ICMRE 2023

CONFERENCE PROGRAM

2023 The 9th International Conference on Mechatronics and Robotics Engineering

2023年第九届机电工程与机器人国际会议

February 10-12, 2023 Shenzhen, China

Hosted by

南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Co-Sponsored by

IEEE

南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

IEEE Robotics & Automation Society

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*** All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间**

Day 1-February 10, 2023 | Friday		
10:00-12:00	Committee & Speakers' Test Session 组委会&嘉宾测试	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
14:00-15:00	Parallel Sessions Test 平行分会测试	ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t ROOM C: 988-8305-4696 Link: https://meeting.tencent.com/dm/wbyVW9KXBIPT

Day 2-February 11, 2023 | Saturday		
8:30-12:10	Opening & Keynote Speeches 开幕式&主旨报告	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
14:00-16:10	Keynote Speech & Invited Speeches 主旨报告 &特邀报告	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
16:30-18:45	Parallel Session 1 平行分会 1	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
16:30-18:30	Parallel Session 2 平行分会 2	ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t

Day 3-February 12, 2023 | Sunday		
9:00-10:00	Invited Speeches 特邀报告	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t
10:40-12:25	Parallel Session 3 平行分会 3	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
10:10-12:10	Parallel Session 4 平行分会 4	ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t
14:00-16:00	Parallel Session 5 平行分会 5	ROOM A：674-7776-7108 Link: https://meeting.tencent.com/dm/uBZRJfFcR2lb
14:00-16:00	Parallel Session 6 平行分会 6	ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t

WELCOME|欢迎辞

Dear distinguished delegates,

On behalf of the conference Committee, we warmly welcome you to 2023 The 9th International Conference on Mechatronics and Robotics Engineering. Our conferences were scheduled to be held in Shenzhen, Guangdong, China on February 10-12, 2023. But considering the long impact of the virus and the epidemic situation, this year, we will hold the conference in a virtual way again to make a smooth communication and conference holding, as well as to ensure the safety of all the attendees.

The conference is addressed to academics, researchers and professionals with a particular interest related to the conference topic. It brings together academics, researchers and professionals in the field of Mechatronics and Robotics Engineering making the conference a perfect platform to share experience, foster collaborations across industry and academia, and evaluate emerging technologies across the globe. The evaluation of all the papers was performed based on the reports from anonymous reviewers, who are qualified in their field. All the presentations are divided into 6 oral parallel sessions with the following topics: Robot system design and control, Robot system design and control, Robot system design and control, Electronic and signal processing, Intelligent system design and optimization, Mechanical and electronic monitoring system.

A word of special welcome is given to our keynote and invited speakers who are pleased to make contributions to our conference and share their new research ideas with us.

Additionally, our special thanks go to our Advisory Committee, Conference Chairs, Program Chairs, and all the other committee members for their excellent work in securing a substantial input of papers from all around the world and in encouraging participation.

With the strong support from all of you, ICMRE2023 conference is more distinctive. We wish that all guests can gain benefits from this conference and improve their academic performance. Thank each of you for your efforts to make this conference successful.

We wish all of you will have an unforgettable experience in the conference.

Yours sincerely,

Conference Chair
Prof. Yongsheng Ma, Southern University of Science and Technology, China
On behalf of organizing committee

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Zhenzhong Jia, Southern University of Science and Technology, China

DETAILED AGENDA|详细日程

DAY 1-Feb.10th | Friday

* All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Committee & Keynote / Invited Guests Test 报告嘉宾测试	
Tencent Meeting 腾讯会议, ROOM A：674-7776-7108 https://meeting.tencent.com/dm/uBZRJfFcR2Ib	
10:00-11:00	Prof. Jiansheng Dai, Prof. Ming Yu, Prof. Hong Zhang, Prof. Dongrui Wu, Prof. Pierre M Larochelle, Prof. James Yang
11:00-12:00	Prof. Jiangping Hu, Assoc. Prof. Chen Chun-Hsien, Assoc.Prof. Wenfeng Hu, Assoc.Prof. Guangcheng Zhang, Asst. Prof. Zhen Gao, Asst. Prof. Bin Wei, Dr Guowu Wei

