YOLOv11 variants 99.8%, while YOLOv5 attains 95%. We further assess accuracy–complexity trade-offs and provide deployment-oriented recommendations. Dataset splits and configurations are released to ensure reproducibility.

OS19 Smart Energy Management (6) **online presentation**

Chair Ammar A.M. Al Talib (UCSI University, Malaysia)

Co-Chair Takao Ito (Hiroshima University, Japan)

OS19-1 IoT-Enabled On-Load Tap Changer (OLTC) Condition Monitoring for Real-Time Health Assessment and Early Fault Detection

Firas Basim Ismail[1], Ammar Al-Bazi[2], Hussein Al-Faiz[1], Hasril Hasini[1], Ammar A.M. Al-Talib[3]

([1] Universiti Tenaga Nasional, Malaysia.); ([2] Aston Business School, UK); ([3] UCSI University, Malaysia)

On-Load Tap Changers (OLTCs) are critical for regulating transformer voltage, yet their failures often cause transformer outages. This study introduces an IoT-based monitoring system using MATLAB analytics and the UBIDOTS cloud to enable real-time assessment. The system tracks key electrical and mechanical parameters every minute and uses threshold-based alerts for anomaly detection. Validated with Tenaga Nasional Berhad data, it achieved 100% accurate fault detection, reducing the need for manual inspections. The results showed multiple anomalies in OLTC #1, normal operation in OLTC #2, and a single voltage issue in OLTC #3.

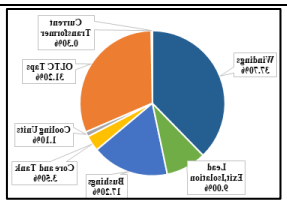


Figure 1 Failure location of substation trans-formers based on 536 failures

OS19-2 Smart Transportation Energy Efficiency: Emerging Intelligent Technologies, Optimization Approaches, and Policy Insights

Firas Basim Ismail[1], Mohammad A. AlMubaidin[2], Saeed Mahmoud AL Shurafa[3], Ahmad Abdul Kareem Ahmad Aqeel[4], Ammar A.M. Al-Talib[5]

([1] Universiti Tenaga Nasional, Malaysia.); ([2] Khawarizmi University Technical College, Jordan); ([3] Middle East University (MEU), Jordan); ([4] Jordan Phosphate Mines Company, Jordan); ([5] UCSI University, Malaysia)

This paper reviews the technological and policy shifts improving energy efficiency in global transportation, with emphasis on ASEAN. It highlights the roles of electrification, intelligent transport systems, low-carbon fuels, and digital mobility in reducing emissions and enhancing energy security. Drawing on international data and regional policy frameworks, the study analyzes trends, technology readiness, and key challenges. Case examples from Malaysia, Thailand, and Indonesia show progress alongside barriers such as limited infrastructure and fragmented regulations. The findings conclude that while electrification is crucial, complementary measures—like battery lifecycle management, low-carbon fuels for heavy transport, and harmonized standards—are also necessary for a scalable and sustainable transition.

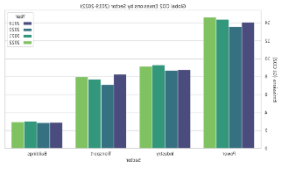


Figure 2 The distribution of global CO_2 emissions by sector in 2022

OS19-3 Energy Efficiency in Industrial Systems: Strategies, Case Studies, and Regulatory Perspectives

Firas Basim Ismail[1], Ahmad Abdul Kareem Ahmad Aqeel[2], Saeed Mahmoud AL Shurafa[3], Mohammad A. AlMubaidin[4], Ammar A.M. Al-Talib[5]
([1]Universiti Tenaga Nasional, Malaysia.); ([2]Jordan Phosphate Mines Company, Jordan)
([3] Middle East University (MEU), Jordan); ([4] Khawarizmi University Technical College, Jordan);
([5]UCSI University, Malaysia)

Industrial energy efficiency (IEE) is central to global decarbonization and industrial competitiveness, as heavy industries consume over one-third of global final energy. Improving efficiency provides a cost-effective way to cut emissions and reduce operating costs. This review combines literature, international energy studies, and a case from Kuala Lumpur Kepong Berhad (KLK) to assess strategies for improving energy performance. Key areas include process optimization, equipment upgrades, waste heat recovery, and cross-cutting improvements. The study also highlights the importance of energy management, workforce competency, and organizational behavior, framed within Malaysia's evolving policies such as the 2024 Energy Efficiency and Conservation Act (EECA).

