2026 11th International Conference on Automation, Control and Robotics Engineering (CACRE 2026)

Conference Programme

https://www.cacre.org

Organized by
Nazarbayev University
Hong Kong Society of Mechanical Engineers(HKSME)

Technically Sponsored by
IEEE RAS, The Hong Kong University of Science and Technology (HKUST), Dalian Maritime University

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Digital Technologies Research and Applications, Machines and Robotics, Robotics Technology and Applications

Aug. 17-20, 2026 • Astana, Kazakhstan

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WELCOME MESSAGE

Dear Participants,

It is our great pleasure to welcome you to the 11th International Conference on Automation, Control and Robotics Engineering (CACRE 2026), taking place in Astana, Kazakhstan, from August 17 to 20, 2026. CACRE 2026 is co-organized by Nazarbayev University and Hong Kong Society of Mechanical Engineers(HKSME), technically sponsored by IEEE RAS, The Hong Kong University of Science and Technology (HKUST) and Dalian Maritime University, in partnership with IEEE Kazakhstan Section, supported by Donghua University, IEEE Hong Kong Joint Chapter, Control Systems/Robotics and Automation Society (CS/RA), Shanghai Jiao Tong University and Kazakhstan CIS/RA Jt. Chapter, media supported by *Digital Technologies Research and Applications, Machines and Robotics, Robotics Technology and Applications.*

Dedicated to building a high-quality academic exchange platform, CACRE 2026 aims to help participants update professional knowledge, explore cutting-edge innovations, and grasp the latest research trends in the fields of automation, control, and robotics engineering. The conference also provides abundant networking opportunities for scholars, engineers, researchers, industry practitioners, sponsors, and exhibitors worldwide to communicate in depth, share insights, and expand academic and industrial cooperation. We sincerely look forward to meeting all of you in person at this prestigious academic event. Beyond the wonderful technical sessions, we also encourage you to take time to experience the unique scenery, profound culture, and charming landscapes of Astana, Kazakhstan.

On behalf of the organizing committee, I would like to thank the distinguished speakers: Prof. Frank Park, Seoul National University, South Korea; Prof. Ljiljana Trajkovic, Simon Fraser University, Canada; Prof. Hatice Gunes, University of Cambridge, UK; Prof. Takayuki Kanda, Kyoto University, Japan; Prof. Ruxu Du, The Zhongke Jianchi Biotechnology Co., Ltd, China; Prof. Yang Chai, The Hong Kong Polytechnic University, Hong Kong, China; Assoc. Prof. Anara Sandygulova, Nazarbayev University, Kazakhstan for sharing their deep insights on future challenges and trends.

We sincerely thank all committee members for their dedicated efforts and rigorous work in the preparation and organization of the conference. We are also highly grateful to all reviewers for their time, professionalism, and rigorous evaluation of the submitted papers. Special thanks go to all participating researchers and students, whose outstanding research achievements and active participation lay a solid foundation for the successful holding of CACRE 2026.

Finally, we wish every participant a rewarding conference experience, a pleasant stay in Astana, and an enjoyable journey of academic exploration and communication!

Regards,

Mehdi Bagheri.

Prof. Mehdi Bagheri
General Chair of CACRE 2026
Nazarbayev University, Kazakhstan

CONFERENCE SPEAKERS

Prof. Frank Park
Seoul National University, South Korea

Biography: Frank C. Park is professor of mechanical engineering at Seoul National University with joint appointment in the SNU Graduate School of AI. His research interests lie at the intersection of mathematical systems theory, machine learning and mathematical data science, and robotics, with differential geometry serving as a common thread. He received degrees from MIT (BS EECS) and Harvard University (PhD applied mathematics), is a fellow of the IEEE, and a member of the Korean Academy of Science and Technology and the Korean National Academy of Engineering. He is former president of the IEEE Robotics and Automation Society, former editor-in-chief of the IEEE Transactions on Robotics, and author of Modern Robotics (2017 Cambridge Univ Press, with K. Lynch) and Dynamics of Mechanical Systems (2025 Cambridge Univ Press, with K.-M. Park). He is co-founder and CEO of Saige, an industrial AI company specializing in automation and quality control.

Keynote Lecture: Toward Human-Level Dexterity in Robot Manipulation: Integrating Control, Learning, Geometry and Mechanics

Abstract: The acrobatic feats of recent humanoids notwithstanding, today's robots still struggle with everyday tasks like opening jars, inserting plugs, using scissors, and other manipulation tasks that humans perform effortlessly. While hardware limitations are partly to blame — today's robot hands still lack the strength, precision, flexibility, and sensing capabilities of human hands — it is also becoming increasingly clear that traditional model-based control methods are also inadequate.

Data-driven methods offer a promising alternative to manually designing complex control laws for manipulation. However, current approaches based on Vision-Language-Action (VLA) models have major shortcomings: they are often device-dependent, require enormous training data, scale poorly, and struggle to generalize across tasks. More fundamentally, they fail to fully leverage the extensive domain knowledge accumulated in control systems design and the mechanics of manipulation.

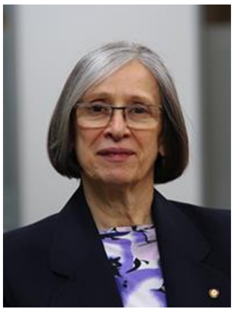
This talk proposes a new control architecture for robot manipulation that merges key concepts from control theory, mechanics, geometry, and human motor control with data-driven methods. Taking Brockett's motion description language (MDL) paradigm as our point of departure, we propose a device-independent, hierarchical, and modular framework for manipulation expressed in the language of control systems. At the highest level, foundation models decompose complex tasks into subtasks, which are then encoded as sequences of robot action primitives at the intermediate level using both state-space control and data-driven learning methods. The lower levels exploit geometric methods to construct minimum distortion latent space manifolds, equivariant learning models, and minimum attention feedforward-feedback control laws. Demonstrations of robots performing general manipulation tasks using this architecture are presented.

Prof. Ruxu Du
The Zhongke Jianchi Biotechnology Co., Ltd, China

Biography: Prof. Ruxu Du was born in China in 1955. He received his Master's degree from the South China University of Technology in 1983 and his Ph.D. degree from the University of Michigan in 1989. He has taught in the University of Windsor, in Windsor, Ontario, Canada (1991−1999), the University of Miami, in Coral Gables, Florida. USA (1999−2001), the Chinese University of Hong Kong in Hong Kong SAR (2001−2018), and the South China University of Technology (2018−2021). Prof. Du is the founding director of the Guangzhou Chinese Academy of Sciences Institute of Advanced Technology (2011−2016), the founding dean of S. M. Wu School of Intelligent Engineering, South China University of Technology, as well as the founding director of the Institute of Precision Engineering in the Chinese University of Hong Kong. Prof. Du's areas of research include AI applications in medicine, precision engineering, design and manufacturing (metal forming, machining, plastic injection molding and etc.), as well as robotics and automation. He has published over 500 papers in various academic journals and international conferences. He is the associate editor / the members of editorial board of six international journals.

Keynote Lecture: AI in the World of Manufacturing Overcapacity

Abstract: One of the fundamental problems in the world today is the manufacturing overcapacity. Can AI help? This talk first gives a quick review on AI. Then, it provides a road map on the use of AI for solving the manufacturing overcapacity problem. Some key issues are discussed including (a) probing the consumer needs, (b) designing for user experience, (c) manufacturing materials selection, and (d) production and service integration.



Prof. Ljiljana Trajkovic
Simon Fraser University, Canada

Biography: Ljiljana Trajkovic received the Dipl. Ing. degree from University of Pristina, Yugoslavia, the M.Sc. degrees in electrical engineering and computer engineering from Syracuse University, Syracuse, NY, and the Ph.D. degree in electrical engineering from University of California at Los Angeles. She is currently a professor in the School of Engineering Science, Simon Fraser University, Burnaby, British Columbia, Canada. Her research interests include communication networks and dynamical systems. Dr. Trajkovic served as IEEE Division X Delegate/Director, President of the IEEE Systems, Man, and Cybernetics Society, and President of the IEEE Circuits and Systems Society. She serves as Editor-in-Chief of the IEEE Transactions on Human-Machine Systems. She is a Distinguished Lecturer of the IEEE Systems, Man, and Cybernetics Society and was a Distinguished Lecturer of the IEEE Circuits and System Society. She is a Fellow of the IEEE.

Keynote Lecture: Data Mining and Machine Learning for Complex Networks

Abstract: Collection and analysis of data from deployed networks is essential for understanding communication networks. Data mining and statistical analysis of network data have been employed to determine traffic loads, analyze patterns of users' behavior, predict future network traffic, and detect traffic anomalies. The Internet has historically been prone to failures and attacks that significantly degrade its performance, affect the Internet connectivity, and cause routing disconnections. Frequent cases of various cyber threats have been encountered over the years and, hence, detection of anomalous behavior is a topic of great interest in cybersecurity. In described case studies, traffic traces collected by various collection sites are used to classify network anomalies. Various anomaly and intrusion detection approaches based on machine learning have been employed to analyze collected data. Deep learning, broad learning, gradient boosted decision trees, and reservoir computing algorithms were used to develop models based on collected datasets that contain Internet worms, viruses, power outages, ransomware events, router misconfigurations, Internet Protocol hijacks, and infrastructure failures in times of conflict. The reported results indicate that while performance of machine learning models greatly depends on the used datasets, they are viable tools for detecting the Internet anomalies.

