2025 3rd International Conference on Control and Robot Technology (ICCRT 2025)

Workshop: 2025 7th International Conference on Mechatronics Systems and Control Engineering

April 16-18, 2025

NTU@one-north Executive Centre (ONEC)

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Welcome Message

On behalf of the organizing committee, it is our great honor and pleasure to welcome you to attend the 2025 3rd International Conference on Control and Robot Technology (ICCRT 2025) and its workshop--2025 7th International Conference on Mechatronics Systems and Control Engineering, held in Singapore during April 16-18, 2025.

ICCRT 2025 brings together leading experts, researchers, and practitioners from around the globe to share cutting-edge advancements, innovative ideas, and collaborative insights in the fields of Control and Robot Technology, Mechatronics Systems and Control Engineering. This conference serves as a premier platform for fostering interdisciplinary discussions, exploring emerging technologies, and addressing the challenges and opportunities in these rapidly evolving domains.

We are delighted to host this event at the prestigious NTU@one-north Executive Centre (ONEC), a hub of academic excellence and innovation.

Over the course of three days, you will have the opportunity to engage in keynote speeches, technical sessions, workshops, and networking events, all designed to facilitate knowledge exchange and collaboration. We are confident that the diverse perspectives and expertise represented here will lead to meaningful discussions and groundbreaking outcomes.

On behalf of all the conference committees, we would like to thank all the authors as well as the technical program committee members and reviewers. Their high competence, their enthusiasm, their time and expertise knowledge, enabled us to prepare the high-quality final program and helped to make the conference become a successful event.

We wish you a productive, inspiring, and enjoyable conference experience. Welcome to ICCRT 2025!

ICCRT 2025 Organizing Committee
April 2025

Conference Committees

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Guideline for Onsite Attendance

Important Notes

- Please enter the meeting room at least 15 minutes before your session. Your punctual arrival and active involvement will be highly appreciated.
- Please wear your name tag for all the conference activities. Lending it to others is not allowed. If you have any companying person, please do inform our staff in advance.
- Please keep all your belongings (laptop and camera etc.) at any time. The conference organizer does not assume any responsibility for the loss of personal belongings.
- Please show name tag and meal coupons when dining.
- Due to force majeure including but not limited to earthquake, natural disaster, war and country policy, the organizer reserves the rights to change the conference dates or venue with immediate effect and takes no responsibility.

Oral & Poster Presentation

- Regular oral presentation: 15 minutes (including Q&A).
- Get your presentation PPT or PDF files prepared. Presentations MUST be uploaded at the session room at least 15 minutes before the session starts.
- Laptop (with MS-Office & Adobe Reader), projector & screen, laser pointer will be provided in all oral session rooms.
- Poster Presenters should bring your poster to the conference venue and put it on designated place.

Guideline for Online Attendance

Platform: ZOOM

- Step 1: Download ZOOM from the link: https://zoom.us/download

How to use ZOOM

* A Zoom account is not required if you join a meeting as a participant, but you cannot change the virtual background or edit the profile picture.

- Rename: Before you enter the conference room, please change your name to Paper ID + Name
- Chat and raise your hand: During the session, if you have any questions, please let us know by clicking “raise your hands” and use “chat” to communicate with conference secretary.
- When you deliver your online speech, please open your camera.
- During the Question section, if you have any questions about keynote speakers or authors, you can also click “raise your hands” or “chat”
- Share Screen: Please open your power point first, and then click “share screen” when it’s your turn to do the presentation.

How to join the conference online

- Find your paper ID and suitable meeting ID on the conference program.
- Open the ZOOM, click the join, paste the meeting ID, then you can join the conference.
- Click the stop share after you finish your presentation

Time Zone

- **Singapore Standard Time (GMT+8)**

Device

- A computer with an internet connection (wired connection recommended)
- USB plug-in headset with a microphone (recommended for optimal audio quality)
- Webcam: built-in or USB plug-in

Online Room Information

Online Room Information

Zoom ID: **87114719359**

Zoom Link: **https://us02web.zoom.us/j/87114719359**

* Please rename your Zoom Screen Name in below format before entering meeting room.

Role	Format	Example
Conference Committee	Position-Name	Conference Chair-Prof.
Keynote/ Invited Speaker	Position-Name	Keynote/Invited Speaker-Prof.
Author	Session Number-Paper ID-Name	S1-SR0001/MC0001-Name
Delegate	Delegate-Name	Delegate-Name

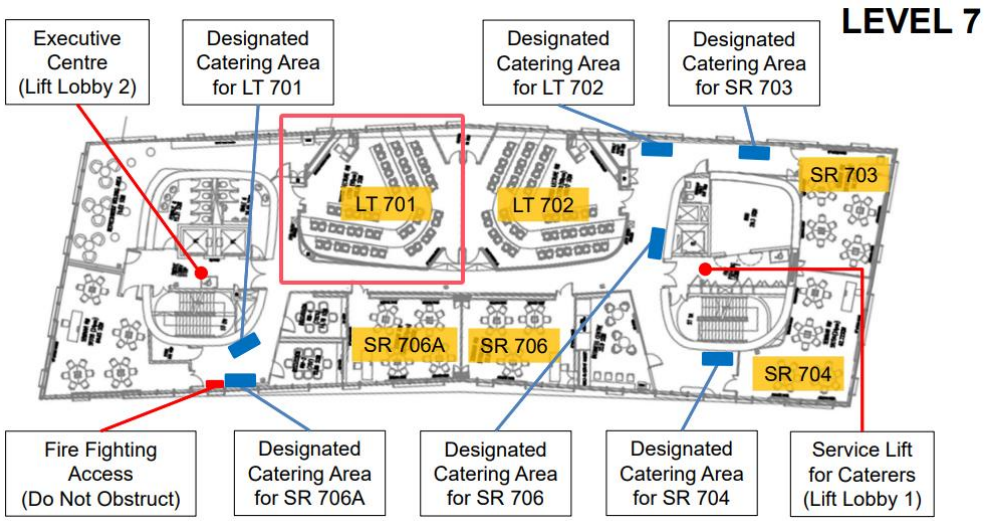
Conference Venue

NTU@one-north Executive Centre (ONEC)
https://www.ntu.edu.sg/life-at-ntu/leisure-and-dining/ntu@one-north
Address: 11 Slim Barracks Rise(off North Buona Vista Road), one-north Executive Centre #09-01, Singapore 138664

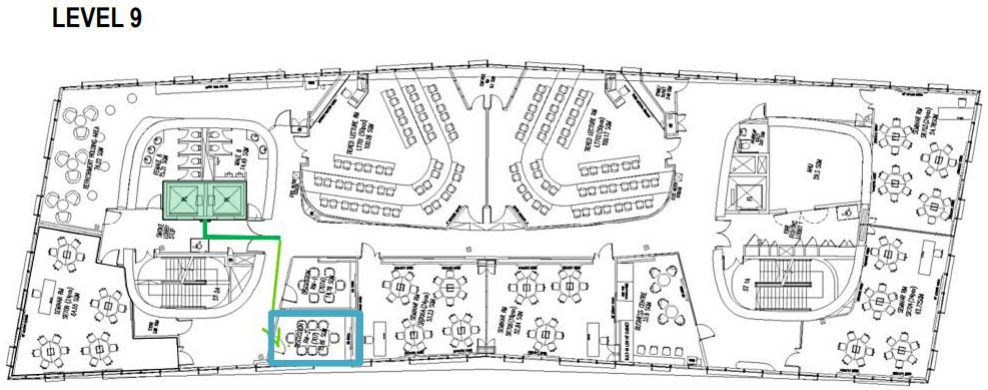
Directions by car: Nearest expressway: AYE
Directions by train: Buona Vista MRT (EW21/CC22), Approximately 5 minutes' walk

The organizer doesn't provide accommodation, and we suggest you make an early reservation.