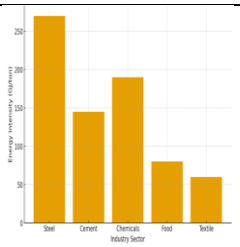


Figure 1 Industrial Energy Intensity Benchmarks

OS19-4 Advances In Energy Efficiency Technologies and Trends: A Comprehensive Review

Firas Basim Ismail[1], Nizar F. O. Al-Muhsen[2], Saeed Mahmoud AL Shurafa[3], Ammar A.M. Al-Talib[4]
([1]Universiti Tenaga Nasional, Malaysia); ([2] Middle Technical University, Iraq), ([3] Middle East University (MEU), Jordan); ([4]UCSI University, Malaysia).

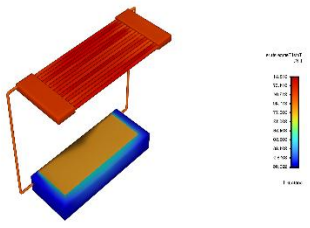
Adopting modern, renewable, and sustainable energy systems may involve high initial costs, but they are financially viable as long-term investments. Enhancing energy system performance is key to supporting cleaner, more sustainable solutions. Beyond lowering energy costs, it can reduce pollution, improve the reliability of renewable supplies, and foster long-term sustainable growth. Achieving significant impact, however, requires up-to-date technologies, supportive policies, and public engagement, along with urgent and coordinated action from all relevant stakeholders

Thermal Insulation Materials

OS19-5 Optimizing Solar Water Heaters Using Phase Change Materials: Enhancing Thermal Storage Efficiency

Firas Basim Ismail[1], Chye Ming Da [1], Saeed Mahmoud AL Shurafa[2], Ammar A.M. Al-Talib[3]
([1]Universiti Tenaga Nasional, Malaysia.); ([2] Middle Technical University, Iraq), ([3] Middle East University (MEU), Jordan); ([4]UCSI University, Malaysia).

This study integrated paraffin-based Phase Change Material (PCM) into solar water heating systems (SWHS) to improve thermal storage. A flat-plate solar collector and PCM-water tank were modeled in SolidWorks and simulated in ANSYS Fluent at mass flow rates of 0.05–0.2 kg/s and solar radiation of 600–1000 W/m². Results showed that higher solar radiation and lower flow rates enhanced PCM melting and storage. Under optimal conditions (1000 W/m², 0.05 kg/s), 87% melting and 65% thermal efficiency were achieved, confirming PCM integration as an effective strategy to boost SWHS performance and reduce energy reliance



Temperature distribution

OS19-6 Intelligent Energy Management Applications Using Data-Driven and IoT-Based Control Systems

Firas Basim Ismail[1], Nizar F. O. Al-Muhsen[2], Saeed Mahmoud AL Shurafa[3], Ammar A.M. Al-Talib[4]
([1]Universiti Tenaga Nasional, Malaysia.); ([2] Middle Technical University, Iraq), ([3] Middle East University (MEU), Jordan); ([4]UCSI University, Malaysia).

While adopting modern, renewable, and sustainable energy systems can involve high initial costs, they are financially viable as long-term investments. Enhancing energy system performance is key to supporting cleaner and more sustainable solutions. Beyond lowering energy costs, this approach can reduce pollution, improve the reliability of renewable energy, and foster long-term sustainable growth. Achieving significant impact, however, requires up-to-date technologies, supportive policies, and public engagement, along with urgent and coordinated actions from all relevant stakeholders

Passive House Design requirement

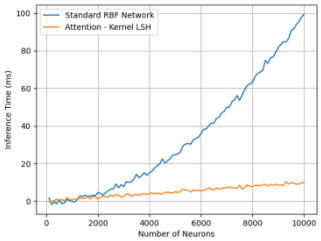
OS20 Pattern Recognition and Control (5) online presentation

