AIM 2026 Workshop Proposal
INTEGRATED INTELLIGENCE FOR UNMANNED SYSTEMS

Description: Driven by rapid AI advances and the growing demand for reliable performance in dynamic, unstructured environments, unmanned systems— spanning aerial, ground, and maritime platforms—are increasingly deployed for critical tasks such as surveillance, logistics, infrastructure inspection, and emergency response. These high-stakes applications demand a paradigm shift toward enhanced autonomy, robustness, and cross-platform adaptability. Despite rapid progress, significant bottlenecks persist in achieving fully integrated intelligence. These include the complexities of *in-situ sensin*g, the precision required in micro/nano-fabrication, the latency of *real-time decision-making*, and the nuances of *human-machine collaboration*. This workshop addresses these gaps by inviting distinguished senior researchers from diverse specializations, including advanced sensing design, perception algorithms, artificial intelligence, adaptive actuation and human–machine interaction. Through a mix of high-level keynote presentations and expert-led discussions, participants will share state-of-the-art insights on achieving higher levels of situational awareness, seamless multi-platform coordination, and trustworthy operation in complex scenarios. This forum aims to foster deep technical exchange and build interdisciplinary partnerships to identify the key opportunities and challenges that will define the next generation of intelligent autonomous systems.

The workshop invites senior contributions on topics that integrate physical modeling with advanced intelligence:

- *Physics-Informed Integrated Intelligence:* Theoretical frameworks bridging multi-physics perception and autonomous control in complex processing and manufacturing.
- *Flexible & Embodied Electronics:* AI-enabled design, laser-induced ablation, and scalable manufacturing of flexible intelligent microsystems.
- *Robust Perception & Manipulation:* Algorithmic solutions for autonomous robotic interaction and manipulation under partial observations or unstructured conditions.
- *Dynamic Locomotion & Stability:* Modeling, sensing, and adaptive control for systems facing unexpected disturbances, such as foot-slips in bipedal robots
- *Bio-inspired & Intelligent Sensing:* Development of high-fidelity, in-situ sensors for real-time perception in unmanned aerial, ground, and maritime platforms.
- *Human–Machine Collaboration:* Shared control architectures and intuitive interaction models for safe and effective human–unmanned system integration
- *Learning-Based Adaptive Control:* AI-driven decision-making and networked communication protocols for robust multi-platform coordination.

Proposers and Organizers: Jingjing Ji <jijingjing@hust.edu.cn> , Huazhong University of Science and Technology, China
Kok-Meng Lee, <kokmeng.lee@me.gatech.edu>, Georgia Institute of Technology, USA

Half-day (July 7th) **Workshop Program** (Tentative)**:**

Time	Presentation title and speaker
14:00–14:05	**Welcoming remarks**
14:05–14:30	*Robust Perception under Partial Observations for Autonomous Robotic Manipulation* **I-Ming Chen** <michen@ntu.edu.sg>, Nanyang Technological University, Singapore
14:30–14:55	*Modeling, Sensing, and Control of Bipedal Locomotion with Unexpected Foot Slip* **Jingang Yi** <jgyi@rutgers.edu>, Rutgers University, USA
14:55–15:20	*Perception and Control for Humanoid Robots in Collaborative Service Environments* **Lorenzo Natale** <lorenzo.natale@iit.it>, Italian Institute of Technology
15:20–15:45	*Physics-Based Integrated Intelligence: Bridging Multi-Physics Perception and Autonomous Control in Thin-Disk Processing* **Kok-Meng Lee**, <kokmeng.lee@me.gatech.edu>, Georgia Institute of Technology, USA
15:45–16:00	**Coffee Break**
16:00–16:25	*AI-embodied Flexible Electronic Microsystems* **YongAn Huang** <yahuang@hust.edu.cn>, Huazhong University of Science and Technology, China
16:25–16:50	*Cognitive architectures for robots: hierarchical, predictive and generative models* **Fulvio Mastrogiovanni**<fulvio.mastrogiovanni@unige.it>, University of Genoa, Italy
16:50–17:15	*Less Actuation, More Mechanical Intelligence: Efficient Mechatronic Design for Unmanned Systems* **Shaohui Foong** <foongshaohui@sutd.edu.sg>Singapore University of Technology & Design, Singapore.
17: 15–17:40	*Laser-Induced Interfacial Ablation for Scalable Manufacturing of Flexible and Intelligent Electronics* **Jing Bian** <jsbianjing@njust.edu.cn>, Nanjing University of Science and Technology, China.
17:40-17:50	**Closing Remarks**