Conference Rooms Directions



LT701 is the conference room on April 17, 2025.



DR907 is for onsite registration on April 16, 2025 only.

To get to DR907, please take the lift from lift lobby 2. Then enter the glass door, sharp turn right and you will see DR907 on the left.

Simple Program

April 16, 2025 (Wednesday)

Onsite Registration

Registration Time: 13:00-16:00
Venue: NTU@one-north Executive Centre (ONEC) **Conference Room: Discussion Room 907 (DR907)**
Address: 11 Slim Barracks Rise (off North Buona Vista Road), one-north Executive Centre #09-01, Singapore 138664
1. Arrive at the Discussion Room 907 (DR907), NTU@one-north Executive Centre (ONEC); **2. Inform the conference staff of your paper ID;** **3. Sign your name on the Participants list;** **4. Sign your name on Lunch & Dinner requirement list;** **5. Check your conference kits;** **6. Finish registration.**

Online Test
Time Zone: GMT+8

Online Test **Zoom ID:** 87114719359 **Link: https://us02web.zoom.us/j/87114719359**	**Duration**
Prof. Maria Pia Fanti	15:00-15:10
Assoc. Prof. Deepika Koundal	15:10-15:20
Session 3: SR0004, SR0006, MC0006-A, MC0004, SR0040, MC0001	15:20-15:50

Note: If you not available from 15:00 to 15:50 on April 16, please contact your conference secretary.

April 17, 2025 (Thursday)

Morning Sessions **Venue: NTU@one-north Executive Centre (ONEC) Room: LT701**		**Duration**
Opening Remark	Assoc. Prof. Ming Xie, Nanyang Technological University, Singapore	9:30-9:35
Keynote Speech 1	Prof. Marcelo H. ANG Jr, National University of Singapore, Singapore Speech Title: Robots in Everyday Life	9:35-10:15
Keynote Speech 2	Prof. Hisato KOBAYASHI (IEEE Life Fellow), Emeritus Professor in Hosei University, Japan Speech Title: Robots and Human Society	10:15-10:55
Group Photo & Coffee Break		**10:55-11:10**
Keynote Speech 3	Prof. Wei-Hsin Liao, The Chinese University of Hong Kong, China Speech Title: Mechatronics and Control of Robotic Exoskeletons for Human Augmentation	11:10-11:50
Invited Speech 1	Dr. ZHANG Hongying, National University of Singapore, Singapore Speech Title: Enhancing Mechanical Intelligence of Soft Robots through Smart Structural Design	11:50-12:10
Lunch at the Conference Room		**12:10-13:30**

Afternoon Sessions Venue: NTU@one-north Executive Centre (ONEC) Room: LT701		
Session 1	Topic: Robotics and Kinematic Analysis Session Chair: Prof. Hisato KOBAYASHI (IEEE Life Fellow), Emeritus Professor in Hosei University, Japan Presentations: SR0005, SR0009, SR0011, SR0013, SR0031, SR1005, SR0008, MC0005	13:30-15:15
Coffee Break		**15:15-15:30**
Session 2	Topic: Visual based intelligent control system and monitoring technology Session Chair: Prof. Shenshen Gu, Shanghai University, China Presentations: SR0012, SR0018, SR0020-A, SR0022, SR0036, SR0037, SR1006, SR0030	15:30-17:15
Dinner at PNI-One North		**18:00-20:00**

Note:

(1) One Best Presentation will be selected from each presentation session, and the Certificate for Best Presentation will be awarded at the end of each session by Session Chairs.

(2) Regular each Presentation: about 15 Minutes including 2-3 Minutes for Question and Answer.

April 18, 2025 (GMT+8)

Afternoon Sessions		Duration
Online Speeches and online session **Zoom ID: 87114719359** **Zoom link: https://us02web.zoom.us/j/87114719359**		
Keynote Speech 4	Prof. Maria Pia Fanti (IEEE Fellow), Polytechnic University of Bari, Italy Speech Title: Enhancing Integration of Cooperative, Connected and Automated Mobility for Passengers and Goods	15:00-15:40
Invited Speech 2	Assoc. Prof. Deepika Koundal, University of Petroleum and Energy Studies Speech Title: Transforming the Future: Automation and Sustainability through Computer Vision & Image Processing	15:40-16:00
Session 3	Topic: Intelligent control system and parameter analysis Session Chair: Assoc. Prof. Deepika Koundal, University of Petroleum and Energy Studies Presentations: SR0004, SR0006, MC0006-A, MC0004, SR0040, MC0001	16:00-17:30

Detailed Program

Opening Remark	
Time	**9:00-9:30, April 17, 2025**
Venue	**NTU@one-north Executive Centre (ONEC), Room: LT701**

Assoc. Prof. Ming Xie

Nanyang Technological University, Singapore

Xie Ming received the B.Eng degree in control and automation engineering from East-China Institute of Textile Technology (now, under the name of Donghua University, Shanghai, China). Subsequently, as a recipient of the nation's prestigious overseas scholarship of Chinese government, he has completed the postgraduate studies and doctorate research works, and has received the Master degree from the University of Valenciennes (France) in 1986 as well as the PhD degree from the University of Rennes (France) in 1989. Since 1986, he has worked as Research Assistant at IRISA-INRIA Rennes, Expert Engineer at INRIA Sophia-Antipolis, Lecturer/Senior Lecturer/Associate Professor of Nanyang Technological University, Fellow of Singapore-MIT Alliance (SMA) (Affiliated with Innovation in Manufacturing Systems and Technology Program), Guest Professor of Huazhong University of Science and Technology (2002, 2006), Professor awarded by China's Jiangsu Provincial Government (2014), and Dean of College of Electrical Engineering and Control Science at Nanjing Tech University (2014-2016). He was the General Chair of 2007 International Conference on Climbing and Walking Robots (CLAWAR), the General Chair of 2009 International Conference on Intelligent Robotics and Applications (ICIRA), the Co-founder of the International Journal of Humanoid Robotics (SCI/SCIE indexed), Co-founder of Singapore-China Association for Advancement of Science and Technology, Co-founder of Robotics Society of Singapore. He has taught the courses such as Robotics, Artificial Intelligence, Applied Machine Vision, Measurement and Sensing Systems, Microprocessor Systems, and University Physics. In terms of scientific research, he has authored three books in English, two books in Chinese, and two edited books in English. He has published several book chapters, over 10 patents of invention, over 40 research papers in scientific journals and over 100 research papers in international conferences. He was the recipient of one best conference paper award from World Automation Congress, the recipient of one best

conference paper award from CLAWAR, the recipient of one outstanding paper award from International Journal of Industrial Robot, the recipient of one Gold Prize (S$8K) from CrayQuest, the recipient of one Grand Champion Prize (S$15K) from CrayQuest, the recipient of one A-Star's Best Research Idea Prize (S$5K), the recipient of one Silver Medal from Dragon Design Foundation.