Prof. Takayuki Kanda
Kyoto University, Japan

Biography: Takayuki Kanda is a professor in Informatics at Kyoto University, Japan. He is also a Visiting Group Leader at ATR Intelligent Robotics and Communication Laboratories, Kyoto, Japan. He received his B. Eng, M. Eng, and Ph. D. degrees in computer science from Kyoto University, Kyoto, Japan, in 1998, 2000, and 2003, respectively. He is one of the starting members of Communication Robots project at ATR. He has developed a communication robot, Robovie, and applied it in daily situations, such as peer-tutor at elementary school and a museum exhibit guide. His research interests include human-robot interaction, interactive humanoid robots, and field trials.

Keynote Lecture: Social Robots in Public Spaces

Abstract: Social robots are beginning to appear in public spaces such as shopping malls, yet deploying them in real environments remains challenging. In this talk, I present a series of field studies using our humanoid robot Robovie, focusing on how robots can interact effectively with people and acquire social acceptance. While robotic technologies continue to advance, our work highlights the importance of human-robot interaction, namely how to design robot behavior in synergy with technological progress. For instance, although modeling human interaction has enabled robots to provide services such as guidance and information, real-world deployments have revealed critical issues, including interaction failure, congestion, and robot abuse. These challenges have led us to a new research direction, "moral interaction," in which robots are designed as social peers that elicit respectful and prosocial behavior. I will introduce our recent studies on understanding and mitigating robot abuse, as well as on leveraging robots to create positive social influence through timely and context-aware interactions.

Prof. Yang Chai
The Hong Kong Polytechnic University, Hong Kong, China

Biography: Prof. Yang Chai is the Chair Professor of Semiconductor Physics of the Hong Kong Polytechnic University. He is an IEEE Distinguished Lecturer, an IEEE Fellow, an Optica Fellow, IOP Fellow, and AAIA Fellow. He is the Director of Research Institute for Artificial Intelligence of Things, the Director of Joint Research Center of Microelectronics, and the Associate Dean of Faculty of Science (Research) at the Hong Kong Polytechnic University. He is also the Chair of Semiconductor Nanotechnology Alliance, the Vice President of the Physical Society of Hong Kong, and an Associate Editor of ACS Nano. His current research interest mainly focuses on emerging electronic devices. He is also He is a receipt of the Falling Walls Science Breakthroughs in Engineering and Technology for his work on "Breaking the Wall of Efficient Sensory AI Systems", the BOCHK Science and Technology Innovation Prize, The Croucher Senior Fellowship, The Ho Leung Ho Lee (HLHL) Foundation Science and Technology Innovation Award, and NSFC Distinguished Scholar.

Keynote Lecture: Bioinspired in-sensor Computing for Artificial Vision

Abstract: The demand for accurate perception of the physical world leads to a dramatic increase in sensory nodes. However, the transmission of massive and unstructured sensory data from sensors to computing units poses great challenges in terms of power - efficiency, transmission bandwidth, data storage, time latency, and security. To efficiently process massive sensory data, it is crucial to achieve data compression and structuring at the sensory terminals. In - sensor computing integrates perception, memory, and processing functions within sensors, enabling sensory terminals to perform data compression and data structuring. In this talk, I will describe our team's efforts towards bioinspired in-sensor computing for artificial vision. I will talk about the framework of the in-sensor computing and demonstrate a few vision sensors for different scenarios, including visual adaptation, motion perception, as well as event-driven vision sensors for spiking neural network.

Prof. Hatice Gunes
University of Cambridge, UK

Biography: Prof. Gunes is an internationally recognized scholar in affective computing and robotics. She is a former President of the Association for the Advancement of Affective Computing (AAAC) and was a Faculty Fellow (2019-2021) of the Alan Turing Institute – UK's national centre for data science and artificial intelligence. She was an Honoree for the Sony Women in Technology Award with Nature 2025 which celebrates inspirational women in technology who are poised to redefine the future of their fields. Hatice Gunes obtained her PhD in computer science from the University of Technology Sydney (UTS) in Australia as an awardee of the Australian Government International Postgraduate Research Scholarship (IPRS) - a prestigious scholarship awarded on the basis of academic merit and research capacity. As a postdoctoral researcher at Imperial College London, she played a crucial role in the EU SEMAINE project, that created the world's first publicly available multimodal, fully autonomous, and real-time human-agent interaction system (the SAL system). Attentive to user affect and nonverbal expressions, the project developed novel nonverbal audiovisual human behaviour analysis and multimodal agent behaviour synthesis capabilities, and won the Best Demo Award at IEEE ACII'09 and the Best Paper Award at IEEE FG'11.

Keynote Lecture: Beyond Autonomy: Building Socially Intelligent Robots that Understand, Learn, and Adapt to People

Abstract: As robots become increasingly integrated into hospitals, schools, workplaces, homes, and public spaces, autonomy alone is no longer sufficient. Future systems must interpret social and emotional contexts, continuously learn from human interactions, personalize their behaviour over time, and align with human values and expectations.

This keynote will present advances in Affective AI and Social Robotics that enable robots to interpret multimodal human behaviour, including facial expressions, speech, and interaction patterns. It will demonstrate how socially aware perception enables adaptive decision-making, and personalized human–robot interaction.

The talk will argue that socially intelligent robots require more than data-driven learning. Through iterative design and human-in-the-loop approaches involving practitioners, clinicians, coaches, and end users, robots can acquire socially appropriate behaviours while identifying risks early in development.

Drawing on research in social robotics for home and hospitality environments, and mental wellbeing support, the keynote will discuss how autonomous systems can integrate perception, reasoning, and action with learning from human expertise and adaptation to individual needs. It will conclude with lessons from deploying socially assistive robots beyond the laboratory and the challenges of building trustworthy systems for real-world environments.

Assoc. Prof. Anara Sandygulova
Nazarbayev University, Kazakhstan

Biography: Dr. Anara Sandygulova is an Associate Professor in the Department of Robotics and Mechatronics at Nazarbayev University, Kazakhstan, where she directs the Human-Robot Interaction (HRI) Laboratory. She received her Ph.D. in Computer Science from University College Dublin, Ireland. Her research focuses on human-robot interaction, artificial intelligence, robot-assisted intervention for autistic children, socially assistive robotics, and sign language technologies. She leads several research projects on AI-powered social robots and AI-driven solutions for sign languages and has authored numerous publications in leading international conferences and journals. Her work has received international recognition, including the Best Paper Award at the ACM/IEEE International Conference on Human-Robot Interaction. Dr. Sandygulova is also the founder of APRIL, a university spin-off that develops AI-enabled robotic solutions for autism intervention. The platform has been deployed in multiple intervention centers across Kazakhstan, supporting hundreds of children through personalized, data-driven therapy. Her mission is to bridge cutting-edge AI research with practical healthcare and educational applications that improve the quality of life for children with developmental differences and their families.

Invited Lecture: AI-Powered Social Robots for Personalized Autism Intervention: From Research to Real-World Impact

Abstract: Autism intervention is most effective when it is personalized, engaging, and supported by objective data. Recent advances in artificial intelligence and social robotics are creating new opportunities to enhance therapy while reducing the workload of specialists. This talk presents our research and practical experience in developing AI-powered robot-assisted intervention for autistic children. I will introduce the APRIL platform, an end-to-end ecosystem that combines social robots, AI-based behavioral analysis, personalized therapy planning, and data-driven progress monitoring. The presentation will discuss how computer vision and machine learning are used to recognize children's engagement and adapt robot behavior in real time. I will also share the challenges of deploying these technologies in clinical and educational settings, lessons learned from working with therapists and families, and the future of AI-driven personalized intervention. The talk demonstrates how interdisciplinary collaboration between robotics, artificial intelligence, psychology, and special education can translate research into scalable solutions with measurable societal impact.

Dr. Tohid Alizadeh
Nazarbayev University, Kazakhstan

Biography: Dr. Tohid Alizadeh is an Assistant Professor of Robotics at Nazarbayev University in Astana, Kazakhstan, where he spearheads research and education in control systems, smart manufacturing, and industrial automation. Holding a Ph.D. in Robotics, Dr. Alizadeh bridges academia and industry through hands-on pedagogy, mentoring students on industrial automation, Node-RED IoT integrations, and PLC-driven digital twins. His expertise in CODESYS—the premier IEC 61131-3 platform—has positioned him as a go-to authority for modern PLC programming, from ladder logic to advanced visualizations and SoftMotion.

Internationally recognized for his acclaimed YouTube channel dedicated to CODESYS PLC programming (www.youtube.com/TohidAlizadeh), Dr. Alizadeh has amassed a global following with practical tutorials that demystify automation for beginners and pros alike. His videos, viewed by thousands in engineering communities worldwide, emphasize real-world applications in Industry 4.0, earning praise for clarity and accessibility—much like this tutorial.

Tutorial Lecture: A Hands-on Tutorial on PLC Programming in CODESYS

Abstract: In today's smart manufacturing landscape, mastering Programmable Logic Controllers (PLCs) is essential for students entering automation fields and industry professionals seeking to upskill in IEC 61131-3 compliant tools. This practical tutorial targets both groups, delivering foundational CODESYS expertise through interactive sessions—no prior experience required. Engineering students will gain a competitive edge for internships and theses in robotics/control systems, while pros from industrial sector can modernize workflows efficiently.