Chair Fengzhi Dai (Tianjin University of Science and Technology, China)
Co-Chair Yunzhong Song (Henan Polytechnic University, China)

OS20-1 Efficient Approximation of RBF Networks through Attention-Kernel LSH

Qianxiao Pan[1], Fengzhi Dai[1], Yunzhong Song[2]
([1] Tianjin University of Science and Technology, Tianjin, China;
[2] Henan Polytechnic University, Jiaozuo, China)

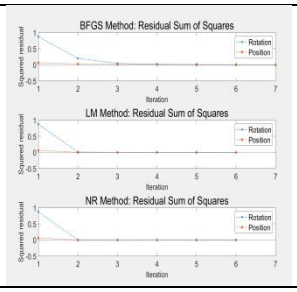
This paper presents the Attention -Kernel LSH, which is a reformulation of radial basis function (RBF) networks that is both theoretically analyzed and experimentally validated. The method employs random Fourier features for kernel approximation and locality-sensitive hashing with attention. On the basis, comparative experiments against the standard RBF networks and approximation baselines are conducted. The results confirm the effectiveness of the proposed design.



OS20-2 Performance Investigation of the Newton-Raphson Algorithm for Inverse Kinematics of a 7-DOF Robotic Manipulator

Hao He, Miao Zhang
(Tianjin University of Science and Technology, Tianjin, China)

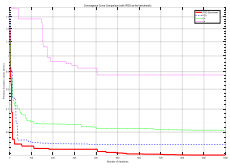
This paper investigates the performance of the Newton-Raphson (NR) algorithm in solving the inverse kinematics of a 7-degree-of-freedom (7-DOF) robotic manipulator. For a comprehensive evaluation, the performance of the NR algorithm is systematically compared with that of the Broyden-Fletcher-Goldfarb-Shanno (BFGS) and Levenberg-Marquardt (LM) algorithms in terms of convergence speed, computational time, end effector pose accuracy, and residual sum of squares. The experimental results highlight the strengths and distinctive characteristics of the NR algorithm in addressing inverse kinematics for high-degree-of-freedom manipulators, offering valuable insights for its practical implementation in 7-DOF robotic systems.



OS20-3 An Improved PSO Algorithm for Solving Robotic Six-DOF Manipulator IK

Kai Sun, Miao Zhang
(Tianjin University of Science and Technology, Tianjin, China)

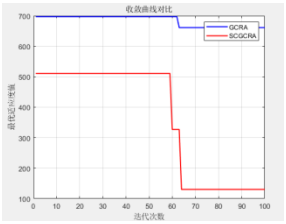
This paper presents an improved particle swarm optimization (IPSO) algorithm designed to address the inverse kinematics problem of a six-axis robotic manipulator. Building upon the Denavit-Hartenberg (DH) model, the proposed method formulates a weighted error function that simultaneously accounts for both positional and orientational deviations. To enhance optimization performance, the IPSO algorithm integrates dynamic velocity constraints, an adaptive inertia weight strategy, time-varying learning factors, and an elite retention mechanism. Experimental results indicate that the IPSO algorithm achieves superior solution accuracy, faster convergence, and enhanced computational efficiency, thereby offering an effective approach for high-precision control in robotic manipulation.



OS20-4 Improved SCGCR Algorithm for 7-DOF Redundant IK

Zhaorui Hao, Miao Zhang
(Tianjin University of Science and Technology, Tianjin, China)

This paper presents a geometric method-based inverse kinematics solver for a 7-degree-of-freedom (7-DOF) robotic manipulator and proposes a redundancy resolution approach integrated with global optimization. A comprehensive objective function is formulated to incorporate end-effector pose accuracy, joint limit constraints, and motion smoothness. Both the Grasshopper Reproduction (GCR) algorithm and the Sine-Cosine Grasshopper Reproduction (SCGCR) algorithm are employed to optimize the solution. Experimental comparison results demonstrate that the improved SCGCR algorithm has enhanced global convergence and solution stability, validating the effectiveness of the proposed redundant inverse kinematics optimization method.