Keynote Speech 1

Host	Assoc. Prof. Ming Xie Nanyang Technological University, Singapore	**Time**	9:35-10:15, April 17, 2025
		Venue	NTU@one-north Executive Centre (ONEC), Room: LT701

Prof. Marcelo H. ANG Jr

National University of Singapore, Singapore

Marcelo H. Ang, Jr. received his BSc and MSc degrees in Mechanical Engineering from the De La Salle University in the Philippines and University of Hawaii, USA in 1981 and 1985, respectively, and his PhD in Electrical Engineering from the University of Rochester, New York in 1988 where he was an Assistant Professor of Electrical Engineering. In 1989, he joined the Department of Mechanical Engineering of the National University of Singapore where he is currently a Professor and the Founding Director of its Advanced Robotics Center. His research interests span the areas of robotics, mechatronics, autonomous systems, and applications of intelligent systems. He teaches robotics; creativity and innovation; applied electronics and instrumentation; computing; design and related topics. In addition to academic and research activities. He is also actively involved in the Singapore Robotic Games as its founding chairman, and the World Robot Olympiad as member of its Advisory Council. Some videos of his research can be found in: http://137.132.146.218/marcelo/videos/

Speech Contents

Speech Title: Robots in Everyday Life

Abstract: Over the years, robotics science and technology have expanded beyond their initial industrial applications in manufacturing to significantly influence sectors such as service, healthcare, education, and entertainment. Today, robots play an integral role in our everyday lives, operating in unstructured environments with a focus on human-centered interactions. They work alongside us, enhancing our quality of life. This talk will explore the latest advancements in the essential robotic capabilities of mobility and manipulability, as well as discuss the challenges that must be overcome to drive the next wave of the robotics revolution.

Keynote Speech 2

Host	Assoc. Prof. Ming Xie Nanyang Technological University, Singapore	**Time**	10:15-10:55, April 17, 2025
		Venue	NTU@one-north Executive Centre (ONEC), Room: LT701

Prof. Hisato KOBAYASHI (IEEE Life Fellow)

Emeritus Professor in Hosei University, Japan

Hisato Kobayashi got B.S., M.S., and D.E. degrees from Waseda University in 1974,1976 and 1979, respectively. He joined Hosei University in 1984. He is now a Professor Emeritus Hosei University. From 2001 to 2002, he was the founding president of Hosei University Research Institute, California. He was the Founding Dean of the Faculty of Engineering and Design from 2007 to 2008. He was a board member of the Robotics Society Japan (RSJ) from 1994 to 1996.

He was a board member of The Society of Instrument and Control Engineers (SICE) from 2002 to 2004 and the vice president from 2018 to 2020. He was editor-in-chief of Advanced Robotics, Journal of RSJ, from 1997 to 2002.

From 2003 to 2005, he was the chairman of the automatic control committee, Science Council Japan, and a member of Science Council Japan from 2006 to 2014. From 2010 to 2013, he was a Program Officer at the Japan Society for the Promotion of Science. Since 2008, he has been the chairman of the Standing Steering Committee IEEE International Conference on Robot and Human Interactive Communication.

He is an IEEE Life Fellow.

Speech Contents

Speech Title: Robots and Human Society

Abstract: In 1992, I founded the IEEE International Conference on Robots and Human Interactive Communication, the world's first international conference focused on robots and human society issues. This conference has been held annually for the past 33 years, and I continue to serve as the chairman of the standing steering committee.

Recently, there has been remarkable progress in robot hardware, which has brought to light the issues I envisioned when establishing the conference.

In this talk, we will discuss the appropriate situations for using robots in human society, particularly the social and ethical challenges that arise when robots become part of our daily lives. Since these issues related to robots and human society are universal, we will explore the methods that should be used to address them. What mechanisms need to be introduced to effectively solve these problems?

Robots can present many challenges, such as privacy violations, the potential for remote control via hacking, misjudgments made by artificial intelligence, and insurrection by robots acting in concert. Additionally, there are numerous problems related to investigating the causes of accidents and providing compensation for them. These issues cannot be resolved solely by the companies that manufacture the robot hardware or software, nor can they be handled exclusively by the countries in which these companies operate.

A fair and neutral global organization is necessary to tackle these common challenges faced by all of humanity. For instance, we might consider establishing a robotic version of the International Criminal Court (ICC), which would not only include traditional judicial experts but also specialists in robotics and artificial intelligence to help resolve these issues.

To facilitate accountability, it would be essential for a global organization to collect and securely store the design data and software source of robots prior to any incidents. It would also be important to mandate the maintenance of records regarding the operational status of robots for future verification.

There are many steps that need to be taken to integrate robots into our daily lives responsibly. In this lecture, we will discuss these issues in detail.

Keynote Speech 3

Host	Assoc. Prof. Ming Xie Nanyang Technological University, Singapore	**Time**	11:10-11:50, April 17, 2025
		Venue	NTU@one-north Executive Centre (ONEC), Room: LT701

Prof. Wei-Hsin Liao

The Chinese University of Hong Kong, China

Wei-Hsin Liao received his Ph.D. in Mechanical Engineering from The Pennsylvania State University, University Park, USA. Since August 1997, Dr. Liao has been with The Chinese University of Hong Kong, where he is Choh-Ming Li Professor of Mechanical and Automation Engineering. His research has led to publications of over 400 technical papers in international journals and conference proceedings, 27 patents. He was the Conference Chair for the 20th International Conference on Adaptive Structures and Technologies in 2009; the Active and Passive Smart Structures and Integrated Systems, SPIE Smart Structures/NDE in 2014 and 2015. He received the T A Stewart-Dyer/F H Trevithick Prize 2005, the ASME 2017 Best Paper Award in Mechanics and Material Systems, the ASME 2021 Energy Harvesting Best Paper Award, and the ASME 2023 Best Paper Award in Structural Dynamics and Control. He is the recipient of the 2020 ASME Adaptive Structures and Material Systems Award and the 2018 SPIE Smart Structures and Materials Lifetime Achievement Award. He is also the recipient of 2023 ASME Leonardo Da Vinci Award for the eminent achievement in the design and invention. Dr. Liao currently serves as an Associate Editor for Journal of Intelligent Material Systems and Structures, on the Executive Editorial Board of Smart Materials and Structures, and a Section Board Member of Machines. Dr. Liao is a Fellow of ASME, HKIE, and IOP.

Speech Contents

Speech Title: Mechatronics and Control of Robotic Exoskeletons for Human Augmentation

Abstract: Robotic exoskeletons are promising devices for motion assistance of mobility impaired patients and motor ability augmentation of healthy people. Considering the interactive action between exoskeletons and human body, a safe and comfortable human-exoskeleton interaction is essential to achieve effective exoskeleton operations for human motion assistance. We developed a novel cable-driven series elastic actuation (CSEA) system to realize a flexible and portable back-support exoskeleton design with safe, efficient, and sufficient assistive torque output capability. Meanwhile, this mechanism enables the CSEA system to integrate series elastic actuator (SEA) with cable transmission and operates with multiple statuses to leverage SEA advantages and to overcome its torque output limitation. A unified torque controller is designed for stable, continuous, and accurate torque control of the CSEA system despite its discontinuous dynamics during operation status transition. The efficacy of the closed-loop CSEA system to enable an ergonomic and efficient back-support exoskeleton actuation with the capability of accurately delivering desired level of assistance is verified via bench tests and human tests. Results verified that the CSEA system actuated exoskeleton can effectively reduce activity of relevant muscles during trunk flexion and extension motions compared to no exoskeleton case, validating successful application of the CSEA system on the exoskeleton for an effective back support effect. In this talk, the developed devices/systems and key results will be presented.