Participants should install the free CODESYS Development System (v3.5 SP19 or later—detailed instructions provided pre-event) on their laptops beforehand, which they must bring for hands-on practice. We'll create a new project, configure virtual or target controllers, and explore the intuitive IDE. Core focus: programming in Ladder Diagram (LD), Function Block Diagram (FBD), Structured Text (ST), Sequential Function Chart (SFC), and Continuous Function Chart (CFC). Attendees build simple yet realistic applications, like traffic light sequencers, conveyor controls, and multi-state machines, mastering variables, tasks, libraries, and debugging with online monitoring and breakpoints.

Visualization takes center stage next: integrating HMI screens via CODESYS Visualization for dynamic operator interfaces, complete with buttons, trends, and alarms. An introduction to SoftMotion follows, covering axis synchronization, and motion control libraries—ideal for entry-level robotics retrofits without hardware.

Guided exercises emphasize rapid prototyping and simulation, enabling immediate testing and iteration. By tutorial's end, you'll deploy functional PLC code to emulated hardware, ready to apply in labs, factories, or Arduino/Node-RED hybrids. Aligned with Industry 4.0 basics, this session builds confidence for certifications and real projects, with YouTube-style demos and resources for ongoing learning.

PRESENTATION GUIDE

Oral Presentation

1. File format: MS-PowerPoint *.ppt or Adobe PDF *.pdf
   PPT size: 4:3

2. Time: About 15mins, including Q/A time.

3. Language: English

4. Fonts: Arial or Times New Roman

5. Dress code: Formal clothes

6. Facility: Presenters need to use own laptop, please notify conference secretary via e-mail in advance and test the connection before session start.

7. Online conference software: Tencent VooV

Poster Presentation

1. Poster Size: A0 Size

2. Language: English.

3. The poster should include: Paper ID, Conference Name's Acronym, Significance of the research, the methods used, the main results obtained, and conclusions drawn.

4. Posters are required to be condensed and attractive.

5. The conference organizer won't send/keep any posters after the conference.

Minutes of Q&A

Keynote Speech: 40 Minutes of Presentation including 5 minutes' Q&A
Oral Presentation: 15 Minutes of Presentation including 2 minutes' Q&A

NOTICE:

- Certificate of Participation will be awarded after presentation.
- One best presentation will be selected from each session. The best one will be announced when each session ends, and will be awarded with a "Best Presentation" certificate.

Online Conference Operation Guide—VooV

Operation Guide:

1. Video meeting software: VooV

Download link:
A.) Chinese Version
https://meeting.tencent.com/download-mac.html?from=1001&fromSource=1 Mac OS
https://meeting.tencent.com/download-win.html?from=1001&fromSource=1 Windows
B.) International Version
https://voovmeeting.com/download/darwinMac OS
https://voovmeeting.com/download/windows Windows

2. Join the Conference:

Method 1: Click the Conference link, or click “Join the conference”, then input the Conference ID. When you join the conference room, you need to fill in your phone number for authentication, then fill in your “Paper ID +Name” at the “Name” to join the conference.

Tip: Should you fail to “Join the Conference” as a visitor, we suggest you register an account by method 2, then log in and join the conference.

Method 2: You can register at the APP/ website https://www.voovmeeting.com/, log in and join the conference by the link or tap the Conference ID.

Note:

- Presentation of paper must be done on the conference by one of authors of the paper. Otherwise, the paper cannot be included into the conference proceeding.
- We’ll record the whole conference. If you do mind, please inform us in advance. The recording will be used for conference program and paper publication requirements. It cannot be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose.
- The conference committee will **call the roll 10-15 minutes before** our conference, please join the conference in advance for at least 10-15 minutes. The conference secretaries will be waiting before Forty five minutes the conference starts.
- Please **wear headphones** during the meeting to block out the outside noise. Keeping the video on and keeping online are suggested.
- Please test the video meeting software in advance.
- Should you have any further questions about this operation guide, please click

https://www.voovmeeting.com/ for help. You can also contact the conference secretary at +86-19150956004 (China), +852-30506862 (Hong Kong).

Conference Information:

Time Zone	GMT+05:00
Conference Time	Aug.17-20, 2026
Online Room ID	779-4283-7527 Password: 0818
Link	https://meeting.tencent.com/dm/KxzfaLMncgmb

CACRE 2026 CONFERENCE PROGRAM OVERVIEW

Conference Venue: Nazarbayev University

ADD.: 53 Kabanbay Batyr Ave, Astana city, Republic of Kazakhstan

Online Room: 779-4283-7527|0818

DAY 1–Aug. 17, 2026 | UTC+5| Monday		
13:00-17:00	Registration and Conference kits collection- *Upper Atrium*	
DAY 2 –Aug. 18, 2026| UTC+5 | Tuesday		
Keynote (I, II and III) **Offline Venue:** *Red Hall, Block C3* **9:15-12:50**		
9:15-9:30	**Check In**	
9:30-10:15	**Opening Ceremony & *Group Photo***	
10:15-10:55	**Keynote Talk I**	**Prof. Frank Park,** *Seoul National University, South Korea*
10:55-11:30	***Coffee Break***	
11:30-12:10	**Keynote Talk II**	**Prof. Ruxu Du,** *The Zhongke Jianchi Biotechnology Co., Ltd, China*
12:10-12:50	**Keynote Talk III**	**Prof. Ljiljana Trajkovic,** *Simon Fraser University, Canada*
13:00-14:30	**Lunch - *Ballroom Right***	
Keynote IV & Lab Tour **Offline Venue:** *Red Hall, Block C3* **14:30-16:30**		
14:30-15:10	**Keynote Talk IV**	**Prof. Takayuki Kanda,** *Kyoto University, Japan*
15:10-15:30	***Coffee Break***	
15:30-16:30	**Lab Tour**	
Tutorial **Offline Venue:** *Block 7.322*		

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<tr><td>16:30-18:00</td><td>Tutorial</td><td colspan="2">Prof. Tohid Alizadeh, Nazarbayev University, Kazakhstan</td></tr>
<tr><td colspan="4">DAY 3 –Aug. 19, 2026| UTC+5 | Wednesday</td></tr>
<tr><td colspan="4">Keynote Session+Invited Session
Offline Venue: Red Hall, Block C3
9:30-12:00</td></tr>
<tr><td>9:30-10:10</td><td>Keynote Talk V</td><td colspan="2">Prof. Yang Chai, The Hong Kong Polytechnic University, Hong Kong, China</td></tr>
<tr><td>10:10-10:50</td><td>Keynote Talk VI</td><td colspan="2">Prof. Hatice Gunes, University of Cambridge, UK</td></tr>
<tr><td>10:50-11:30</td><td colspan="3">Coffee Break</td></tr>
<tr><td>11:30-12:00</td><td>Invited Talk I</td><td colspan="2">Assoc. Prof. Anara Sandygulova, Nazarbayev University, Kazakhstan</td></tr>
<tr><td>12:00-13:30</td><td colspan="3">Lunch - Ballroom Right</td></tr>
<tr><td></td><td colspan="2">Block 3 e220</td><td>Block 3 e224</td></tr>
<tr><td rowspan="2">13:30-15:00</td><td colspan="2">Technical Session I(A)- Intelligent Robotics and AI-Driven Control: From Bioinspired Design to Autonomous Systems</td><td>Technical Session II(A)- Robotics and Intelligent Control: Design, Perception, and Autonomy</td></tr>
<tr><td colspan="2">CR022, CR023, CR031, CR032, CR033, CR043</td><td>CR069, CR026*, CR038*, CR053*, CR065*, CR072*</td></tr>
<tr><td>15:00-16:00</td><td colspan="3">Coffee Break & Poster Session</td></tr>
<tr><td rowspan="2">16:00-17:30</td><td colspan="2">Technical Session I(B)- Intelligent Robotics and AI-Driven Control: From Bioinspired Design to Autonomous Systems</td><td>Technical Session II(B)- Robotics and Intelligent Control: Design, Perception, and Autonomy</td></tr>
<tr><td colspan="2">CR055, CR056, CR059, CR071, CR076, CR027</td><td>CR077*, CR092*, CR094*, CR093*</td></tr>
<tr><td>17:30-18:00</td><td colspan="3">Closing Ceremony</td></tr>
<tr><td>18:30-20:30</td><td colspan="3">Banquet Dinner-Jent</td></tr>
<tr><td colspan="4">DAY 4 –Aug. 20, 2026| UTC+5 | Thursday</td></tr>
<tr><td>10:00-18:00</td><td colspan="3">Technical Tour (Pending)</td></tr>
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ROOM OVERVIEW

Oral Session		
Block 3 e220	**Technical Session I** 13:30–17:30 Aug. 19	**Technical Session I(A):** CR022, CR023, CR031, CR032, CR033, CR043
		Technical Session I(B): CR055, CR056, CR059, CR071, CR076, CR027
Block 3 e224	**Technical Session II** 13:30–17:00 Aug. 19	**Technical Session II(A):** CR069, CR026*, CR038*, CR053*, CR065*, CR072*
		Technical Session II(B): CR077*, CR092*, CR094*, CR093*
Poster Session		
Near Block 3 e224	**Poster Session** 15:00-16:00 Aug. 19	CR007, CR008, CR091
Online Room 779-4283-7527|0818	**Poster Session** 15:00-16:00 Aug. 19	CR005*, CR010*, CR011*, CR012*, CR014*, CR016*, CR018*, CR019*, CR020*, CR021*, CR042*, CR045*, CR046*, CR047*, CR052*, CR070*, CR079*, CR089*, CR096*

* Represents online presenter.