OS20-5 A New Cleaning Robot for Organisms Attached to Ocean-going Ships

Haozhe Li, Xinlin Wang, Xinyu Chen, Jiaxu Cheng, Shengzhou Chen, Xingyu Zhao, Youyang Ye, Yang Tang, Ruirui Zhang, Wei Xiao, Fengzhi Dai
(Tianjin University of Science and Technology, Tianjin, China)

A large number of marine organisms adhering to the hulls of ocean-going vessels can cause damage to the ship structure. To address this issue, this paper presents a cleaning robot capable of performing hull maintenance. The robot utilizes permanent magnet adhesion technology to achieve stable movement along the hull and employs high-pressure water jetting technology, widely used in the cleaning field, to perform effective cleaning. Experimental results demonstrate that it significantly reduces a series of problems caused by biofouling on the ship bottom. This provides a stable and reliable solution for the maintenance of ocean-going vessels.

OS21. Research Towards the Renewable Energy and the Sustainable Development Goals (SDG's) (10) online presentation

Chair Ammar A.M. Al Talib (UCSI University, Malaysia)
Co-Chair Takao Ito (Hiroshima University, Japan)

OS21-1 Prediction of Head Movement during Slalom Driving using Ensemble Learning

Wong Wei Herng[1], Sarah 'Atifah Saruchi[2], Ammar A.M. Al-Talib[3], Sharifah Munawwarah[4], Mohd Hatta Mohamed Ariff[5], Nurhaffizah Hassan[6], Nor Aziyatul Izni[7], Alvi Khan Chowdury[8] ([1,3]UCSI University, Malaysia, [2]UMPSA, Malaysia, [4]University of Tsukuba, Japan, [5]UTM, Malaysia, [6,7]UiTM, Malaysia, [8]Monash University, Malaysia)

Research on motion sickness (MS) shows that head movement plays a crucial role during slalom driving, where the drivers commonly tilt their heads against centripetal force, whereas the passengers tilt their heads aligning with it. Existing studies rely heavily on sensors attached to occupants' heads to analyse these motion patterns. Although accurate, such intrusive sensing is impractical for continuous monitoring. To address this limitation, this study proposes an ensemble prediction model combining Artificial Neural Networks (ANN) and Support Vector Machines (SVM) to estimate head movements without physical sensors. Simulations show that the ensemble approach achieved the lowest root-mean-squared-error (RMSE), outperforming individual ANN and SVM models.

OS21-2 Smart Elderly Health Monitoring Device Via Internet-of-Things (IoT)

Eii Tze Xian[1], Sarah, Atifah Saruchi[2], Wan Zailah Wan Said[3], Ammar A.M. Al-Talib[4], Nor Aziyatul Izni[5], Nurhaffizah Hassan[6], Alvi Khan Chowdury[7], Sheikh Muhammad Hafiz Fahami[8] ([1,3,4]UCSI University, Malaysia, [2,8]UMPSA, Malaysia,[5,6]UiTM, Malaysia, [7]Monash University, Malaysia)

The ageing global population has led to a rise in older adults living alone, increasing their risk of accidents and medical emergencies. Traditional monitoring methods are often inadequate, resulting in delayed intervention and compromised care. Thus, this study proposes an IoT-based smart healthcare device designed for continuous and remote monitoring of geriatric elderly. The system integrates multiple sensors, including temperature, pulse, accelerometer, and fall detection to assess vital signs and identify abnormal events. Results show that the device capable of sending immediate alert notification once an aberrant occurrence, such as abnormal temperature and heart rate, as well as a fall.

OS21-3 Smart Petting System Via Internet of Things (IoT)

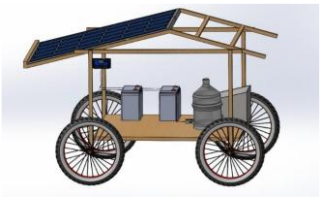
Siah Jing Yi[1], Sarah, Atifah Saruchi[2], Wan Zailah Wan Said[3], Ammar A.M. Al-Talib[4], Nurhaffizah Hassan[5], Nor Aziyatul Izni[6], Sunmiya Fujita[7] ([1,3,4]UCSI University, Malaysia, [2,7]UMPSA, Malaysia,[5,6]UiTM, Malaysia)

Pet owners often struggle to provide consistent, nutritious meals due to time constraints, while long vacations further complicate pet care. This paper presents an Internet-of-Things (IoT) based smart petting system designed to address these challenges through automated, real-time monitoring of pet feeding activities. The developed prototype integrates an ESP32 microcontroller to manage three key subsystems: an automated feeder, an automated water dispenser, and a real-time monitoring module. The system features a user dashboard, mobile application for remote control, a camera for pet observation, and Telegram-based notifications. Experimental validation demonstrated efficient system performance, with sensor readings maintained within a 5% accuracy margin.