Keynote Speech 4 (Online)

Time	**15:00-15:40, April 18, 2025 (GMT+8)**
Zoom ID	**87114719359**
Zoom Link:	**https://us02web.zoom.us/j/87114719359**

Prof. Maria Pia Fanti (IEEE Fellow)

Polytechnic University of Bari, Italy

Maria Pia Fanti (IEEE Fellow and Fellow of the Asia-Pacific AIA) received the Laurea degree in electronic engineering from the University of Pisa, Pisa, Italy, in 1983. She was a visiting researcher at the Rensselaer Polytechnic Institute of Troy, New York, in 1999. Since 1983, she has been with the Department of Electrical and Information Engineering of the Polytechnic of Bari, Italy, where she is currently a Full Professor of system and control engineering and Chair of the Laboratory of Automation and Control. Her research interests include modeling and control of complex systems, intelligent transportation systems, smart logistics; Petri nets; consensus protocols; fault detection. Prof. Fanti has published more than +310 papers and two textbooks on her research topics. She was senior editor of the IEEE Trans. on Automation Science and Engineering and member at large of the Board of Governors of the IEEE Systems, Man, and Cybernetics Society. Currently, she is Associate Editor of the IEEE Trans. on Systems, Man, and Cybernetics: Systems, member of the AdCom of the IEEE Robotics and Automaton Society, and chair of the Technical Committee on Automation in Logistics of the IEEE Robotics and Automation Society. Prof. Fanti was General Chair of the 2011 IEEE Conference on Automation Science and Engineering, the 2017 IEEE International Conference on Service Operations and Logistics, and Informatics and the 2019 Systems, Man, and Cybernetics Conference.

Speech Contents

Speech Title: Enhancing Integration of Cooperative, Connected and Automated Mobility for Passengers and Goods

Abstract: This talk will present some approaches developed to accelerate the integration of innovative CCAM technologies and systems for passengers and goods in terms of design and implementation of enhanced physical, digital and operational infrastructures. In particular, the talk will show some innovative techniques for designing and applying traffic control methods such as signalized intersection management, route planning services and last mile delivery strategies. The used methodologies encompass global and distributed optimization, artificial intelligence techniques and simulation frameworks applied for a full integration of CCAVs in the real traffic for transportation of both passengers and goods. The talk will also describe some recent results obtained in case studies by simulation environments and in the field.

Invited Speech 1

Host	Assoc. Prof. Ming Xie Nanyang Technological University, Singapore	**Time**	11:50-12:10, April 17, 2025
		Venue	NTU@one-north Executive Centre (ONEC), Room: LT701

Dr. ZHANG Hongying

National University of Singapore, Singapore

Dr ZHANG Hongying joined the Department of Mechanical Engineering as a Lecturer in Mar 2021. She received her B.S. degree in Mechanical Engineering from the Huazhong University of Science and Technology (HUST), China, in 2013. She began her doctoral research at the Chinese University of Hong Kong (CUHK) in the same year. Following her research supervisor, she then joined the National University of Singapore (NUS) to continue her PhD study in 2014 after a year of study in Hong Kong. At NUS, she worked on design, analysis, and manufacturing of topology-optimized soft robots and wearable dielectric sensors. Sponsored by the Facebook Virtual Reality Lab, Dr Zhang joined Prof Jamie Paik's group (Reconfigurable Robotics Laboratory) at the École Polytechnique Fédérale de Lausanne (EPFL) as a postdoctorate researcher in 2018. At EPFL, Dr Zhang has led the work on developing methodologies to analyze novel origami robots, designing origami-inspired metamaterials, and designing new functional origami patterns. Dr Zhang has more than 17 publications in high-impact journals and conferences including Soft robotics, IEEE/ASME Transactions on Mechatronics, IEEE Robotics and Automation Letters, Extreme Mechanics Letters, Materials and Design, ICRA, IROS, MSEC, etc.

Speech Contents

Speech Title: Enhancing Mechanical Intelligence of Soft Robots through Smart Structural Design

Abstract: This seminar explores smart structural designs to enhance the mechanical intelligence of soft robots, facilitating their transition from laboratory prototypes to practical applications in industrial and healthcare settings. Celebrated for their dexterity and safe interactions, soft robots still face significant challenges like standardization, motion accuracy, durability, and payload capacity. We will discuss two promising approaches to overcome the challenges: LEGO-like origami robots and muscular-skeletal systems.

Origami folding enables the creation of modular soft actuators that replicate rigid robot motions—translation, bending, and twisting—allowing for LEGO-like assembly with high motion accuracy. We developed soft actuators capable of over 10,000 cycles of repeatable high-accuracy motion, and an optimization-based inverse design algorithm for assembling these actuators into functional robotic systems, such as robotic arms and bipedal walking robots. Inspired by the human arm, we have created a muscular-skeletal arm composed of a large scale of origami-based artificial muscles and a rigid skeletal structure, controlled by a compact pneumatic controller, PneuChip. The PneuChip is able to control n^2 soft muscles through 2n input signals to generate 2^2n-2^(n+1)+2 independent configurations.

The seminar will also cover the reconfigurability, ultra-lightweight, and high deploy-to-store ratio nature of origami structures, making them ideal for designing innovative robots and mechanical metamaterials. Examples include a shape-changing robot for ground coverage tasks, an ultra-lightweight metamaterial supporting over 2,700 times its weight, and an oscillating flasher with pure expansion for deployable robots. This seminar aims to inspire new designs in soft robotics, advancing their mechanical performance and broadening their real-world applicability.

Invited Speech 2 (Online)

Time	**15:40-16:00, April 18, 2025 (GMT+8)**
Zoom ID	**87114719359**
Zoom Link:	**https://us02web.zoom.us/j/87114719359**

Assoc. Prof. Deepika Koundal

University of Petroleum and Energy Studies

Deepika Koundal is currently associated as an Associate Professor with University of Petroleum and Energy Studies, Dehradun and Adjunct Professor in Ho Chi Minh City Open University, Vietnam. She is listed as world's top 2% researcher and has received the recognition and honorary membership from Neutrosophic Science Association from University of Mexico, USA. She is the awardee of best paper award by Journal of visual communication and image representation – Elsevier in 2023. She is also selected as a Young scientist in 6th BRICS Conclave by NIAS-DST in 2021. She is the awardee of research excellence award given by UPES in 2022, 2023 and by Chitkara University in 2019. She received the Master and Ph.D. degrees in computer science & engineering from the Panjab University, Chandigarh in 2016. She has published more than 80 research articles in reputed SCI and Scopus indexed journals, conferences, two patents and four books. She is also serving as Associate Editor in IEEE Transaction in Artificial Intelligence, Healthcare Analytics, BMC Medical Imaging, Plos One, Supply Chain Analytics and International Journal of Computer Applications. She also has served on many technical program committees as well as organizing committees and invited to give guest lectures and tutorials in Faculty development programs, international conferences and summer schools. Her Areas of Interest are Artificial Intelligence, Biomedical Imaging and Signals, Image Processing, Soft Computing, Machine Learning/ Deep Learning. She has also served as reviewer in many repudiated journals of IEEE, Springer, Elsevier, IET, Wiley and Sage.

Speech Contents

Speech Title: Transforming the Future: Automation and Sustainability through Computer Vision & Image Processing

Abstract: In an era where technology is reshaping industries, Computer Vision and Image Processing play a pivotal role in driving automation and sustainability. These AI-powered technologies are revolutionizing sectors such as manufacturing, agriculture, smart cities, healthcare, and energy by enabling intelligent automation while promoting environmental responsibility. This presentation explores the intersection of automation and sustainability through computer vision, highlighting key applications such as smart manufacturing, waste reduction, renewable energy optimization, traffic management, and precision agriculture. Additionally, it addresses challenges, emerging trends, and the role of AI-driven solutions in fostering a greener, more efficient future. By leveraging deep learning, edge AI, and real-time image analysis, industries can achieve energy efficiency, resource optimization, and carbon footprint reduction, aligning with global sustainability goals. The session will also showcase real-world case studies, demonstrating how computer vision is reshaping automation while ensuring a sustainable future.