TECHNICAL SESSION

Keynote (I, II, III)

Chair: *Annie Ng*, Nazarbayev University, Kazakhstan

9:30-12:50, Aug. 18, Tuesday

Main Venue: Red Hall, Block C3

Time	No.	Content	Page
9:30-10:15	**Opening Ceremony&Group Photo**		
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10:55-11:30	**Coffee Break**		
11:30-12:10	KN#2	AI in the World of Manufacturing Overcapacity ***Ruxu Du,*** The Zhongke Jianchi Biotechnology Co., Ltd, China	3
12:10-12:50	KN#3	Data Mining and Machine Learning for Complex Networks ***Ljiljana Trajkovic,*** Simon Fraser University, Canada	4

Keynote IV & Lab Tour

Chair: *Mohammad Hashmi,* Nazarbayev University, Kazakhstan

14:30-15:10, Aug. 18, Tuesday

Main Venue: Red Hall, Block C3

Time	No.	Content	Page
14:30-15:10	KN#4	Social Robots in Public Spaces ***Takayuki Kanda,*** Kyoto University, Japan	5
15:10-15:30	**Coffee Break**		
15:30-16:30	**Lab Tour**		

Tutorial

16:30-18:00, Aug. 18, Tuesday

Venue: Block 7.322

16:30-18:00	Tutorial	A Hands-on Tutorial on PLC Programming in CODESYS ***Tohid Alizadeh,*** Nazarbayev University, Kazakhstan	9

Keynote Session + Invited Session

Chair: *Gulsim Kulsharova,* Nazarbayev University, Kazakhstan

9:30-12:00, Aug.19, Wednesday

Main Venue: Red Hall, Block C3

Time	No.	Content	Page
9:30-10:10	KN#5	Bioinspired in-sensor Computing for Artificial Vision ***Yang Chai,*** The Hong Kong Polytechnic University, Hong Kong, China	6
10:10-10:50	KN#6	Beyond Autonomy: Building Socially Intelligent Robots that Understand, Learn, and Adapt to People ***Hatice Gunes,*** University of Cambridge, UK	7
10:50-11:30	**Coffee Break**		
11:30-12:00	IS#1	AI-Powered Social Robots for Personalized Autism Intervention: From Research to Real-World Impact ***Anara Sandygulova,*** Nazarbayev University, Kazakhstan	8

Technical Session I(A): Intelligent Robotics and AI-Driven Control: From Bioinspired Design to Autonomous Systems

Chairs: *Xianping Fu,* Dalian Maritime University, China
***Xinnian Wang,* Dalian Maritime University, China**

13:30-15:00, Aug. 19, Wednesday

Venue: Block 3 e220

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	Offline	Perspective ***Alireza Bab-Hadiashar,*** RMIT University, Australia	
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Technical Session I(B): Intelligent Robotics and AI-Driven Control: From Bioinspired Design to Autonomous Systems

Chairs: *Xianping Fu*, Dalian Maritime University, China
***Xinnian Wang*, Dalian Maritime University, China**

16:00-17:30, Aug. 19, Wednesday

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Chair: ***Sungjin Cho, Hankyong National University, South Korea***

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14:00-14:15	CR038*-Online	Design and Development of an Eco-Friendly 3D Concrete Extrusion Nozzle with In-Nozzle Admixture Dosing and Continuous Mixing ***Joaquin Velarde-Yaranga,*** Universidad Peruana de Ciencias Aplicadas, Peru	30
14:15-14:30	CR053*-Online	Research on Robot Path Planning Based on Multi-Strategy Improved RRT* Algorithm ***Yucong Yang,*** Shenyang University of Technology, China	31
14:30-14:45	CR065*-Online	A Lightweight Two-Stage Hierarchical Decoupled Terrain Recognition Framework for Lower-Limb Exoskeletons ***Qiliang Zhang,*** University of Shanghai for Science and Technology, China	31
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CR007	MonoYOLO: Monocular 3D Detection via Cross-Modal Feature Fusion ***Ronghui Liang,*** South China University of Technology, China
CR008	Trajectory Optimization for Morphing Hypersonic Vehicles Based on Optimal Configuration Profile ***Kechen Xiang,*** Northwestern Polytechnical University (NWPU), China
CR091	Design and Experimental Study of One Dimensional Magnetic Field Topologies for Magnetic Particle Imaging Systems ***Loc Phuoc Nguyen***, Nazarbayev University, Kazakhstan

CR005*	Research on Window Stealth Mechanism of Aircraft Optical System ***Hong xiang Zhu,*** Changchun Institute of Optics, Fine Mechanics and Physics, Chunese Academy of Sciences, China
CR010*	Evaluating and Reducing the Force Ratio in Multi-agents Shepherding Tasks ***Qiting Liu,*** National University of Defense Technology, China
CR011*	Design and Implementation of a Digital Twin- and Augmented Reality- Enabled Multi-modal Teleoperation System for Dual-Arm Robots in Live-Line Operations ***Yifei Meng,*** State Grid Beijing Electric Power Company, China
CR012*	A Variational Bayesian Filtering Algorithm Based on Residual Feedback for Inverse Wishart Distribution ***Sai Wang,*** Sun Yat-sen University, China
CR014*	The Dual-Channel Interaction Network with Adaptive Loss for Underwater Image Denoising ***Zhiqiang Lei,*** Dalian Maritime University, China
CR016*	EUMNet: An End-to-End Framework for Underwater Low-Light Image Enhancement and Aquatic Object Detection ***Ruiying Wang,*** Dalian Polytechnic University, China
CR018*	LightViServo: Real-Time Visual Servoing for Robotic Arm Manipulation via Traditional Vision on Edge Devices ***Yawen Xue,*** Chongqing University, China
CR019*	Semi-supervised Image Translation between Unpaired Cellular-resolution OCT and Stained Images ***Sheng-Lung Huang,*** National Taiwan University, Taiwan, China
CR020*	A Two-Stage Transfer Learning Method with Domain-Statistics Alignment for Few-Shot FICS Defect Detect ***Zheng Zheng,*** Guangzhou University, China
CR021*	DMDQN: Double DQN with Action Masking for Ship Block Arrangement Problem ***Mingzong Li,*** Guangzhou University, China
CR042*	Design for Control Circuit Diagnosis and Fault Localization in PLC-based Electrical Control Systems ***Tao Wang,*** Hebei Baisha Tobacco Co., Ltd., China
CR045*	A Magnetic-Saturation-Aware MTPA Current Allocation Strategy for DC-Biased Sinusoidal-Excited SRM Drives ***Di Liu,*** City Institute, Dalian University of Technology, Dalian, China
CR046*	Research on Wind Load of the Shell Structure of a Lifting Box-type Thickness Measuring Device ***Bo Wei,*** Tianjin Port Engineering Institute, Co., Ltd. of CCCC First Harbor Engineering Co., Ltd., China

CR047*	Design of a Ship Attitude and Ice Layer Multidimensional Monitoring System for Extremely Cold Environments ***Bo Wei,*** Tianjin Port Engineering Institute, Co., Ltd. of CCCC First Harbor Engineering Co., Ltd., China
CR052*	Consensus Control for Multi-Agent Systems via Cooperative Game-Based Leader Trajectory Generation ***Junfu Li,*** University of Electronic Science and Technology of China, China
CR070*	A Study on a Rail-mounted Robotic System for Inspecting Steel Structure Welds on Aerial Construction Platforms ***Chang Ge,*** Shanghai Robot Industrial Technology Research Institute, China
CR079*	Explainable Artificial Intelligence for Trustworthy Decision-Making and Planning in Autonomous Driving ***Zhuo Song,*** China North Artificial Intelligence ＆ Innovation Research Institute, China
CR089*	Design and Fabrication of a Heating Platform for Microfluidic Cell Culture and IVF Applications ***Gulsim Kulsharova,*** Nazarbayev University, Kazakhstan
CR096*	Efficiency Map Guided Design and Experimental Validation of a Noncircular Gear Transmission for Hand Crank Generators ***Haixuan Yan,*** Chongqing University, China