Author(s) Test 作者测试		
Tencent Meeting 腾讯会议 Room B: 947-8872-9649 https://meeting.tencent.com/dm/p5o989zCMa7t		Tencent Meeting 腾讯会议 Room C:988-8305-4696 https://meeting.tencent.com/dm/wbyVW9KXBIPT
Time	Room ID	Presenter
14:00-15:00	Room B	Session 1: MR-018, MR-026, MR-044, MR-047, MR-062, MR-102, MR-121, MR-007, MR-135
		Session 2: MR-020, MR-029, MR-050, MR-070, MR-085, MR-156, MR-171, MR-186
		Session 3: MR-017, MR-019, MR-035, MR-056, MR-097, MR-129, MR-094
14:00-15:00	Room C	Session 4: MR-010, MR-041, MR-082, MR-105, MR-144, MR-032, MR-016, MR-174
		Session 5: MR-038, MR-059, MR-126, MR-132, MR-159, MR-1001, MR-006, MR-180
		Session 6: MR-003, MR-009, MR-011, MR-012, MR-013, MR-118, MR-123, MR-153

DETAILED AGENDA | 详细日程

DAY 2-Feb.11th | Saturday

* All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Conference Opening & Keynote/Invited Speeches 会议开幕式 & 嘉宾报告		
Tencent Meeting 腾讯会议, ROOM A：674-7776-7108 https://meeting.tencent.com/dm/uBZRJfFcR2Ib		
Time	Event	Presenter
Chaired By: Prof. Yongsheng Ma, Southern University of Science and Technology, China 报告主持人：马永胜教授，南方科技大学，中国		
8:30-8:40	Opening Remarks	Prof. Yongsheng Ma, Southern University of Science and Technology, China 马永胜教授，南方科技大学，中国
8:40-9:20	Keynote Speech Ⅰ	Prof Jian S. Dai, FREng, FIEEE, FASME, FRSA Fellow of Royal Academy of Engineering Editor-in-Chief of ROBOTICA Director of SUSTech Institute of Robotics (SIR), Honorary Chair Professor of King's College London Southern University of Science and Technology, China 戴建生 院士（英国皇家工程院院士）南方科技大学，伦敦国王学院荣誉教授 *Speech Title: Artificial Intelligence and Mechanism Intelligence in the New Generation of Robots*
9:20-10:00	Keynote Speech Ⅱ	Prof. Ming Yu, (IEEE Fellow, CAE Fellow) Southern University of Science and Technology, China 于明教授(IEEE Fellow, CAE Fellow)，南方科技大学，中国 *Speech Title: Key microwave technologies and applications of 5G/6G/ space-earth Internet*
10:00-10:20	Break & Group Photo	
10:20-11:00	Keynote Speech Ⅲ	Prof. Hong Zhang, (IEEE Fellow), Southern University of Science and Technology, China 张宏教授(IEEE Fellow)，南方科技大学，中国

		Speech Title: Applications of Deep Learning in Autonomous Robot Navigation
Chaired By: Prof. Dan Zhang, York University, Canada 报告主持人：张丹教授，约克大学，加拿大		
11:00-11:40	Keynote Speech Ⅳ	Prof. Dongrui Wu (IEEE Fellow), Huazhong University of Science and Technology, China 伍冬睿教授(IEEE Fellow)，华中科技大学，中国 *Speech Title: Transfer Learning in EEG-based Brain-Computer Interfaces*
11:40-12:10	Keynote Speech Ⅴ	Prof. Pierre Larochell, (ASME Fellow), South Dakota School of Mines & Technology, USA Pierre Larochell 教授，(ASME Fellow),南达科他州矿业与技术学院，美国 *Speech Title: Spatial Free Form Additive Manufacturing of Lattice Structures*
12:10-14:00	**Lunch time**	

Keynote/Invited Speeches
嘉宾报告

Tencent Meeting 腾讯会议, ROOM A：674-7776-7108 https://meeting.tencent.com/dm/uBZRJfFcR2Ib		
Time	Event	Presenter
Charied by Prof. Bin He, Shanghai University, China 报告主持人：何彬教授，上海大学		
14:30-15:00	Invited Speech Ⅰ	Prof. Jiangping Hu, University of Electronic Science and Technology of China, China 胡江平教授，电子科技大学，中国 *Speech Title: Optimal control of lower limb exoskeleton systems via reinforcement learning methods*
15:00-15:30	Invited Speech Ⅱ	Prof. Chen Chun-Hsien, Nanyang Technological University, Singapore Chen Chun-Hsien 教授，南洋理工大学，新加坡 *Speech Title: Informatics Enabled Human-Centric Smart Product-Service Systems*
15:30-16:00	Invited Speech Ⅲ	Prof. Guowu Wei, University of Salford, UK Guowu Wei 教授，索尔福德大学，英国 *Speech Title: Using bio inspired design and development*