Session 1 (13:30-15:15)

Topic: Robotics and Kinematic Analysis
Session Chair: Prof. Hisato KOBAYASHI (IEEE Life Fellow),
Emeritus Professor in Hosei University, Japan
Time: 13:30-15:15, April 17, 2025
Venue: NTU@one-north Executive Centre (ONEC), Room: LT701

***Presenters are recommended to enter the meeting room 10 mins in advance.**
***Presenters are recommended to stay for the whole session in case of any absence.**
***After the session, there will be a group photo for all presenters.**

SR0005 (13:30-13:45)

Optical Object Localization and RRT Motion Planning for Human-Robot Collaboration

Alexander Arntz
University of Applied Sciences Ruhr West Institute of Computer Sciences, Bottrop, Germany

Abstract-In this paper, an approach for detecting objects and individuals to enable an industrial robot to conduct safe and reliable trajectories within a Human-Robot Collaboration (HRC) context is proposed. This implementation combines a depth camera image analysis and classification combined with a rapidly exploring random tree (RRT) motion planning algorithm, and a Particle Swarm Optimization (PSO) method to solve the inverse kinematics. The aim is to provide a solid framework for the HRC research community to conduct empirical studies with a robot arm. Apart from the concept itself and the technical implementation, the strengths and disadvantages of this method such as the calculations intensive trajectory planning process are discussed.

SR0009 (13:45-14:00)

On modelling and control of four cable suspended robots

Yassine Hajjej[1], Latifa Boutat-Baddas[2], Dominique Martinez[3], Maria Paula Huertas-Ninos[3], Assem Thabet[4] and **Mohamed Boutayeb[2]**
1: National Engineering School of Gabes, University of Gabes, Tunisia
2: University of Lorraine, Longwy, France
3: Aix-Marseille University, Marseille, France
4: MACS Research Laboratory, University of Gabes - Gabes, Tunisia

Abstract-In this note, we investigate the problem of modeling and controlling four-cable-

suspended robots during the motion of a platform carrying a given payload. Indeed, one of the challenges faced involves payload oscillations during motion. Initially, we elaborate on the dynamic model of the motion of the center of gravity of the platform-load assembly, which showcases this phenomenon. Subsequently, we establish an LQR type control law to achieve trajectory tracking where oscillations are reduced or eliminated. High performances of the proposed approach are shown through numerical simulations, including in the case of uncertain models.

SR0011 (14:00-14:15)

Design and Optimization of Gait Transition Control for Loaded Snake Robots Using CPG Algorithms

Junqi Mu[1,2], Xiaofeng Zong[1,2], Xuping Hou[1,2] and Yuanyuan Zhang[3]
1: China University of Geosciences, Wuhan, China
2: Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems, Wuhan, China
3: School of Aeronautics and Astronautics, Huazhong University of Science and Technology, Wuhan, China

Abstract-Inspired by the exceptional locomotive efficiency and adaptability of snakes across diverse terrains, this study employs a Central Pattern Generator (CPG) algorithm based on the Matsuoka oscillator model. Through fine-tuning of the CPG control parameters, the developed snake robot is capable of generating not only rhythmic undulatory motions but also a spectrum of distinct gaits, including rectilinear progression and accordion-like maneuvers. Leveraging the stability of the Matsuoka oscillator, the CPG endows the robot with the capacity to dynamically adapt to varying environmental conditions and mission-specific demands. The primary control parameters are optimized using genetic algorithms, facilitating seamless gait transitions. This research pioneers the application of this method to gait transformation in snake robots, with experimental valida- tion, thereby holding significant implications for advancements in the field.

SR0013 (14:15-14:30)

Tactile Contact Patterns for Robotic Grasping: A Dataset of Real and Simulated Data

Berith Atemoztli De la cruz Sánchez, Jennifer Kwiatkowski and Jean-Philippe Roberge
Command and Robotics Laboratory École de Technologie Supérieure Montreal, Québec, Canada

Abstract-Advancing tactile sensing in robotics and machine learning necessitates high-

quality datasets encompassing real- world and simulated interactions. In this paper, we present a comprehensive dataset containing 46,200 samples collected from a deformable, capacitive-based tactile sensor. The dataset is equally divided into three main groups: 15,400 real samples, 15,400 synthetic samples generated using Abaqus, and 15,400 synthetic samples generated using Isaac Gym through finite element analysis (FEA). Data acquisition was performed under two experimental scenarios. In the first scenario, 49 unique indenters were pressed onto the sensor at various force levels, producing various contact patterns. In the second scenario, the sensor was integrated into a 2F-85 Robotiq parallel gripper to grasp 12 different objects. We provide a detailed account of the dataset construction process, elaborate on its composition, and introduce a graphical user interface that enables the creation of customized datasets tailored to specific application needs. Ultimately, we present a case study employing Transfer Learning to exemplify the dataset's potential by utilizing real and synthetic data to recognize surface types (flat or curved), showcasing how synthetic data can be effectively leveraged alongside real data to enhance performance. To access the code and resources used in this research, all files are available in our GitHub repository at [TactileDataset](https://github.com/Lab-CORO/TactileDataset).

SR0031 (14:30-14:45)

Design and Implementation of Real-time Target Recognition System for FPGA-based Tennis Serving Robot

Yikai Wu, Tengfei Li, Yulong Ren, Reining Lei and **Shenshen Gu**
Shanghai University, Shanghai, China

Abstract-With the rapid development of artificial intelligence, object detection has become essential in fields like surveillance, autonomous driving, UAVs, and robotics. However, traditional methods often have high requirements for computational performance, limiting their deployment on edge devices. To address this issue, this paper proposes an FPGA-based object detection accelerator, which integrates stream architecture and DSP packing to improve computational efficiency and reduce latency. The detection model is efficiently mapped onto the hardware, significantly reducing the reliance on external memory. Moreover, this accelerator is applied to an intelligent tennis-serving robot. The robot uses object detection to dynamically adjust its serving strategy, improving adaptability in various training scenarios. The experimental results show that the robot featured with a dual-friction-wheel serving mechanism and four-wheel

differential control with a PID system can precisely regulate serving angle, speed, and spin for efficient and intelligent training.

SR1005 (14:45-15:00)

Path Planning for Quadrotor's Collision Avoidance Using a Single Field Programmable Gate Array Platform

Tai-Chiang Chou, **Cheng-Min Jen** and Ying-Hao Yu
National Chung Cheng University, Chia-Yi, Taiwan

Abstract-A collision avoidance system is critical to safe navigation for unmanned aerial vehicles (UAVs), especially in complicated terrain like farmland. Existing solutions often integrate multiple computational platforms, increasing payload and power consumption. This paper proposes a novel, lightweight, real-time path-planning system based on a single field-programmable gate array (FPGA) platform and a monocular camera for onboard processing. A key innovation of this work is introducing the Rotation Matrix and Arc Path Planning (RMAPP) algorithm, which optimizes computational efficiency and ensures precise obstacle avoidance. Compared to conventional methods, RMAPP significantly reduces processing overhead by abridging complex trigonometric calculations, making it more suitable for resource-constrained embedded platforms. Theoretical justifications and comparative data demonstrate that this method enhances quadrotor maneuverability while reducing power consumption. Experimental results validate the efficiency of the proposed approach in real-world farmland environments. This research will contribute to advanced quadrotor navigation in the future.