OS21-4 Seawater Desalination and Purifier Machine

Ammar A.M. Al-Talib, Alvin Loke Ting Foong, Rodney Tan Hean Gay (UCSI University, Malaysia)

Water scarcity remains a pressing global challenge, particularly in coastal and remote regions where access to clean drinking water is limited. This project presents the design, fabrication, and evaluation of a solar-powered seawater desalination and purification system aimed at providing a sustainable and affordable source of potable water. The system utilizes solar photovoltaic panels to supply the required energy and incorporates a distillation-based process to convert seawater into freshwater. A prototype was developed and tested under varying salinity levels of 23 ppt, 30 ppt, and 33 ppt to evaluate system performance, water quality, and efficiency. Experimental results indicated that the system consistently produced between 3.1 and 3.6 liters of distilled water per day, with desalination efficiencies ranging from 79% to 85%. The treated water was confirmed to meet World Health Organization (WHO) standards for drinking water in terms of pH and total dissolved solids (TDS). The study also revealed that both salinity and environmental factors, such as solar irradiance and ambient temperature, significantly influenced daily yield.

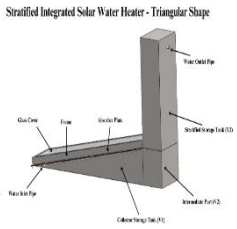


Overview of the Whole Structure

OS21-5 A Compact Stratified Integrated Solar Water Heating System

Ammar A.M. Al-Talib, Farouk Hesham Farouk Elkholy, Rodney Tan Hean Gay (UCSI University, Malaysia)

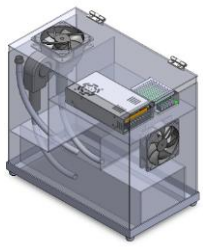
The only limitation to the effectiveness of integrated collector-storage solar water heaters in the rainy tropical areas is night cooling. This is a prototype and field-test of a 70 L Compact Stratified Integrated Solar Water Heating System (CSISWHS) that has a 30 L collector tank, a 10 L intermediate section and a 30 L stratified storage tank in SS316 with aluminum-foil bubble insulation and waterproof foil tape. K-type four thermocouples were connected to important nodes, digitized with an ESP32-CAM, and recorded in real time with a cloud spreadsheet; the SM206 solar meter was used to measure solar radiation manually. On 34 successive outdoor days (Malaysia, July August 2025) we used ISO 9459: static testing (no draw) and dynamic testing with three 25 percent draw/refill events at approximately 07:00, 13:00 and 19:00. The CSISWHS met the targets during most days when evening water regularly hit 40-50 °C and top layer was at or above 35 °C by 06:00 except in the event of persistent rain.



OS21-6 Air Purifier and Humidifier using Water as Filter

Ammar A.M. Al-Talib, Koh Yong Chuan, (UCSI University, Malaysia)

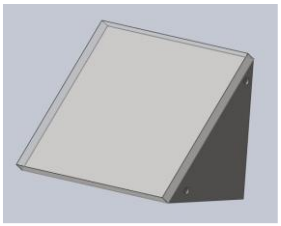
Air pollution reached alarming levels in 2021, posing a severe threat to global health. According to the World Health Organization (WHO), approximately 7 million people lose their lives each year due to prolonged exposure to polluted air. Shockingly, around 91% of the world's population breathes contaminated air daily. This not only affects outdoor environments but also means that the air inside our homes is far from clean. To address this growing concern, Author have designed a compact air purifier that eliminates the need for costly filters by utilizing water as a natural filtration system. Additionally, this device serves as an air humidifier and an essential oil diffuser, promoting relaxation while also combating certain airborne bacteria and viruses. The system operates using two high-power, low-noise centrifugal fans that effectively draw in air through a protective mesh.