Professor Jingjing Ji (M'14) received the B.S. and Ph.D. degrees in mechanical engineering from Zhejiang University, Hangzhou, China, in 2008 and 2014, respectively. She was a Visiting Scholar with the Georgia Institute of Technology, Atlanta, GA, USA, from 2012 to 2013. She is currently a Professor with the State Key Laboratory of Intelligent Manufacturing Equipment and Technology, School of Mechanical Science and Engineering, Huazhong University of Science and Technology, Wuhan, China. Her research interests include intelligent electronic skin sensing, physical field reconstruction-based distributed perception, near/in sensor computing. She received the Best Paper Award Finalist in the 2021 *IEEE/ASME Transactions on Mechatronics*, and also at the 2016 and 2020 *IEEE/ASME International Conference on Advanced Intelligent Mechatronics* (AIM). She served as Editorial Board Member for AIM since 2018.

Professor Kok-Meng Lee (kokmeng.lee@me.gatech.edu) received his M.S. and Ph.D. degrees in Mechanical Engineering from the Massachusetts Institute of Technology in 1982 and 1985, respectively. He joined the Georgia Institute of Technology in 1985 and dedicated his career to research and education in mechanical engineering until his retirement on January 1, 2025.

As a professor of mechanical engineering, Dr. Lee's research interests encompassed system dynamics and control, machine vision, robotics, mechatronics, and automation, with applications in manufacturing, food processing, and healthcare.

Dr. Lee was the founding Editor-in-Chief (EIC) of the *Springer International Journal of Intelligent Robotics and Applications (IJIRA)*. Prior to this, he served as EIC for the *IEEE/ASME Transactions on Mechatronics* (2008–2013). He co-founded the *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)* in 1997 and served as General Chair for AIM 1999 in Atlanta, USA. Additionally, he held editorial and leadership roles in the IEEE Robotics and Automation Society, including Associate Editor for *Robotics and Automation Magazine* (1994–1996), *Transactions on Robotics and Automation* (1994–1998), and *Automation Science and Engineering* (2003–2005). He was also a member of the Executive Committee for ASME's Dynamic Systems and Control Division (2013–2017), serving as Chair in 2016.

Dr. Lee co-authored four books on modeling and field-based approaches for designing and controlling electromagnetic actuators and flexonic systems. He also held multiple patents related to machine vision systems, ball-joint-like spherical motors, and automated systems for transferring live objects.

A Life Fellow of both ASME and IEEE, Dr. Lee received numerous accolades for his contributions to research and engineering, including the *Presidential Young Investigator (PYI) Award*, *Sigma Xi Junior Faculty Award*, *International Hall of Fame New Technology Award*, *Woodruff Faculty Fellow*, *Geneva Inventions Silver Medal*, and the *Michael J. Rabins Leadership Award*.

Professor I-Ming Chen received B.S. degree from National Taiwan University in 1986, and M.S. and Ph.D. degrees from California Institute of Technology, Pasadena, CA in 1989 and 1994 respectively. He is currently Full Professor in the School of Mechanical and Aerospace Engineering, Director of Bachelor's Degree Program in Robotics, and Co-Director of CARTIN (Center for Advanced Robotics Technology and Innovation) in Nanyang Technological University (NTU), Technical Advisor to National Robotics Program Office in Singapore, and Certified Patent Valuation Analyst (CPVA). He was Editor-in-chief of IEEE/ASME Transactions on Mechatronics from 2020 to 2022, and Director of Robotics Research Centre (NTU) from 2013 to 2017. Professor Chen is Fellow of Singapore Academy of Engineering (SAEng), Fellow of IEEE and Fellow of ASME, General Chairman of 2017 IEEE International Conference on Robotics and Automation (ICRA 2017) in Singapore. His research interests are in Robot AI & perception, Industrial AI, logistics and construction robots, human-robot interaction, and industrial automation. He founded Transforma Robotics Pte Ltd developing robots for construction industry and Hand Plus Robotics Pte Ltd developing robotics and AI solutions for logistics and manufacturing industry.