SR0008 (15:00-15:15)

FUZZ-PPO: Fuzzy-Proximal Policy Optimisation for Enhanced Robotic Control in Dynamic Environments Using Meta-Reinforcement Learning

Baljinder Kaur Sanghera and Karikeya Kaur Walia
Nottingham Trent University, United Kingdom

Abstract-This paper introduces Fuzzy-Proximal Policy Optimization (Fuzz-PPO), a unique hybrid control framework that improves robotic control in dynamic and unpredictable situations by utilising Meta-Reinforcement Learning (Meta-RL). Typically, traditional robotic control systems require significant training data and struggle to achieve fast convergence and stability, especially under dynamic conditions. To overcome these problems, the suggested Fuzz-PPO model makes use of Meta-RL's generalisation capabilities, which enable robots to seamlessly adjust to shifting situations without

requiring retraining. The use of a fuzzy logic controller also strengthens the original policy's resilience, enhancing its overall functionality. Utilising the CartPole-v1 environment, the hybrid Fuzz-PPO with Meta-RL was evaluated in a dynamic control simulation, where the goal was to stabilise the inverted pendulum whilst adapting to the system's dynamic changes. The findings show that the suggested method performs noticeably better than traditional Reinforcement Learning (RL) and PPO-based methods. Specifically, Fuzz-PPO achieved 30% faster convergence compared to traditional PPO, with a 20% improvement in stability during the learning process. Additionally, the model demonstrated 15% higher balancing control accuracy, reducing the occurrence of instability in dynamic environments. These findings support the claim that the hybrid Fuzz-PPO with Meta-RL is more resilient to fluctuations and better equipped to handle uncertain conditions. This paper contributes to the advancement of robotic control by providing a highly flexible, efficient, and real-time decision-making model that excels in managing complex and dynamic environments.

MC0005 (poster)

Study on fatigue strength of small maglev vehicle

Yang Liu

Dalian Jiaotong University, China

Abstract- With the development of domestic and foreign economy, the development of national economy is unprecedented high, in order to meet the needs of the people, it is imperative to develop a new means of transportation. Therefore, in the world, many countries have begun to study and develop the maglev train, and have made remarkable achievements. With the continuous improvement of transportation speed, the structural strength of maglev train body also puts forward higher requirements. As the research object, the finite element model of car body, according to the EN12663, determine three fatigue conditions, based on the nominal stress method of the car body under fatigue welding structure, the results of 2 cumulative damage value is 0.241. After the structural improvement, the cumulative damage ratio of the fatigue weak parts under all working conditions is less than 1, meet the requirement of fatigue strength.

Session 2 (15:30-17:15)

Topic: Visual based intelligent control system and monitoring technology

Session Chair: Prof. Shenshen Gu, Shanghai University, China

Time: 15:30-17:15, April 17, 2025

Venue: NTU@one-north Executive Centre (ONEC), Room: LT701

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SR0012 (15:30-15:45)

Distributed PFI consensus control for discrete-time second-order stochastic multi-agent systems

Xuping Hou[1,2,3], Xiaofeng Zong[1,2,3], Junqi Mu[1,2,3] and Yuanyuan Zhang[4]

1: China University of Geosciences, Wuhan, China

2: Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems, Wuhan, China

3: Engineering Research Center of Intelligent Technology for Geo-Exploration, Ministry of Education, Wuhan, China

4: School of Aeronautics and Astronautics, Huazhong University of Science and Technology, Wuhan, China

Abstract-The distributed proportional-fragment-integral (PFI) consensus control problem for discrete-time second-order stochastic multi-agent systems(MASs) is investigated in this paper, which is an extension of general proportional-integral control. Firstly, mean square(m.s.) and almost sure(a.s.) exponential stability criterion is established for discrete-time stochastic linear difference equation with fragment-integral term. Then, based on this stability criterion, sufficient conditions for achieving m.s. and a.s. consensus of discrete-time stochastic MASs under distributed discrete PFI control protocol are obtained, indicating that the discrete fragment-integral term can facilitate stochastic MASs consensus. Finally, a simulation example is given to verify the validity of the theoretical results.

SR0018 (15:45-16:00)

Modelling and Construction of Radial Magnetic Bearing for an Overhung System

Azman. Jamaludin[1], M Zarhamdy M Zain[1], Nur Safwati Mohd Nor[1] and M Azmi Kamari[2]

1: Universiti Teknologi Malaysia, Malaysia

2: Crescent Engineering (M) Sdn Bhd, Malaysia

Abstract-This paper seeks to explore the process of designing and constructing a radial bearing for a permanent magnet in an overhung system. The rising energy densities of permanent magnet materials have contributed to the increasing of demand for using permanent magnet in many applications. It is crucial to consider the usage of permanent magnetic bearings for replacing current radial bearing in rotating machinery. The advantageous of permanent magnet bearing would be able to support global environment movement in reducing the usage of fossil fuel and minimize power usage for driving various applications in industry. Despite many attempts, there are still gaps in magnetic bearing performance and magnetic energy efficiency which led to less effective and escalating development costs. This paper is to presents the modelling and construction for Ø50 mm rotor. Backers [4] has built foundation works, contributed to the design and implementation of the research. The research has been enhanced in several ways, including a 38% increase in bearing gap and length, as well as a ratio of ring thickness with initial gaps at 2.3. These enhancements have been considered in the analysis of the results and the writing of the manuscript.

SR0020-A (16:00-16:15)

Performance and Security Analysis of Image Data Encryption Algorithm Combining RC6 with Control of Chaotic Systems and Machine Learning

Feng-Hsiag Hsiao, **Chih-Te Chiu** and Po-Wei Chiu

Department of Electrical Engineering, National University of Tainan, Taiwan

Abstract-Due to the continuous advancements in password-cracking technology, communication systems face escalating security requirements. In response to this, this study proposes an RGB image data encryption algorithm that combines the Rivest Cipher 6 algorithm (RC6) with control of chaotic systems to enhance the security of color images. The RC6 algorithm, originally designed to meet the requirements of the Advanced Encryption Standard (AES) competition, has excellent calculation speed and security. Additionally, it can be parameterized to support longer key lengths and more encryption rounds.

With the anticipated widespread adoption of quantum computers in the coming years,

research indicates that existing encryption algorithms may prove unreliable in ensuring security. Many current encryption methods are vulnerable and can be compromised rapidly. This study proposes a solution based on chaotic encryption, which is aimed at improving the security of color images.

Chaos, being highly sensitive to initial conditions and challenging to predict in its trajectory, presents advances in cryptography, including strong confidentiality and favorable randomness. Consequently, numerous studies explored the application of control of chaos to enhance the confidentiality of information transmission, with image cryptography systems based on chaos emerging as one ideal encryption method. This study aims to introduce control of chaotic systems as a countermeasure to security challenges posed by quantum computers. Furthermore, this study utilized machine learning to optimize the encryption effects within chaotic systems to enhance algorithm performance.

Machine learning, a branch of artificial intelligence, revolves around designing and analyzing algorithms that allow computers to automatically "learn." These algorithms automatically analyze data, extract patterns, and leverage them for predicting unknown data. Among these techniques, Convolutional Neural Network (CNN) proves particularly effective in handling data with a grid-like structure, such as images. CNN utilizes convolution, a mathematical operation that enables them to capture spatial and temporal correlations in data. This network structure finds wide applications in image recognition, video classification, object detection, and other related fields. Leveraging the characteristics of chaos–disarray and irregularities, this study employs CNN models to enhance encryption algorithm security.