ABSTRACT

Technical Session I(A)	
Time	**Content**
13:30-13:45 Aug.19	**CR022:** Mechanism Design and Dynamic Modeling of Flying-Crawling Multifunctional Flapping-Wing Air Robot **Presenter:** ***Wenqing Yang,*** Northwestern Polytechnical University, China **Authors:** ***Wenqing Yang, Xiyue Wang, Jianlin Xuan*** **Abstract:** Flapping-wing air robot has received extensive attention due to their unique bionic performance and can be widely used in military and civilian fields. However, the lack of ground mobility makes them unable to traverse special terrains or achieve long-term perching and reconnaissance. This greatly limits their applications in reconnaissance, rescue, inspection and other fields. This paper focuses on the flying-climbing multifunctional bionic flapping wing air robot and its development process including mechanism design, aerodynamic model establishment, dynamic model establishment, attitude controller design and prototype integration, a prototype capable of achieving aerial flight, ground crawling and the transition between ground crawling and aerial flight has been successfully developed. Regarding the attitude controller design, the definition and conversion relationships of coordinate systems are clarified. A dynamic model is established based on the single-rigid-body assumption and is linearlyized under small disturbances in the straight and level flight state. A cascade PID algorithm is used to design the attitude controller. The process of determining the parameters of the inner and outer loop controllers is analyzed in detail. Compared with the ordinary feedback PID controller, this algorithm has a small overshoot, fast response and no steady-state error, significantly improving the attitude control performance of the flapping-wing air robot. This multifunctional flapping-wing air robot makes up for the deficiency that traditional flapping-wing air robot do not have the ground crawling ability and expands the application prospects of bionic air robot.
13:45-14:00 Aug.19	**CR023:** Dynamic Modeling of a Bird-like Flapping-wing Air Robot **Presenter:** ***Jianlin Xuan,*** Northwestern Polytechnical University, China **Authors:** ***Jianlin Xuan, Xiyue Wang, Wenqing Yang*** **Abstract:** The bird-like flapping-wing air robot, resembling a bird in appearance, is difficult to detect visually, offering excellent stealth capabilities. This paper aiming to establish a high-precision dynamic model for flight control system design, and provide a theoretical basis for the flight control of bird-like flapping-wing air robot. Based on the actual flight state of the flapping-wing air robot, the results of the unsteady vortex lattice method are combined with an aerodynamic surrogate model to establish a high-precision aerodynamic surrogate model for the flapping wings. The aerodynamic derivatives of the fuselage and tail under incoming wind speed

	were computed, establishing an aerodynamic model for the fuselage and tail, and ultimately creating a high-precision aerodynamic model for the flapping-wing air robot. After that, a dynamic model for the bird-like flapping-wing air robot is established based on the single rigid body assumption. The influence mechanism of the tail aerodynamic characteristics on flight performance was analyzed in detail. Based on the stability theory, through static stability analysis and dynamic response characteristics study, the intrinsic motion characteristics and laws of the air vehicle are obtained from both longitudinal and lateral-directional motion modes. A longitudinal controller for the flapping-wing air robot was designed, achieving stable control and tracking of flight attitude, speed, and altitude using cascade PID control algorithm and total energy control algorithm. These results can provide references for the design of flapping-wing air robot controller and also offer a basis for the iterative optimization design of bionic tails.
14:00-14:15 Aug.19	**CR031:** Automated Animal Welfare Management in Remote Feedlots: Design Perspective **Presenter:** ***Alireza Bab-Hadiashar,*** RMIT University, Australia **Authors:** ***Son Dao, Ruwan Tennakoon, Amirali Khodadadian Gostar, Alireza Bab-hadiashar*** **Abstract:** This paper presents the design of an automated animal welfare monitoring system for commercial feedlots, integrating machine vision, intake and weight sensors, and Radio Frequency Identifier (RFID)-based identification to enable continuous, non-invasive assessment of livestock wellbeing. A core technical contribution is a multi-view image aggregation method that combines data from multiple camera angles into a unified representation, supporting longitudinal animal tracking, weight estimation, and re-identification (Re-ID). The system's tracking performance was evaluated under controlled conditions and piloted in a commercial feedlot, demonstrating multi-animal tracking capability while exposing hardware resilience challenges. Large Language Models (LLMs) were integrated for dataset labelling and a natural language query prototype. This work targets researchers, feedlot operators, and agritech developers seeking scalable, AI-driven livestock monitoring.
14:15-14:30 Aug.19	**CR032:** Real-Time Close-Proximity Soccer Ball Detection: Model Benchmarking and Inference Optimization **Presenter:** ***Yessimkhan Orynbay,*** Nazarbayev University, Kazakhstan **Authors:** ***Azamat Shmitov, Altay Kairat, Arlen Smagulov, Yessimkhan Orynbay*** **Abstract:** Close-proximity indoor soccer ball detection is more challenging than broadcast-style analysis due to rapid motion, strong scale variation, and frequent motion blur. Using the ProxiBall dataset and a strictly held-out, view-separated testbench, we benchmark ten modern detectors under both clean and synthetic-blur conditions and evaluate a lightweight temporal-refinement module. RT-DETR-L achieves the highest accuracy on the clean testbench. However, under practical runtime and footprint constraints, YOLOv26s is selected for deployment due to its superior robustness to severe blur and improved recall on fast targets compared to YOLOv10s. All detectors degrade significantly with increasing blur, and stratified

	analysis shows that small and fast targets remain the primary failure modes. The temporal module is designed for inference throughput—adaptive frame skipping with Kalman propagation targets 100+ FPS on edge hardware—and a controlled accuracy ablation reveals a slight recall gain alongside substantially increased false persistence on negative frames. Robust close-proximity ball perception thus requires detector selection by blur robustness under runtime constraints, and pre-deployment validation of temporal propagation's precision impact.
14:30-14:45 Aug.19	**CR033:** Cost of Transport Analysis of Capture Point-Based Balancing Strategies for a Payload-Bearing Humanoid **Presenter:** ***Michele Folgheraiter,*** Nazarbayev University, Kazakhstan **Authors:** ***Nurberdi Myrzabay, Abylay Akshulakov, Timur Umurzakov, and Michele Folgheraiter*** **Abstract:** Payload-bearing humanoid walking becomes chal-lenging as upper-body mass shifts the center of mass (CoM) upward, increasing the energetic cost of balance correction. This paper investigates how the physical location of corrective action affects stability and efficiency by comparing three strategies: an offline-optimized open-loop gait, a torso-driven Pendulum controller, and a leg-driven Hip/Ankle controller, both based on Capture Point (CP) feedback. Unlike prior work combining mul-tiple stabilization mechanisms, this study isolates torso- and leg-based corrections under identical conditions. While all strategies achieve short-horizon walking, they differ significantly in energy efficiency and drift behavior. The Pendulum controller improves stability but increases the Cost of Transport (CoT) to 2.56 due to repeated upper-body acceleration. In contrast, the Hip/Ankle controller redistributes correction to the stance leg, achieving a CoT of 1.15 while maintaining stable walking. These results demonstrate that, for payload-bearing humanoids, applying CP-based correction through the lower body is substantially more energy-efficient than torso-driven stabilization.
14:45-15:00 Aug.19	**CR043:** Enhancement of Dynamic Output Performance for Grid-Forming Photovoltaic and Energy Storage Systems through Buffer Function and Damping Dynamic Adaptation **Presenter:** ***Santao Jiang,*** Shihezi University, China **Authors:** ***Santao Jiang, Lijiao Gong, Xin Zhang, Jingyun Li, Xin Qu*** **Abstract:** The coordinated integration of energy storage systems (ESS) with distributed photovoltaic (PV) generation through grid-forming (GFM) active support control represents a critical technology for resolving stability challenges in high-penetration distributed PV scenarios. This paper addresses the deficient dynamic power response capability of grid-forming photovoltaic and energy storage systems (GFM-PESS) under small-signal disturbances by proposing a control strategy that integrates buffer function and damping dynamic adaptation (BFDDA). The proposed methodology co-optimizes steady-state and transient performance to significantly enhance GFM-PESS power dynamic response. First, analytical models are developed to reveal how key parameters affect the power-frequency characteristics of the system. Subsequently, a dynamic virtual inertia adjustment mechanism based on a buffer function is designed, mapping the derivative of angular

	velocity to the inertia coefficient regulation process, thereby improving stability during power dynamic regulation. The impact of this mechanism on system stability is rigorously analyzed using Lyapunov stability theory. Moreover, the damping control loop incorporates an advanced first-order lead-lag compensator that enables adaptive switching between transient and steady-state damping, thus boosting the stability of the power dynamic response. Finally, hardware-in-the-loop (HIL) experimental validation demonstrates the proposed strategy's effectiveness in enhancing GFM-PESS power dynamic response performance across multiple operating conditions. The proposed BFDDA approach demonstrates significant value for enhancing the stable operation and dynamic behavior of new type power systems with high-penetration distributed PV.
Technical Session I(B)	
Time	**Content**
16:00-16:15 Aug.19	**CR055:** Design and Validation of an Amphibious Flapping-Wing Aircraft with Wing Torsion and Webbed-Foot Mechanisms **Presenter:** ***Yugang Zhang,*** Northwestern Polytechnical University, China **Authors:** ***Yugang Zhang, Runyu Wang, Zhirui Zhang and Haifeng Yang*** **Abstract:** Bird-inspired flapping-wing aircraft have prominent advantages in low noise and high concealment for covert reconnaissance and biological research. However, most conventional flapping-wing aircraft only adapt to aerial flight with poor maneuverability and no water floating capability, limiting their marine applications. This paper designs a bird-inspired flapping-sliding integrated aircraft with a 1.3 kg takeoff weight, capable of cruising steadily under Level 5 winds, floating on water at 0.5 m/s, and performing sliding water landings. An active wing root torsion mechanism is designed to realize synchronous and differential torsion of wings, improving the aircraft's wind resistance and maneuverability. A passive opening-closing webbed foot mechanism is developed to provide water propulsion. Prototype tests show that the adjustable torsion angle of the active wing root torsion mechanism ranges from approximately -1.5° to +4.0°. Differential torsion produces effective rolling moment, whereas synchronous torsion optimizes the lift-drag ratio during gliding. The periodic average thrust of the webbed foot mechanism reaches 103.5 gram-force, which fully meets the water propulsion requirements. The flat-arched bottom fuselage has a draft of approximately 42 mm at a displacement of 1.3 kg, and excellent floating stability with maximum heeling angle of about 20°. The glide locking mechanism locks the wings at a dihedral angle of 7.5°. Integrating the active wing root torsion and passive webbed foot mechanisms, this design supports both aerial flight and water cruising. It lays a technical foundation for amphibious bionic flapping-wing aircraft development.
16:15-16:30 Aug.19	**CR056:** A Multi-agent Cooperative Harvest-Transport Operation System Based on the "Cloud-Edge-Device" Architecture **Presenter:** ***Rongxuan Li,*** Shihezi University, China