		to improve the performance of robotic systems
Parallel Sessions 1 -2|平行分会 1-2 Tencent Meeting 腾讯会议		
Time	Room ID	Sessions & Presenter
16:30-18:45	ROOM A： 674-7776-7108	Session 1: Intelligent robot and engineering application 平行分会 1：智能机器人与工程应用
		MR-018, MR-026, MR-044, MR-047, MR-062, MR-102, MR-121, MR-007, MR-135
16:30-18:30	Room B: 947-8872-9649	Session 2: Electronic and signal processing 平行分会 2：电子与信号处理
		MR-020, MR-029, MR-050, MR-070, MR-085, MR-156, MR-171, MR-186

DETAILED AGENDA|详细日程

DAY 3-Feb.12th | Sunday

* All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Invited Speeches & Parallel Sessions 3 嘉宾报告&平行分会 3		
Tencent Meeting 腾讯会议, ROOM A：674-7776-7108 https://meeting.tencent.com/dm/uBZRJfFcR2Ib		
Time	Event	Presenter
9:30-10:00	Invited Speech IV	Assoc.Prof. Wenfeng Hu, Central South University, China 胡文峰教授，中南大学，中国 *Speech Title: The development of event-triggered control in multi-agent systems and some related issues*
10:00-10:30	Invited Speaker V	Asst. Prof. Bin Wei, Texas A&M University, USA Bin Wei 助理教授，德州农工大学，美国 *Speech Title: Overall framework of stability analysis of equilibrium states of nonlinear dynamics*

10:30-10:40	**Break Time**	
10:40-12:25	Session 3	Session 3: Robot system design and control 平行分会 3：机器人系统设计与控制 MR-017, MR-019, MR-035, MR-056, MR-097, MR-129, MR-094
Invited Speeches & Parallel Sessions 4 嘉宾报告&平行分会 4		
Tencent Meeting 腾讯会议, ROOM B: 947-8872-9649 Link: https://meeting.tencent.com/dm/p5o989zCMa7t		
9:00-9:30	Keynote Speech Ⅵ	Prof. Wilson Wang, Lakehead University, Canada Wilson Wang 教授，湖首大学，加拿大 *Speech Title: Intelligent Diagnostics of Machinery Systems*
9:30-10:00	Invited Speaker VI	Assoc.Prof. Guangcheng Zhang, University of Shanghai for Science and Technology,China 张广成副教授，上海科技大学，中国 *Speech Title: Comprehensive mPoint: A Method for 3D Point Cloud Generation of Human Bodies Utilizing FMCW MIMO mm-Wave Radar*
10:00-10:10	Break Time	
10:10-12:10	Session 4	Session 4: Machine vision and measurement 平行分会 4：机器视觉与测量 MR-010, MR-041, MR-082, MR-105, MR-144, MR-032, MR-016, MR-174
12:30-14:00	**Lunch time**	
Parallel Sessions 5 | 平行分会 5 Tencent Meeting 腾讯会议 Room A: 674-7776-7108		Parallel Sessions 6 | 平行分会 6 Tencent Meeting 腾讯会议 Room B: 947-8872-9649
14:00-16:00	Room A	Session 5: Intelligent system design and optimization 平行分会 5：智能系统设计与优化 MR-038, MR-059, MR-126, MR-132, MR-159, MR-1001, MR-006, MR-180
14:00-16:00	Room B	Session 6: Mechanical and electronic monitoring system 平行分会 6：机械与电子监测系统 MR-003, MR-009, MR-011, MR-012, MR-013, MR-118, MR-123, MR-153

GUIDELINE|参会指南

*** All schedules will be scheduled in Beijing Time (GMT+8) 时间安排均为北京时间**

Platform | 线上会议平台

Download Link: | 下载链接：

*https://voovmeeting.com/download-center.html?from=1001 (Tencent Meeting)

*https://meeting.tencent.com/download/ (For Chinese Author(s) only)

Video Tutorials | 视频教程

https://intl.cloud.tencent.com/document/product/1054?lang=en&pg=

Time Zone | 时区

The whole program is based on Beijing Time (GMT+8), please check on the program for your own test time and formal presentation time, and then convert it to the local time in your country.