OS21-7 Compact High Efficiency Solar Water Heater

Ammar A.M. Al-Talib, Lee Shi Wei, (UCSI University, Malaysia)

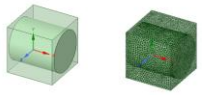
This project aims at the design and manufacture of a high-efficiency solar water heater which would have a triangular tank structure. The design capacity of the system is capable of heating 30 liters of water to a desired range of temperature between 40 and 50 °C hence it is applicable in domestic setups. The tank body was made of stainless steel with flat black paint as absorber coat, polyurethane foam as insulator and acrylic sheets as transparent cover. The procedures included cutting processes, welding, coating, insulation and fitting of valves. Two approaches were undertaken, Static testing (consisting of constant heating and cooling without draw off) and Dynamic testing (under realistic conditions of 25% draw-off at 8:00 am, 2:00 pm, and 8:00 pm). Static tests demonstrated the peak temperature of over 50 °C and efficiencies ranged between 55 and 94 percent and dynamic testing confirmed systems capacity to capture heat after draw-offs and maintain a usable water temperature.



OS21-8 Study of Multiscale Micromechanics and RVE Validation of Nano-Modified Carbon/GNP-PEEK Laminates for Lightweight Aerospace and UAV Structures

Noor Idayu[1], Sultan[2], Ammar A.M. Al-Talib[3], Tabindah[4], Tabassam[5] ([1,2,4,5] King Fahd University Petroleum and Mineral,Saudi Arabia, [3]UCSI University, Malaysia)

A multiscale approach to predict the mechanical behavior of nanomodified Carbon/GNP-PEEK laminates designed for lightweight aerospace structures such as UAV airframes and small satellite panels. By determining the properties of a GNP reinforced PEEK matrix using a hybrid micromechanics model. The neat PEEK matrix has an elastic modulus of 3.6 GPa, and after adding a small amount of graphene nanoplatelets, the stiffness increases to about 3.7 GPa, showing a clear improvement from the nanoreinforcement. These updated matrix properties are then combined with carbon fibers, and six analytical micromechanics models Voigt, Reuss, Hybrid RoM, CCA, Elasticity, and a semiempirical formulation are used to estimate the resulting lamina elastic constants. To verify these predictions, a finite element Representative Volume Element (RVE) is created in ANSYS Software using periodic boundary conditions. The FE results show strong agreement with the analytical models, confirming the reliability of the multiscale framework for laminate level evaluation.



OS21-9 Structures Comparative Analysis of CubeSat Orientation on Aerodynamic Drag and Structural Stability

Noor Idayu[1], Atif[2], Tabassam[3],Ammar A.M. Al-Talib[4] ([1,2,3] King Fahd University Petroleum and Mineral,Saudi Arabia, [4]UCSI University, Malaysia)

CubeSats operating in Low Earth Orbit (LEO) are continuously exposed to aerodynamic drag, which can shorten orbital lifetime, affect attitude stability, and introduce structural stresses. In this study, we investigate how different orientation angles of a 6U CubeSat influence its aerodynamic drag and structural behaviour. Our goal is to identify an orientation that minimizes drag while still maintaining adequate structural stability during flight. To achieve this, Computational Fluid Dynamics (CFD) will be used to estimate drag forces and coefficients, while Finite Element Analysis (FEA) will evaluate the resulting structural response and stiffness. Early insights from published studies suggest that edge-on orientations generally produce lower drag than face-on configurations and still retain acceptable rigidity for stable operation. Ongoing simulation work will quantify these effects more accurately and support the selection of an optimal cruising orientation for the mission.

OS21-10 Navigating the Future: Skills and Job Market Trends in Malaysia's Construction Sector

Salihah[1], Cheah YQ[1], Deprizon[1] ([1] UCSI University, Malaysia)

The Malaysian construction industry is rapidly transforming due to digitalization, new technologies, and changing workforce needs. This study, using a mixed-methods approach, identifies rising demand for digital skills such as BIM, automation, and sustainable construction practices, while traditional skills like manual drafting are declining. It also reveals a gap between current training programmes and industry requirements. Aligned with Sustainable Development Goal 8, the study emphasizes updating curricula, integrating emerging technologies, and strengthening industry–academia collaboration to build a future-ready workforce.