	Authors: ***Rongxuan Li, Lijiao Gong, Yujie Li*** **Abstract:** To address the bottlenecks of difficult capacity matching and delayed dynamic scheduling in multi-machine cooperative harvest-transport operations within smart agriculture, this paper proposes a multi-agent cooperative operation system based on the "cloud-edge-device" architecture, achieving "global optimization-local perception" closed-loop control. On the cloud side, the system establishes a cooperative scheduling model aimed at minimizing the total operation time and designs a chaotic spiral dung beetle optimization (CSDBO) algorithm for the efficient solving of path planning and resource allocation. On the edge-device side, the system integrates multi-source sensing data such as LiDAR to achieve real-time environmental perception and autonomous obstacle avoidance for unmanned agricultural machine agents. Dual validations via simulations and agricultural machine agent experiments demonstrate that under constrained working conditions facing transport capacity bottlenecks, the proposed system achieves efficient software-hardware collaboration. Specifically, the embedded CSDBO algorithm reduces the total system operation time by 15.73% compared to the basic DBO algorithm, significantly enhancing the operation efficiency and adaptive scheduling capability of multi-machine cooperation.
16:30-16:45 Aug.19	**CR059:** Model-Free Policy Iteration–Q Learning Based Prescribed Performance Optimal Tracking Control of T–S Fuzzy Hindmarsh–Rose Neuronal Systems Under DoS Attacks **Presenter:** ***Kathiresan Sivakumar,*** Nazarbayev University, Kazakhstan **Authors:** ***Kathiresan Sivakumar, Rakkiyappan Rajan, Ardak Kashkynbayev*** **Abstract:** This paper addresses a model-free optimal tracking control problem for Hindmarsh–Rose (HR) neuronal systems under prescribed performance constraints and denial-of-service (DoS) attacks. The nonlinear HR dynamics are represented via a Takagi–Sugeno (T–S) fuzzy framework to enable discrete-time formulation, while the controller is designed without requiring explicit system matrices. A prescribed performance function (PPF) guarantees that the tracking error evolves within predefined transient and steady-state bounds. Through error transformation, the constrained tracking problem is reformulated as an unconstrained optimal regulation problem in the transformed space. A deterministic Successive Over-Relaxation–based Scaling Policy Iteration Q-learning (SPI–Q) algorithm is developed to solve the resulting optimal control problem. The method employs a relaxed Bellman operator that preserves the optimal Q-function as its unique fixed point and establishes contraction properties to ensure convergence. Unlike conventional policy iteration schemes, the proposed approach does not require an initial admissible or stabilizing policy. Closed-loop stability is rigorously proven via Lyapunov analysis under a detectability condition, guaranteeing asymptotic convergence of the transformed tracking error. The framework is further extended to DoS-induced control packet dropouts through a switched system formulation, and explicit bounds on attack frequency are derived to ensure stability preservation. Simulation results validate that optimal tracking performance is achieved while strictly satisfying prescribed performance constraints, even under adverse DoS conditions.

16:45-17:00 Aug.19	**CR071:** Further Improved Stability Conditions and State Feedback Control Design for T-S Fuzzy System **Presenter:** ***JUN YONEYAMA,*** Aoyama Gakuin University, Japan **Author:** ***Jun Yoneyama*** **Abstract:** The paper attempts to obtain improved and relaxed stability conditions for Takagi-Sugeno(T-S) fuzzy systems. First, we consider the stability for T-S fuzzy systems. There have been many results on the stability of T-S fuzzy systems. However, these results are only sufficient conditions for the stability and there is still room to improve them. To this end, integrated membership function techniques are extended with some matrix relaxation methods and lead to obtain new improved stability conditions, which reduce conservativeness from the already existing stability conditions. This approach is one of so called multiple Lyapunov matrix approaches. It contains multiple slack matrices that find an appropriate Lyapunov function for a T-S fuzzy system. Based on such a obtained stability condition, we propose a state feedback control design scheme for T-S fuzzy systems. A state feedback controller in this paper is a type of non-Parallel Distributed Compensator(PDC). PDC has been used for a T-S fuzzy system as a standard controller. However, it was found out that a PDC stabilized a limited class of T-S fuzzy systems. Since our controller design conditions with non-PDC are less conservative and are applicable to a wider class of T-S fuzzy systems, they can make a stabilizing controller design for a wider class of T-S fuzzy systems. To illustrate the validity of our proposed control design, a numerical example is simulated and proves the validity our control design scheme. Finally, we give some remarks as a conclusion.
17:00-17:15 Aug.19	**CR076:** Upper-Limb Exoskeleton for Power Augmentation in Industrial Applications **Presenter:** ***Anel Saudanbekova,*** Nazarbayev University, Kazakhstan **Authors:** ***Miras Muratkanov, Ardana Utepbergen, Anel Saudanbekova, Aibek Niyetkaliyev*** **Abstract:** This paper presents the design, development, and control of a bilateral shoulder–elbow exoskeleton for enhancing worker endurance and reducing musculoskeletal strain during repetitive industrial tasks. Biomechanical inverse-dynamics mod-eling established assistive torque targets of 30–45 Nm at the shoulder and 15–20 Nm at the elbow. Iterative mechanical design produced a carbon-fiber-reinforced 4-bar linkage that closely replicates physiological scapulo-humeral motion. Actuation is provided by backdrivable CubeMars AK80-64 KV80 brushless motors powered by a custom 8S1P LiFePO4 battery pack. A robust, encoder-only state-machine controller implementing discrete PID control achieves real-time user-intent detection across four operational states—IDLE, ASSISTING, HOLDING, and RELEASED—without reliance on surface EMG, thereby avoiding calibration drift and electrode-placement sensitivity. Benchtop trials validate electrical efficiency across the full assistive torque range, while multi-subject fitting trials confirm flexible anthropometric adjustability.

17:15-17:30 Aug.19	**CR027:** Development of AI Helper in Higher Education in Kazakhstan: Video-Based Lecture Assistance **Presenter:** ***Nurkhat Zhakiyev,*** Harvard University, United States **Authors:** ***Dinara Abdukhamitova, Dauletkhan Bulanbayev, Daniya Seitzhaparova, Ruslan Omirgaliyev, Nurkhat Zhakiyev*** **Abstract:** This research investigates the design, development, and evaluation of a video-based artificial intelligence (AI) assistant aimed at enhancing accessibility, engagement, and personalized learning in higher education within Kazakhstan. Although AI adoption in universities worldwide continues to grow, many institutions still rely on passive online learning platforms that provide limited interactivity and lack efficient content navigation. This project addresses this issue by proposing a multimodal AI system that transforms passive video lectures into searchable, summarized, and interactive learning resources. The system integrates three core components: speech recognition (Whisper) to transcribe spoken content, optical character recognition (Tesseract) to extract visual text from slides, and natural language processing through the Ollama large language model (LLM) to generate summaries and context-aware responses. The study adopts a mixed-method approach, combining software engineering design with empirical evaluation to assess both technical performance and user experience. The system was implemented using Node.js and Python-based AI pipelines and tested on ten lecture videos across five academic disciplines. Quantitative data analyses demonstrated that the AI assistant achieved a transcription accuracy of 92.4%, OCR accuracy of 88.7%, and an average query response time of 1.9 seconds. Qualitative analysis indicated that the AI assistant has the potential to improve search efficiency and support self-paced, personalized learning in educational settings. The results suggest that multimodal AI technologies has the potential to act as a key enabler of Kazakhstan's Digital Qazaqstan strategy and modernization of the higher education sector.