Meeting Rooms | 线上会议房间号

Room A：674-7776-7108

Room Link: https://meeting.tencent.com/dm/uBZRJfFcR2Ib

Room B: 947-8872-9649

Room Link: https://meeting.tencent.com/dm/p5o989zCMa7t

Room C:988-8305-4696

Room Link: https://meeting.tencent.com/dm/wbyVW9KXBIPT

Equipment needed | 设备及环境需求

*A computer with internet connection and camera 带有摄像头的电脑设备

*Headphones 耳机

*Stable internet connection 稳定的网络连接

*A quiet place and Proper background 安静的地方，合适的背景

How to USE Tencent Meeting | 腾讯会议使用指南

Step 1: Download Tencent Meetings

Step 2: Sign up for an account. (If you cannot sign up, no worry, when you join the conference after pasting the Meeting ID, it will require you enter your phone number for verification, and then you can join it successfully.)

Step 3: You can set up the languages and do some basic test.

Step 4: How to join the conference online:

1. Open the program, search with your paper ID, find your presentation, you will see there is a meeting ID in each session.

2. Open the Tencent Meeting app, click the join (choose JOIN MEETING), paste the meeting ID in the blank, then you can join the conference.

3. If you don't have an account, you may be required to enter your phone number for verification first.

Step 5: Get familiar with the basic functions: rename, chat, raise hands, and screen share, etc.

Step 6: On February 10, we will have test session, on that day, we will teach you how to use Tencent Meeting and the functions mentioned above, so please download Tencent Meeting first.

Step 7: Every time you enter the conference or the session, **please rename as SESSION NUMBER+PAPER ID+YOUR NAME, for example: S1+S1-001+Tom**

Presentation Tips | 报告提示

➢Get your presentation PPT prepared. To effectively control the time and avoid some unexpected situations, we suggest you send us the recorded video in advance as a backup.

➢ Regular oral presentation: 15 minutes (including 2-3 minutes for Q&A).

➢Your punctual arrival and active involvement in each session will be highly appreciated. Please join in the room at least 15 minutes before your session.

Attention please | 请注意

➢ We take screenshots when each author is doing his or her presentation.

➢ The screenshots may be edited, copied, and/or displayed on the office conference website for public broadcast or for any lawful purpose.

➢Participants will not allow recording other presenters' presentation nor distributing it to or share with anyone unless the presenter gives written consent of agree. If someone failure to do so will be considered a serious academic violation subject to disciplinary/ lawful action.

➢ The host totally respect all the presenters' copyright. If you need to record your own presentation, please do inform our host in advance.

Keynote Speakers|主旨报告嘉宾

Prof Jian S. Dai, FREng, FIEEE, FASME, FRSA
Fellow of Royal Academy of Engineering
Editor-in-Chief of ROBOTICA
Director of SUSTech Institute of Robotics (SIR)
Honorary Chair Professor of King's College London
Southern University of Science and Technology, China

▼**Room A** (Meeting ID: 674-7776-7108) | 08:40-09:20 | Feb. 11, 2023

Bio: Dai Jiansheng, Dean of the Robotics Research Institute of SUSTech, Academician of the Royal Academy of Engineering (FREng), IEEE Fellow, ASME Fellow, RSA Fellow, IMechE Fellow. Robotica Editor-in-Chief (editor-in-chief), the international flagship journal of robotics, editor-in-chief of Mechanism and Machine Theory, and editor-in-chief of the "Robotics Science and Technology" series of Higher Education Press. He has been engaged in the basic theory and application research of theoretical kinematics, mechanism and robotics for a long time, and has profound mathematical foundation and attainments in the fields of spinor algebra, Lie groups, and Lie algebra. He has made many pioneering and internationally leading work in various robotic mechanisms such as metamorphic mechanisms, reconfigurable mechanisms, and reconfigurable robots, as well as their applications in the field of rehabilitation and manufacturing technology. In 2015, he won the ASME "Mechanism and Robotics Lifetime Achievement Award", which is the 27th recipient in the 41 years since the award was established. Received the ASME "Mechanical Design Lifetime Achievement Award" in 2020, the 58th recipient in the 62 years since the award was established. 2020 Awards: For pioneering and groundbreaking contributions to the establishment of the field of reconfigurable mechanisms and the subfield of metamorphic mechanisms; and for lasting impact on mechanical design through research, application, teaching, and service, bridging the The gulf between expensive robots and efficient but inflexible machines.