Professor Jingang Yi received the B.S. degree in electrical engineering from Zhejiang University in 1993, the M.Eng. degree in precision instruments from Tsinghua University in 1996, and the M.A. degree in mathematics and the Ph.D. degree in mechanical engineering from the University of California, Berkeley, in 2001 and 2002, respectively. He is currently a Full Professor in mechanical engineering and Peter D. Cherasia Faculty Scholar at Rutgers University. His research interests include physical human-robot interactions, autonomous robotic and vehicle systems, mechatronics, dynamic systems and control, automation science and engineering. Prof. Yi has received multiple awards, including the 2018 Japan Society for the Promotion of Science (JSPS) Invitational Fellowship for Research, 2017 Rutgers Chancellor's Scholars, 2014 ASCE Charles Pankow Award for Innovation, the 2013 Rutgers Board of Trustees Research Fellowship for Scholarly Excellence, and the 2010 NSF CAREER Award. He has coauthored several best papers in *IEEE Transactions on Automation Science and Engineering* and at IEEE/ASME AIM, ASME DSCC, and IEEE ICRA, etc.

He currently serves as a Senior Editor for *IEEE Transactions on Automation Science and Engineering*. He also served as the Editor-in-Chief of Conference Editorial Board for IEEE International Conference on Automation Science and Engineering (CASE) (2023-2025), Associate Editor of IFAC journals *Control Engineering Practice, Mechatronics, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Automation Science and Engineering*, *IEEE Robotics and Automation Letters*, and *ASME Journal of Dynamic Systems, Measurement and Control* and a Senior Editor of *IEEE Robotics and Automation Letters.* Prof. Yi is a Fellow of ASME and IEEE.

Dr. Lorenzo Natale is Tenured Senior Researcher at the Italian Institute of Technology. He received his degree in Electronic Engineering (with honours) and Ph.D. in Robotics from the University of Genoa. He was later postdoctoral researcher at the MIT Computer Science and Artificial Intelligence Laboratory. He was invited professor at the University of Genova where he taught the courses of Natural and Artificial Systems and Antropomorphic Robotics for students of the Bioengineering curriculum and was later on visiting Professor at the University of Manchester.

Lorenzo Natale has contributed to the development of various humanoid platforms. He was one of the main contributors to the design and development of the iCub platform and he has been leading the development of the iCub software architecture and the YARP middleware. His research interests range from vision and tactile sensing to software architecture for robotics.

He has been principal investigator and co-principal investigator in several EU funded projects (FP7, H2020 and Horizon Europe) and is currently coordinator of the Horizon Europe project CONVINCE. He was general chair of IEEE ARSO 2018 and served as Program Chair of ICDL-Epirob 2014 and HAI 2017 and associate editor for IEEE-Transactions on Robotics and IEEE Robotics and Automation Letters. He is Specialty Chief Editor for the Humanoid Robotics Section of Frontiers in Robotics and AI, Ellis Fellow and Core Faculty of the Ellis Genoa Unit. Since 2025 he is Distinguished Lecturer for the IEEE-RAS Technical Committee for Software Engineering for Robotics and Automation.

Professor YongAn Huang (yahaung@hust.edu.cn), Chief Professor at Huazhong University of Science and Technology (HUST), Deputy Director of the State Key Laboratory of Intelligent Manufacturing Equipment and Technology, and Director of the Center for Advanced Electronic Manufacturing at School of Mechanical Science and Engineering, HUST. He is a recipient of the National Science Fund for Distinguished Young Scholars (continued funding) and the Xplorer Prize. His research focuses on flexible electronics design, manufacturing, and applications, with nearly 200 SCI papers published, 4 books, and over 100 national/international patents granted, with successful technology transfer achievements. He has developed intelligent aircraft skins, robotic electronic skin systems, and pioneered conformal printing principles and equipment for 3D curved circuits, as well as laser direct-writing/stripping/mass transfer equipment. He has received awards including the Second Prize of National Technology Invention, First Prizes of Hubei Provincial Natural Science, and Hubei Provincial Technology Invention. He also serves as Editor-in-Chief of Soft Science and Vice Chairman of the Microm/Nano Manufacturing and Equipment Division and Micronano Actuators and Microsystems Division of the Chinese Society of Microm/Nano Technology.