This study initially employed the RGB component method to break down the color plaintext image into its red, green, and blue component values. The RC6 encryption algorithm was then applied to generate a set of new encrypted data. This data was then reintegrated into an image using the inverse RGB component method, producing a ciphertext image encrypted with RC6. Simultaneously, the Logistic chaotic system was employed to train the CNN model, generating a chaotic map characterized by points with irregular distribution. The RC6 ciphertext image was then intricately combined with the chaotic map through confusion and diffusion, resulting in a final encrypted image marked by pixel disturbance. Lastly, security analysis was conducted on the dual-encrypted image to verify the confidentiality of this method. This method addresses the potential challenges quantum computers pose to traditional encryption algorithms, ensuring the secure transmission of images.

SR0022 (16:15-16:30)

An Innovative Advancement in Vibration-Assisted Steam Sensing Technology (VASST)

Farhan Al-Enazi, Hassan Al-Qarni, Mohammed Al-Subaie, Ali Ghazwani, Hassan Al-Ali, Muhammad Azhar Khan and Abdul Aziz Afzal
Prince Mohammad Bin Fahd University, Al Khobar, Saudi Arabia

Abstract-This paper focuses on the design and development of a novel condensation detection system to improve energy efficiency and operational reliability in steam piping infrastructures. The proposed system utilizes a non-invasive approach, combining vibration and temperature sensors, to detect and analyze condensation events in real time. By addressing the limitations of traditional detection methods, such as invasiveness and lack of sensitivity, this study introduces a compact and energy-efficient device capable of seamless integration into existing piping systems. The prototype design is tailored for lab-scale experiments, with key parameters optimized for availability and suitability. Detailed theoretical analysis and future experimental testing are considered within this paper. The provided design from this phase will undergo further development and testing, contributing to a scalable solution for industrial applications and predictive maintenance strategies

SR0036 (16:30-16:45)

Complementary Filter-based Attitude Control of Rigid Aircraft with Multiple Inertial Measurement Units

Linan Wang, Meng Zhang and Huatian Zhu
Southeast University, Nanjing, China

Abstract-This paper proposes a novel complementary filter-based attitude control method for rigid aircraft equipped with multiple Inertial Measurement Units, specifically designed to address gyro bias. By integrating attitude estimation and control within a unified framework, the proposed approach utilizes filtered inertial measurements to ensure robustness and stability in the presence of gyro bias. Theoretically, it is demonstrated that the system achieves global asymptotic stability, with attitude and angular velocity errors converging to zero. Simulation results validate the effectiveness of the proposed controller, showcasing its capability to compensate for gyro bias and accurately track the desired attitude and angular velocity.

SR0037 (16:45-17:00)

Vision-based technique to estimate the roll angle of Powered Two-Wheeled Vehicles

Obaida Alrazouk, Amine Chellali and **Hichem Arioui**
Universite´ d'E´vry Paris-Saclay Evry, France

Abstract-This paper presents an innovative vision-based method for estimating the roll angle of Powered Two-Wheeled Vehicles with respect to the road surface. This method uses a single camera attached to the vehicle as an input. The algorithm is based on a novel technique that exploits perspective distortion and Inverse Perspective Mapping to calculate the sub-pixel distance difference between the edge and center lane markers and estimates the camera roll angle. The vehicle roll angle is then obtained in the Euler convention. This method is tested on various scenarios with different speeds and road shapes using BikeSim simulator. The results are promising, showing a low estimation error. Moreover, its main advantage is that the estimation is not cumulative, thus avoiding drift errors over time.

SR1006 (17:00-17:15)

The Convergence of Digital Twins, Eye-Tracking, and Human-Robot Interfaces: Advancing Zero UI and Touchless Technology for WearablesPaper

Zhuoya Bao, Saedah Binti Siraj and Siti Hajar Halili
University of Malaya, Kuala Lumpur, Malaysia

Abstract-Focusing on the digital technology for wearables, this paper examines the interplay between digital twin, eye-tracking, and Human-Robots Interfaces. By systematically analyzing and synthesizing 107 papers from Elsevier's Scopus and Web of Science databases, this review uncovers and interprets their interconnections. We employed Multiple Correspondence Analysis to highlight the theoretical foundations and main research themes. This methodological approach facilitates the visualization of the foundational intellectual structure and the identification of new research opportunities, thereby fostering further synthesis and advancement. Following the analysis of the selected papers and in response to the need for a framework focusing exclusively on empirical studies, we developed a Zero UI within Touchless Technology framework based on empirical evidence from a sub-sample of 77 manuscripts. Based on the results of the multiple correspondence analysis and evaluations of empirical papers, this review outlines main theoretical foundations related to DT-enabled gaze-based interfaces, DTs facilitate real-time, context-aware modeling of user interactions, enabling seamless gaze-driven control in cyber-physical and robotic systems without reliance on physical inputs. It also identifies major research themes, including DT-based gaze control, Zero UI frameworks,

DT-human-robot collaboration, and AI-enabled personalization. Furthermore, the article highlights gaps and future research opportunities within these intersecting domains, acknowledges advancements in radical and process technological innovation, such as artificial intelligence and machine learning, and provides an overview of the latest developments

SR0030 (poster)

LDSD: Lemon surface defect detection system based on decision tree

Yiyang Wei, Huibo Wang, Xinpeng Ouyang, Junqi Mu, Junyang Xu and Xiaofeng Zong
China University of Geosciences (Wuhan), Wuhan, China

Abstract-Conventionally, fruit sorting was predominantly carried out manually by workers, who relied on visual inspection to detect and classify surface defects of the fruits, and used measuring tools to assess their diameter and weight. However, with the increasing labor costs and the manufacturers' pursuit of higher production efficiency, people have begun to adopt a method that integrates machine vision with sensors to perform fruit inspection tasks. Numerous researches related to machine learning have emerged around the world. It has been adapted to fields including disease prediction, market prediction, industrial procedures etc. The use of machine learning for surface defect detection in fruit sorting is still an area that requires further research. Among the existing researches, only limited number of models are used, resulting in the lack of comparison of accuracy. In this article, our team compares the accuracy of four models: Decision Tree, Support Vector Machine (SVM), Naïve Bayes, K-Nearest Neighbors (KNN). This paper will explain why these four models were selected as candidate models. After selecting the most suitable model (Decision Tree) for the task of lemon surface defect detection, this paper designs a corresponding vision system for capturing lemon images, develops a diameter detection algorithm for measuring the diameter of lemons, designs a set of sensors and their accompanying data acquisition card for obtaining lemon weight data, and refines the design of a high-quality lemon grading system for classifying the results. In the end, the model based on decision tree outperformed other models with an accuracy of 0.9520, an area under curve of 0.9416, a F1 score of 0.9484, a precision of 0.9482 and a recall of 0.9520. The system will be of high efficiency and significantly reduce the cost of labor cost in order to cope with increasingly high market demand and assist manufacturers stand out in the fierce competition of modern market.

Session 3 (GMT+8)

Topic: Intelligent control system and parameter analysis
Session Chair: Assoc. Prof. Deepika Koundal, University of Petroleum and Energy Studies
Time: 16:00-17:30, April 18, 2025
Zoom ID: 87114719359
Zoom link: https://us02web.zoom.us/j/87114719359

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SR0004 (16:00-16:15)

Firing Methods for Firing robots Based on Supervised Learning and Model Predictive Control

Yunlong Gao, Yongjuan Wang, Jinyu Kang, Shida Chen, Cancan Hu and Xingyu Lu
Nanjing University of Science and Technology, Nanjing, China

Abstract-In order to improve the firing accuracy of firing robot against moving targets, hit probability estimation and image servo control are investigated in this paper. Firstly, a method to predict the impact points based on supervised learning is proposed. An corrected ballistic trajectory model is applied to generate training samples, and the mapping relationship that expresses the state of the impact points is formed. In addition, an image servo control method based on model predictive control and human key point detection is proposed, which effectively improves the tracking accuracy of moving targets. Finally, numerical simulation and firing experiment validation are carried out, and the results show that the precision firing method of firing robot proposed in this paper can effectively improve the firing accuracy of firing robot.