Technical Session II(A)

Time	Content
13:30-13:45 Aug.19	**CR069:** Development of Robust Perovskite Quantum Dot–Polymer Composite Materials for Optical Tactile Sensing Applications **Presenter:** ***Mukhammadali Ibragim,*** Nazarbayev University, Kazakhstan **Authors:** ***Mukhammadali Ibragim, Danissa Sandykbayeva, Asylkhan Seitzhanov, Daryn Kenzhebek, Amir Yelenov, Madina Turmagambetova, Bektayir Tuleshov, Zhanat Kappassov, Annie N*** **Abstract:** Replicating human touch perception in robotic systems remains a critical challenge for applications ranging from industrial manipulation to surgical robotics. While optical tactile sensors offer advantages like high resolution and simpler data acquisition, conventional designs suffer from ambient light sensitivity, low image

	contrast, and spectral crosstalk from broad-emission markers. This work demonstrates a flexible optical tactile sensor that integrates metal halide perovskite quantum dots (PQDs) embedded within a protective polymer matrix. PQDs provide sharp, narrow-band fluorescence under ultraviolet excitation. This narrow emission concentrates optical energy, eliminating spectral overlap and allowing for easier feature extraction against ambient noise. The PQDs are encapsulated within a flexible polymer matrix to reduce their sensitivity to moisture and oxygen, thereby producing durable luminescent markers capable of enduring repeated mechanical deformations. This design enables high-contrast force mapping with minimal interference, providing a reliable materials platform for high-resolution tactile sensing in robotic systems.
13:45-14:00 Aug.19	**CR026*:** Design and Prototype Manufacturing of End-Effectors Specific to the Guide-Pulling Task in Open-Source SCARA Robots **Presenter:** ***Güllü Akkaş,*** Kayseri Univesity, Türkiye **Authors:** ***Güllü Akkaş,Gültekin Uzun,Ercan Karaköse,İhsan Korkut*** **Abstract:** An open-source SCARA robot design was selected for use in the study. This robot has been customised for the guide pulling operation, which is one of the manufacturing processes. It has thus been transformed into a task-oriented system. This robot, which has an open-source mechanical and control infrastructure, has been structurally examined, and a number of task-specific modifications have been planned. At the forefront of these modifications is the end-effector design. A significant portion of the robot was manufactured using additive manufacturing methods. This resulted in a new industrial robot prototype capable of drilling holes. In this context, the expected original value of this study is the ability of open-source robot platforms to bring low-cost and accessible research opportunities to the industrial sphere.
14:00-14:15 Aug.19	**CR038*:** Design and Development of an Eco-Friendly 3D Concrete Extrusion Nozzle with In-Nozzle Admixture Dosing and Continuous Mixing **Presenter:** ***Joaquin Velarde-Yaranga,*** Universidad Peruana de Ciencias Aplicadas, Peru **Authors:** ***Joaquin Velarde; Gianpiero Huaricapcha; Miguel Lara; Camila Sulen*** **Abstract:** Extrusion-based 3D concrete printing (3DCP) has demonstrated significant potential for automated and material-efficient construction; however, achieving both high resolution and structural reliability remains a major challenge. Limitations such as inconsistent extrusion flow, uncontrolled setting kinet-ics, and filament deformation continue to restrict applications requiring precision and durability. To address these issues, this paper presents the conceptual design of an extrusion nozzle in-corporating in-nozzle admixture injection and continuous mixing. The proposed system enables the introduction of a rapid-setting accelerator directly into the mortar stream near the outlet, where an internal mixing element promotes homogeneous blending immediately prior to deposition. This approach aims to enhance buildability and surface quality by controlling setting behavior at the point of extrusion, without compromising pumpability. In ad-dition, the system is conceived to be compatible with eco-friendly cementitious mixtures, including

	formulations incorporating 10%eggshell ash as a partial replacement of Portland cement. This contributes to reduced environmental impact and aligns with sustainable development goals related to industry innovation and responsible consumption (SDG 9 and SDG 12). The study integrates CAD modeling, analytical formulations, and compu-tational fluid dynamics (CFD) simulations to evaluate internal flow behavior and mixing performance. The proposed framework establishes a foundation for future experimental validation and the development of adaptive 3D concrete printing systems capable of producing high-quality and structurally reliable components using sustainable materials.
14:15-14:30 Aug.19	**CR053*:** Research on Robot Path Planning Based on Multi-Strategy Improved RRT* Algorithm **Presenter:** ***Yucong Yang,*** Shenyang University of Technology, China **Authors:** ***Yucong Yang, Qianlong Jin, Mengfei Ge, Zhongxu Qin*** **Abstract:** To tackle challenges like route redundancy, prolonged computation duration, and convoluted paths within the RRT* algorithm for robot path planning, this research proposes a multi-strategy enhanced APF-RRT* algorithm termed MSAP-RRT*. In order to decrease the number of sampling points and increase the effectiveness of path planning, this method first combines the RRT* algorithm with a dynamic target-biased sampling strategy. Second, to improve the repulsive potential field function in the artificial potential field, obstacle density and the target distance adjustment factor are contained. This enables real-time adjustment of the repulsive force magnitude to improve the quality of path planning. To speed up convergence and cut down on running time, an adaptive step size method based on obstacle density and target distance adjustment factor is then presented. Lastly, cubic B-spline curves and greedy pruning are combined to optimize the original path, reducing its length and enhancing its quality. Simulation comparative analyses conducted in typical scenarios show that the MSAP-RRT* algorithm reduces the average path length by 6.49%, the average runtime by 82.10%, the average number of nodes by 90.70%, and the average number of iterations by 85.20% when compared to the improved APF-RRT* algorithm. Robots are strongly guaranteed to create safe and effective routes in areas with lots of obstacles according to the MSAP-RRT* algorithm.
14:30-14:45 Aug.19	**CR065*:** A Lightweight Two-Stage Hierarchical Decoupled Terrain Recognition Framework for Lower-Limb Exoskeletons **Presenter:** ***Qiliang Zhang,*** University of Shanghai for Science and Technology, China **Authors:** ***Qiliang Zhang, Tianyu Xu, Jingsen Zhang, Zhipeng Zou, Yitian Han, Yuling Zhang， Hongliu Yu, and Qiaoling Meng*** **Abstract:** Lower-limb exoskeletons require lightweight terrain perception to support terrain-adaptive locomotion assistance. Existing methods mainly focus on coarse terrain classification, while fine-grained terrain parameters such as stair height are less explored. This paper proposes a lightweight two-stage hier-archical decoupled terrain recognition framework for lower-limb exoskeletons using a single VL53L5CX depth sensor. In the first stage, a CNN-based classifier performs coarse

	terrain recognition among level ground, stair ascent, stair descent, and others. In the second stage, a CNN-based regressor further estimates stair height for stair-ascent scenes. Field experiments show that the first-stage network achieves an overall terrain-recognition accuracy of 96.9%. The second-stage network achieves a stair-height prediction MAE of 0.47 cm, outperforming an MLP baseline with a MAE of 0.62 cm. The proposed method can run on an STM32F407 microcontroller, demonstrating its feasi-bility for lightweight embedded terrain perception in lower-limb exoskeletons.
14:45-15:00 Aug.19	**CR072*:** Towards a Modular Bin-picking Framework for Handling Object Pose Uncertainties **Presenter:** ***Frederik Hagelskjaer,*** University Of Southern Denmark, Denmark **Author:** ***Frederik Hagelskjaer*** **Abstract:** In recent years, there has been growing interest in robust robotic systems for precise bin-picking applications. To achieve reliable performance, such systems must address errors arising from both the object pose estimation and the grasping process. Although various approaches have been proposed, they typically target specific challenges and do not offer general solutions. In this paper, we present a modular framework that jointly handles both error types. The framework incorporates object pose distribution estimation to account for pose uncer-tainty, which frequently arises in situations with ambiguous observations where a single correct pose cannot be determined. To further reduce uncertainty, we introduce a second-viewpoint module that computes complementary pose distributions, which are subsequently fused. This fusion decreases overall uncertainty and improves system efficiency. Additionally, two independent modules are included to compensate for grasping errors. The modular design allows the components to be combined for optimal performance or used individually, depending on the physical setup. The proposed method is evaluated in a real-world setup with three different objects, with no errors, and all modules are shown to improve efficiency. These results suggest that incorporating pose distributions with grasping pose errors is a promising direction for developing more flexible and reliable robotic production systems. To the best of our knowledge, this is the first framework that jointly addresses both grasping and object pose uncertainties using interchangeable modules. We believe there is ample op-portunity to integrate additional modules, resulting in improved performance and flexibility. The current framework is limited to pose uncertainties in SO(2), but it could be extended to SE(3), enabling additional modules to improve the system.

Technical Session II(B)