Dr. Shaohui Foong is the Provost’s Chair Professor, Associate Head of the Engineering Product Development Pillar, and Co-Director of the Dyson–SUTD Innovation Studios at the Singapore University of Technology and Design (SUTD). He leads the Aerial Innovation Research (AIR) Laboratory, where his work focuses on novel unmanned systems, nature-inspired and embodied robotics, and efficient mechatronic design. His research has produced widely recognized platforms including monocopters, autorotating aerial robots, and hybrid inspection systems, many of which have been translated into real-world deployments through industry partnerships and spin-offs.

Dr. Fulvio Mastrogiovanni is an Associate Professor at the Department of Informatics, Bioengineering, Robotics and Systems Engineering, University of Genoa, Italy, and Honorary Expert at Shanghai Polytechnic University, China. He received a Laurea Degree in Computer Engineering and a Ph.D. in Bioengineering, Materials Science and Robotics from the University of Genoa in 2003 and 2008, respectively. His research lies at the intersection of Artificial Intelligence and Cognitive Robotics, with a focus on Embodied Cognition, Embodied AI, and Physical AI. He led as PI or co-PI to numerous national and international research projects. He leads TheEngineRoom, a multidisciplinary research group at UniGe. Fulvio has been Visiting Professor at institutions in Europe, Asia, and Latin America. He is a member of the Board of the National Ph.D. School in Robotics and of the Ph.D. School in Bioengineering and Robotics at UniGe, and he serves on university boards for technology transfer and international affairs. He served as Head of Program for the international MSc in Robotics Engineering (EMARO+/JEMARO) and Deputy Rector for International Affairs. Fulvio has co-organized numerous international events, including IEEE RO-MAN, IROS, ERF, and served as General Chair of IAS 2025. He is the founder of Teseo and Intra-Operative Surgical Research (IOSR), and advisor for companies and startups on AI-based solutions worldwide. He received awards for both his research and innovation activities, including the Italian Young Innovator Award in 2021. Fulvio has co-authored more than 260 scientific contributions, including 70 journal papers, 7 patents, and is the recipient of several best paper awards.

Dr. Jing Bian (jsbianjing@njust.edu.cn) is an Associate Professor at the School of Microelectronics, Nanjing University of Science and Technology. His research focuses on advanced flexible electronics and micro/nano-manufacturing technologies, with interests in laser-based processes for heterogeneous and hybrid integration.

His current research topics include laser transfer printing for heterogeneous/ heterostructure integration, laser-enabled micro/nano-fabrication of functional surface and interfacial nanostructures, laser-induced direct writing of conductive structures, and the design and fabrication of hybrid flexible circuits and sensors.

Dr. Bian received his B.S. degree in 2015 and Ph.D. degree in 2020 from Huazhong University of Science and Technology. From 2020 to 2023, he served as a Lecturer at Nanjing University of Posts and Telecommunications. He joined Nanjing University of Science and Technology as an Associate Professor in 2024. In recent years, Dr. Bian has published 15 peer-reviewed papers as first or corresponding author in leading journals, including Science Advances (two papers), Advanced Materials, and Light: Science & Applications, and holds nine authorized Chinese patents.

Robust Perception under Partial Observations for Robotic Manipulation
I-Ming Chen