SR0006 (16:15-16:30)

3D LiDAR SLAM for Roadheader in Coal Mines

Tao Ren[1], Canguang Zheng[2], Lin Chen[2], Hongbo Lv[1], Yachao Liu[1] and Qinghua Liu[1]
1: North China University of Technology, Beijing, China
2: Yankuang Energy Group Company Limited, China

Abstract-The traditional UWB-IMU (ultra-wideband, inertial measurement unit) positioning method has been used in the positioning of roadheader, but its accuracy in the Z-axis direction and yaw angle is insufficient. In order to improve the localization

accuracy, a 3D LiDAR SLAM (simultaneous localization and mapping) scheme is proposed in this paper. Through the registration of roadway point cloud, the pose of UWB-IMU is corrected to improve the accuracy. According to the work flow and complex environment of roadheader, a 3D scanning system with wide pitch angle is constructed and an improved cloth filter algorithm is proposed to segment the point cloud of the roadheader working area. In order to avoid few features affecting the matching results in the roadway environment, this paper adopts the way of the point cloud feature extraction based on curvature and uses the measurement results of UWB-IMU as the initial value for registration. The test results in the experimental roadway show that the positioning accuracy of the proposed method in Z direction and yaw angle is significantly improved compared with the traditional UWB-IMU.

MC0006-A (16:30-16:45)

Optimized Control of Methane Transpiration Cooling System for Injector Porous Plate during Combustion in Thrust Chamber

Xuetong Hao, Juan Shi, Jianan Ge and Zhenqian Chen
Southeast University, China

Abstract-Control technologies are of fundamental significance in enhancing the performance of aerospace propulsion systems. However, extant research, particularly regarding the optimization and control of the thrust chamber's transpiration cooling system, remains insufficient. In this study, methane-oxygen is employed as the propellant. The combustion process of methane and oxygen is expounded upon the basis of the Eddy Dissipation Model. Taking into account the thermal equilibrium characteristics of the porous injector plate, the methane inlet pressure and the porosity of the porous plate are controlled and adjusted to enhance the thermal protection capability of the system. The research results show that when the methane inlet pressure increases from 5.862 MPa to 6.217 MPa, the cooling efficiency increases from 0.819 to 0.875, and the thermal immersion depth of the high-temperature gas decreases. When the porosity doubles, through real-time monitoring of the temperature of the injector plate, it is found that the maximum temperature on its surface decreased by 38.94%. This study provides an optimized strategy for the transpiration cooling system of the thrust chamber, and furnishes theoretical support for the dynamic changes and adaptive control technologies of aerospace propulsion systems.

MC0004 (16:45-17:00)

Exploring PPO in G2RL: A Reinforcement Learning-Based Path Planning Approach for Dynamic Environments

Abraham K Yalley, Yang Chen and Hao Fu
Wuhan University of Science and Technology, China

Abstract-Autonomous navigation in dynamic environments presents significant challenges for reinforcement learning (RL)-based robot navigation, including adapting to real-time obstacle dynamics and ensuring reproducibility of results across frameworks. The Globally Guided Reinforcement Learning (G2RL) framework offers a promising hierarchical approach, combining global path planning with A*-based algorithms and local decision-making using Double Deep Q-Learning (DDQN). However, value-based methods like DDQN can suffer from instability and suboptimal performance in highly dynamic environments. This paper investigates the feasibility of replacing DDQN with Proximal Policy Optimization (PPO), a policy-gradient method known for its stability and adaptability, within the G2RL framework. Using the original G2RL source code, environment configuration, and reward structure, this study compares the performance of PPO and DDQN in identical conditions. Both models were trained on a single random map with 10 dynamic obstacles and tested on the same map with 60 obstacles. The results reveal that while the DDQN implementation failed to replicate the original paper's reported performance, PPO demonstrated robustness under dynamic conditions and showed potential as a viable alternative for hierarchical frameworks. This study highlights the importance of reproducibility in RL research and showcases PPO's adaptability, even though its overall performance requires further optimization for real-world applications.

SR0040 (17:00-17:15)

Stability-Constrained Parameter Estimation for Mecanum Cart with Limited Input Frequency

Shangshang Nie[1], Naoki Igo[2] and Kiyoshi Hoshino[1,3]
1: University of Tsukuba, Tsukuba, Japan
2: Tokyo Information Design Professional University, Tokyo, Japan
3: Meiji University, Japan

Abstract-The purpose of this study is to model a 4-wheeled Mecanum cart, with the input signal frequency designed to be 10 Hz and its overall motion derived by considering the mounting angles of the rollers on wheels. By integrating stability constraints into the parameter estimation process, this study aims to ensure both the model's accuracy and its

system stability. The cart model consists of two parts: the kinematic equation between the wheel rotational speed and the overall motion of the cart and the relationship between the input driving signal and the wheel rotational speed which was represented as a difference equation. The parameters of difference equation were estimated using the gradient descent method, with the Routh-Hurwitz stability criterion incorporated as a constraint via the Karush-Kuhn-Tucker conditions to guide the system's stability during the estimation process. Test data measured from real cart rotation, consisting of 13 sets of step signals (ranging from 10 rpm to 130 rpm in increments of 10 rpm) with 5 experimental repetitions per set, were used to compare the dynamic and steady-state characteristics of models obtained with and without stability constraints. Also 5 trials of random input experiments were performed to compare the dynamic and steady-state response of the models obtained from 2 methods. Results showed a decrease in the gradient descent success rate from 90% to 60%, while the system stability rate, defined as the ratio of the number of stable models to the total number of parameter estimate trials, improved from 30% to 60%. Additionally, a t-test on the mean errors between model outputs and the real cart output revealed no significant difference between the two methods. These results indicated that the effectiveness of introducing stability checks into parameter estimation for limit input signal frequency systems, ensuring both accuracy and system stability.

MC0001 (17:15-17:30)

Thermal elastohydrodynamic coupling characteristics of wet clutch under time-varying friction interface parameters

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Abstract- Friction interface parameters of wet clutches vary with time during its sliding. The thickness of the oil film changes with the contact ratio of micro-convex peaks, providing lubrication boundary conditions. Due to the interaction of temperature, strain, and flow fields, the thermal elastohydrodynamic coupling boundary conditions alternate, resulting in complex slip characteristics. This study investigates the thermal elastohydrodynamic coupling characteristics of a vehicle wet clutch with time-varying friction interface parameters. Based on hydrodynamic lubrication and heat transfer theories, the finite element method is used to establish the thermal elastohydrodynamic coupling model of wet clutches that considers the effect of temperature on oil parameters. The thermal elastohydrodynamic coupling characteristics are analyzed by comparing variations in parameters such as oil film thickness, relative speed, controlled oil pressure, and surface roughness. A wet clutch test scheme is designed, and a multifunctional vertical friction and wear testing machine is used for validation. The accuracy of model is verified

by comparing the temperature-rise performances of friction plates. The distributions of temperature, pressure, stress, and strain on the surface of friction plate under the thermal elastohydrodynamic coupling conditions are studied, revealing the slip process mechanism. This research provides a theoretical basis for the dynamic design and structural optimization of wet clutches.

Note

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