Time	**Content**

16:00-16:15 Aug.19	**CR077*:** Application of Machine Learning Methods for Leak Localization in Main Pipelines Based on Pressure Differential Analysis **Presenter:** ***Nurbol Shmitov,*** L.N. Gumilyov Eurasian National University, Kazakhstan **Authors:** ***Nurbol Shmitov, Dana Satybaldina, Nurdaulet Teshebayev, Korlan Kulniyazova, Aina Zakarina, Nurgul Kissikova*** **Abstract:** Oil and gas pipeline systems are critical infrastructure that require reliable and accurate leak monitoring to ensure safe and efficient operation. This study investigates the influence of hydraulic parameters on leak localization accuracy using machine learning techniques. A simulation model of a 110-km main oil pipeline was developed in MATLAB Simulink with the Simscape Fluids library to generate datasets for leak flow rates ranging from 40 to 148 L/min. Pressure measurements from five monitoring points were used to evaluate hydraulic input features under previously unseen leak flow conditions. A Random Forest model was employed to analyze the importance of absolute pressures, pressure differentials, and leak flow for leak localization. Results showed that absolute pressure values alone provided poor localization accuracy, whereas pressure differential features substantially improved prediction performance, reducing the root mean square error by 92.7%. Feature importance analysis identified a reduced input set consisting of the leak flow rate and two pressure differentials, enabling accurate localization with fewer measurement channels. Among the evaluated machine learning algorithms, CatBoost achieved the best performance with an RMSE of 1.92 km and an R^2 of 0.981. Additional validation under transient pump operation confirmed the applicability of the proposed pressure-differential-based approach beyond steady-state conditions.
16:15-16:30 Aug.19	**CR092*:** Dynamic Modeling and Collision Simulation Analysis of a Rigid-Soft Coupled Underwater Snake Robot **Presenter:** ***Fei Gao,*** Dalian Maritime University, China **Authors:** ***Fei Gao, Yinglong Chen, Xingtian Xiao,Bo Yan*** **Abstract:** Addressing the operational demands in complex underwater environments, this paper constructs a collision dynamics model for the ResqSerpent, a rigid-soft coupled underwater snake robot. The Lagrange method is employed to derive the system's energy and generalized forces, and an analytical collision model is established by incorporating nonlinear contact theory. Based on MATLAB/Simulink simulations, the kinematic responses and macroscopic energy dissipation mechanisms under various conditions are comprehensively analyzed. The results demonstrate that soft joints effectively absorb and dissipate longitudinal impact energy, substantially reducing transient acceleration in posterior modules to protect internal components. Decreasing the collision incidence angle significantly reduces normal forces and energy loss, enhancing maneuvering safety in confined spaces. Furthermore, actively reducing joint stiffness increases structural buckling deformation and prolongs buffering time, effectively mitigating peak transient collision forces. This research provides a critical theoretical reference for the crash-resistant design and safe control of rigid-soft coupled underwater robots.

16:30-16:45 Aug.19	**CR094*:** Hybrid Adaptive PINN–EKF Estimation for Sparse-Measurement UAV Pitch Dynamics under Parameter Mismatch **Presenter:** ***Alibi Sansyzbay,*** Nazarbayev University, Kazakhstan **Authors:** ***Zhansha Ansagan, Mukhammed Zhumali, Alibi Sansyzbay, Gulnara Bektemyssova, Akbota Akim, Saltanat Nuralykyzy*** **Abstract:** The pitch rate is unknown, and the restoring co-efficient γ = mgl can also be unknown and biased in the estimator. A hybrid adaptive-PINN-to-EKF method is proposed to solve this problem. In the first stage, an adaptive PINN is used to reconstruct the hidden pitch rate and, at the same time, to adaptively estimate the unknown physical parameter γ from angle-only noisy measurements. The learned parameter is then used as prior knowledge in the second stage, namely the Extended Kalman Filter (EKF) stage, to obtain a PINN-corrected EKF, where the hidden pitch rate is accurately and efficiently tracked. Three different pitch-input excitation profiles, random measurement realizations, biased values of the model parameter γ, and several ablation variants are used to evaluate the proposed method. We found that the learned parameter γ can be identified with a mean relative error of about 0.7%–1.1%. Using the PINN-corrected EKF to track the hidden pitch rate under biased γ, the root mean square error is about 0.028–0.029 rad/s. This is lower than that of the biased-parameter EKF and also lower than that of the adaptive PINN used alone. However, when the EKF is used with the exact known parameter, its performance is very competitive. The proposed adaptive-PINN-based method is therefore most useful when the physical parameter is uncertain, not when the model is exact.
16:45-17:00 Aug.19	**CR093*:** Development of a Digital Twin for Automated Production of Ayran and Sary Irimshik Based on SCADA and IoT Technologies **Presenter:** ***Nurzhan Zhumakhan,*** Almaty Technological University, Kazakhstan **Authors:** ***Mariam Alimardanova Nurzhan Zhumakhan Kulzhan Togzhanova Dinara Tlevlessova*** **Abstract:** The food industry is increasingly adopting Industry 4.0 technologies to improve product quality, production safety, and energy efficiency. This study presents the development of a digital twin for the automated production of traditional national dairy products, namely ayran and sary irimshik. The proposed system integrates Internet of Things (IoT) sensors, programmable logic controllers (PLC), SCADA software, and mathematical models into a unified cyber-physical production environment. The digital twin combines physical process models with real-time process data collected from temperature, pH, pressure, flow rate, level, and viscosity sensors. Mathematical models describing heat transfer, homogenization, fermentation kinetics, coagulation, drying, and moisture migration were developed to simulate the technological process. A model predictive control (MPC) strategy was implemented to optimize fermentation temperature, homogenization pressure, and starter dosage while minimizing energy consumption and ensuring stable product quality. The automation architecture is based on an OWEN BE-U PLC, ONI operator panel, Modbus RTU communication protocol, and SCADA Owen Process Manager. The proposed system enables continuous monitoring of technological

	parameters, automatic control of processing equipment, alarm management, and historical data storage. A hybrid digital twin architecture was developed to support predictive control and process optimization under varying raw material conditions.

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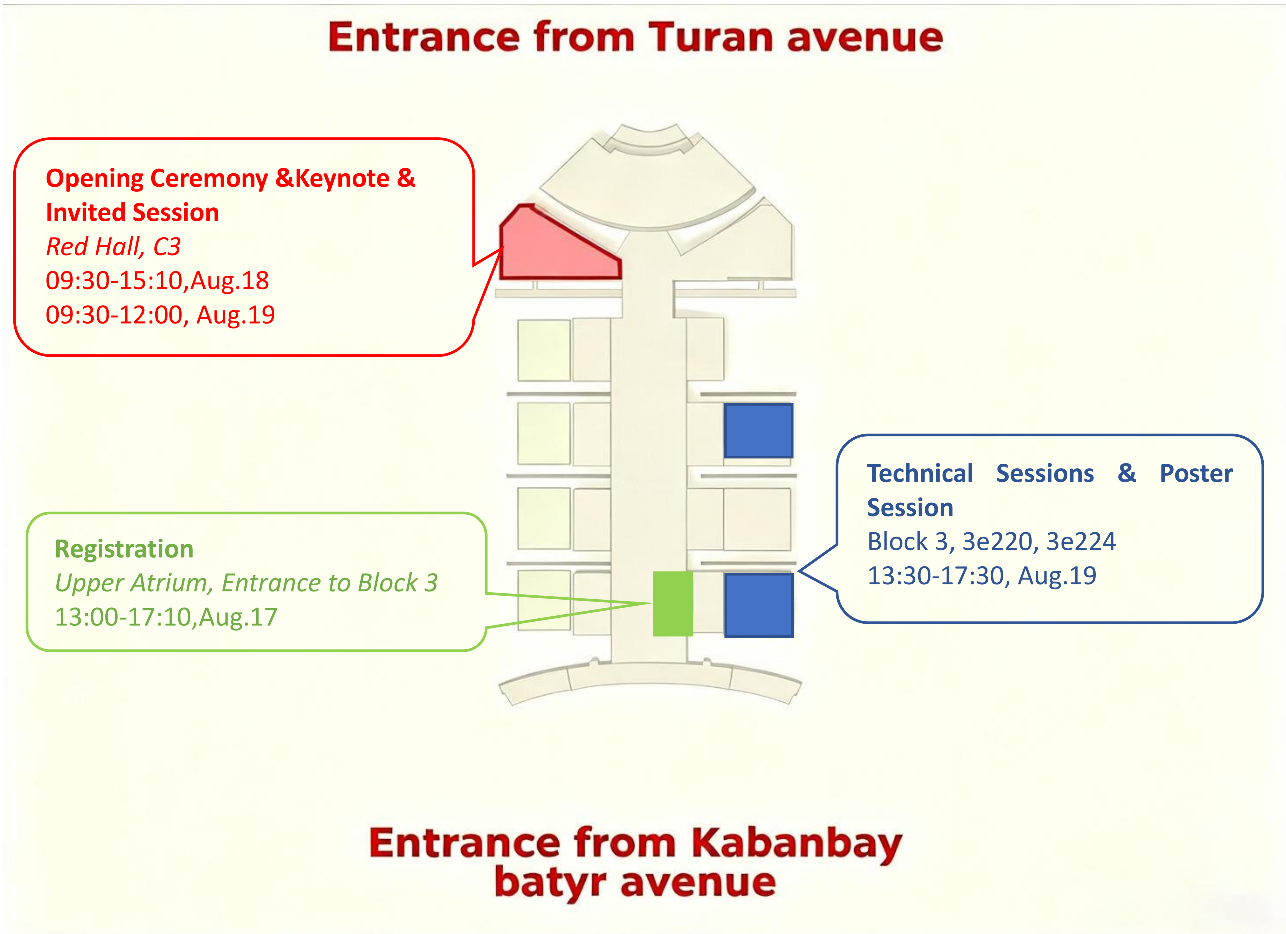

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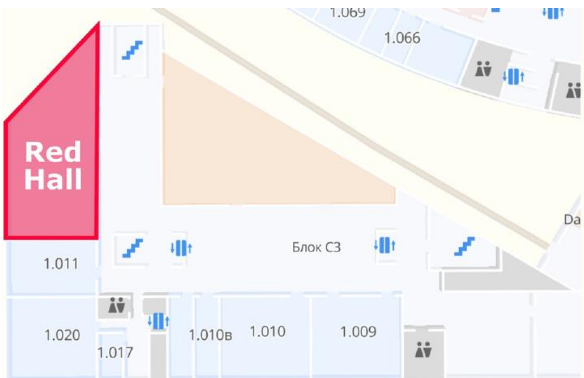

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