Abstract: Robots operating in real-world environments must contend with uncertainty arising from partial and noisy observations. Occlusions, limited sensor viewpoints, and environmental complexity often result in fragmented 3D data, which hinders accurate geometry understanding, motion planning, and safe interaction. These challenges are especially pronounced in unstructured environments, where full visibility and clean inputs cannot be assumed. Addressing them requires robust shape reconstruction from incomplete observations and the ability to leverage completed geometry for reliable manipulation. This talk presents a unified perception-driven framework that enables robots to perceive, plan, and act effectively across object-level, task-level, and scene-level settings. At the object level, we address 3D shape completion from sparse and occluded RGB-D inputs. To overcome the limitations of geometry-only approaches, we propose a hierarchical cross-modal network, HGACNet, which fuses point cloud geometry with image-based semantic information. By integrating graph attention encoding, cross-modal feature fusion, and contrastive learning, HGACNet reconstructs complete and high-fidelity object shapes. Extensive evaluations on ShapeNet-ViPC and YCB-Complete demonstrate state-of-the-art performance and strong generalization to real-world objects. Building on this capability, we develop a completion-aware grasping pipeline that bridges perception and action. Completed object shapes are used to generate grasp candidates, which are then validated by a collision-aware module, GraspSafe, that accounts for local scene structure and kinematic constraints. This filtering enables robust and physically feasible grasping in cluttered and occluded environments. At the scene level, we address partial observations in large-scale environments using multi-view perception, supporting both offline reconstruction and online incremental updates during exploration. The proposed graph-based attention-aware geometry network refines large-scale surfaces and supports ray-casting-based pattern projection and adaptive trajectory generation. Experiments in simulation and real-world settings validate reliable and continuous surface interaction under scene-level uncertainty.

Modeling, Sensing, and Control of Bipedal Locomotion with Unexpected Foot Slip
Jingang Yi

Abstract: Bipedal locomotion involves complex underlying dynamics. Perturbations during human walking, such as slips or trips, require rapid whole-body adjustments and significantly increase task complexity. Capturing these movements and designing devices to assist during such perturbations presents a challenge. I will present modeling, sensing and control approaches for characterization of bipedal walking with foot slip. I will first demonstrate that the combination of modeling and sensing of shoe-floor interactions during human walking can be used to reveal and predict foot slip initiation and propagation using a soft-solid contact model. Development of a robotic bipedal model and control for analyzing human balance stability during slip perturbation will be then presented. This approach will be extended to describe the development of a wearable inertial sensor-based, real-time foot slip detection system for human walking. Finally, I will present the development of wearable knee exoskeletons to prevent slip-induced falls for human walking and the whole-body control strategies for balance recovery of biped robots. These approaches and systems have applications in the field of biomedical engineering and humanoid robotics.

Perception and Control for Humanoid Robots in Collaborative Service Environments
Lorenzo Natale

Abstract: Thanks to their versatility, rich capabilities, and potential to interact naturally with humans, humanoid robots are emerging as a solution for a wide range of tasks across domains spanning manufacturing, service robotics, and healthcare.In this talk, I will provide an overview of my group’s work on developing humanoid robots capable of acting autonomously in collaborative human environments. Specifically, I will discuss advances in visual recognition, tactile perception, and object manipulation. I will then illustrate how these methods can be integrated in complete systems and deployed across different applications, with examples from service robotics and human–robot collaboration. The talk will highlight how humanoid embodiment and recent advances in AI support the development of robots capable of flexible and effective interaction in everyday scenarios.

Physics-Based Integrated Intelligence: Bridging Multi-Physics Perception and Autonomous Control in Thin-Disk Processing, *Kok-Meng Lee*

Abstract: This presentation examines how *physics-based integrated intelligence* can unify multi-physics perception with autonomous decision-making to advance the capabilities of unmanned and intelligent mechatronic systems. Using the precision machining of thin-disk components as a representative example, we illustrate how embedded sensing, model-based estimation, and multi-domain physical reasoning can jointly capture the coupled thermal, structural, and dynamic behaviors that govern machining accuracy. Unlike purely data-driven approaches, this framework embeds physical laws directly into the intelligence loop, enabling robust performance in dynamic and unstructured environments where data may be sparse or noisy. We discuss the transition from multi-physics perception to an autonomous system capable of real-time adaptation, highlighting the generalizability of this approach to broader unmanned and mechatronic systems. By integrating "intelligence" at the physical level, we provide a pathway toward next-generation autonomous platforms that are both trustworthy and highly adaptable.

AI-embodied Flexible Electronic Microsystems
YongAn Huang

Abstract: Flexible electronic microsystems represent an advanced technological framework that integrates microelectronics, flexible structures, and intelligent systems. The primary challenge lies in achieving flexibility, miniaturization, and intelligence to extend the functionalities of conventional intelligent microsystems to novel applications characterized by large-area, sensing, deformation, and adaptation to complex dynamic environments. To address this, this study proposes a new paradigm termed " AI-embodied flexible electronic microsystems." This framework deeply integrates programmable flexible electronic skins, bio-inspired modular actuators, and on-chip neuromorphic computing cores, establishing a unified perception-actuation-cognition architecture. Through the co-design of reconfigurable structural topology, distributed oscillatory actuation, and multimodal sensing networks (e.g., vision, touch, temperature), the system achieves multimodal locomotion (flying, creeping, and swimming). Additionally, empowered by on-chip hyperdimensional computing-based embodied intelligence, it can autonomously perform tasks such as terrain recognition and obstacle avoidance, heat source tracking, and path optimization without external intervention or reliance on predefined models.

Addressing the inherent challenge of balancing structural compliance, multifunctional integration, and embedded computational intelligence, this study develops an integrated platform that merges flexible electronics, bio-inspired mechanics, and embodied artificial intelligence. This provides a viable technological pathway for the next generation of autonomous intelligent microsystems capable of operating in dynamic, confined, and unstructured extreme environments.

Cognitive architectures for robots: hierarchical, predictive and generative models
Fulvio Mastrogiovanni

Abstract: Cognitive architectures have long provided a principled framework for integrating perception, reasoning, memory, planning, and action in autonomous robots. However, the emergence of large-scale AI models, embodied intelligence, and long-term autonomous operation is challenging traditional assumptions about how cognition should be organised within robotic systems. This talk reviews the evolution of cognitive architectures for robots, from hierarchical deliberative systems to predictive and generative approaches inspired by advances in machine learning, world models, and cognitive science. Particular attention is devoted to architectures that maintain explicit internal representations of the environment, support reasoning under uncertainty, and continuously couple predictions, memory, and action during execution. The presentation discusses how concepts such as predictive world models, active memory, generative reasoning, and multi-agent cognitive organisation can enable robots to operate robustly in complex and changing environments. A central theme is the role of embodiment: rather than treating cognition as an isolated computational process, modern architectures increasingly view intelligence as emerging from the interaction between internal models, physical bodies, and the surrounding world.

Less Actuation, More Mechanical Intelligence: Efficient Mechatronic Design for Unmanned Systems
Shaohui Foong

Abstract: Unmanned systems operating in unstructured environments are often limited not by algorithms, but by actuation complexity, energy efficiency, and robustness. This talk advocates an alternative pathway to integrated intelligence: embedding intelligence directly into mechanical and mechatronic design to reduce actuation demands while improving autonomy and reliability. Using examples including samara-inspired autorotating wings (SAW), single-actuator monocopters (SAM), compliant soft-wing systems (CASARO), and task-specific inspection robots such as BINO, the presentation demonstrates how aerodynamic shaping, passive stability, and structural compliance can offload control and decision-making to physics. These systems achieve robust, efficient operation with minimal actuation and sensing. The talk distills design principles for physics-informed, embodied intelligence that enable scalable and deployable unmanned systems.

Laser-Induced Interfacial Ablation for Scalable Manufacturing of Flexible and Intelligent Electronics
Jing Bian

Abstract: The scalable manufacturing of flexible and intelligent electronics critically relies on precise and controllable processing at heterogeneous material interfaces. This talk presents laser-induced interfacial ablation of polyimide as an effective strategy to tailor interfacial adhesion and local material properties through well-controlled laser–matter interactions.

By exploiting confined energy deposition at buried interfaces, this approach enables a range of key manufacturing operations, including substrate debonding, selective transfer of micro-scale devices, and laser-defined conductive patterning, without compromising the integrity of flexible functional layers. Focusing on the fundamental scientific question of laser-induced debonding mechanisms and material evolution at heterogeneous interfaces, we analyze the roles of localized ablation, interfacial modification, and process parameter control.

Building on these insights, the talk further discusses how laser interfacial ablation can be leveraged as a scalable and design-flexible manufacturing principle for next-generation flexible and intelligent electronic systems, where precise interface engineering is essential for reliable integration and performance.