Speech Title: Artificial Intelligence and Mechanism Intelligence in the New Generation of Robots

Abstract: This talk starts from the definition of robots to explore the composition of the intelligent robots, particularly the classification of intelligent robots, as well as the bottleneck of the development based on the two 25-year periods. With the presentation of the key technologies of intelligent robots, the talk puts forward the core technologies of intelligent robots, including both the mechanism intelligence and the artificial intelligence. The talk proposes the intelligent structure and the intelligent mechanism, from which the regeneration and evolution of robots are evolved, by metamorphosis and polymorphism, and by reconfiguration. The talk then shows the evolution and development of intelligent mechanisms based on the metamorphic mechanisms and introduces Lie group and Lie algebras in the intelligent mechanism design to adapt to evolutionary mechanism design and mechanism evolution. The talk will combine the newly published 2nd edition of monograph Screw Algebra and Lie groups and Lie Algebras, and the latest monograph on Reconfigurable Mechanism and Reconfigurable Robot to show various applications of mechanism intelligence

Keynote Speakers|主旨报告嘉宾

Prof. Ming Yu, IEEE Fellow, CAE Fellow
Southern University of Science and Technology, China

▼Room A
(Meeting ID: 674-7776-7108) | 9:20-10:00 | Feb. 11, 2023

Bio: Professor Yu Ming, Academician of the Canadian Academy of Engineering, IEEE Fellow, Academician of the Hong Kong Institute of Engineers, winner of the 2020 IEEE Microwave Theory and Technology Association Award for Microwave Applications and IEEE International Microwave Global Outstanding Speaker Rank in the top 2% of the world. Engaged in the microwave industry for more than 30 years, he is an expert in the "amphibious" industry and academia. Its main research field is the design and manufacture of microwave devices, and its applications include 5G wireless communication base stations and new-generation satellite communication systems. Holds more than 30 patents, authored or co-authored nearly 200 publications and numerous proprietary reports. Completed nearly 40 scientific research projects as a PI, generating more than $500 million in economic benefits to the industry. Academician Yu Ming has 24 years of experience in the North American industry. He has served as the chief scientist, R&D director of a Fortune 500 company and a tenured professor at a world-renowned university. He is currently a chair professor of the Department of Electronic and Electrical Engineering of Southern University of Science and Technology and a distinguished researcher of Shenzhen National Center for Applied Mathematics.

Speech Title: Key microwave technologies and applications of 5G/6G/ space-earth Internet
Abstract:

Keynote Speakers|主旨报告嘉宾

Prof. Hong Zhang, IEEE Fellow, CAE Fellow
Southern University of Science and Technology, China

▼Room A
(Meeting ID: 674-7776-7108) | 10:20-11:00 | Feb. 11, 2023

Bio: Zhang Hong, academician of the Canadian Academy of Engineering, IEEE Fellow, and a leading talent of the "Pearl River Talent Program" in Guangdong Province, is currently a chair professor of the Department of Electronic and Electrical Engineering, Southern University of Science and Technology. He used to work in the Department of Computer Science of the University of Alberta in Canada for many years, and was a tenured professor of the department before leaving. During his work in Canada, he completed a number of major R&D projects and served as the Chief Industrial Research Professor of the Natural Science and Engineering Foundation of Canada (NSERC IRC). His current research interests include mobile robot navigation, autonomous driving, computer vision, and image processing. He has trained more than 80 masters, doctors and postdoctoral fellows, many of whom teach in famous universities at home and abroad, including the University of Toronto in Canada and the National University of Defense Technology of China. He is the editor-in-chief of several international journals and the chairman of the conference. Currently, he is the editor-in-chief of the IROS editorial committee of the flagship conference of the IEEE Robotics and Automation Society (2020-2023).

Speech Title: Applications of Deep Learning in Autonomous Robot Navigation

Abstract: Over the past decade, research in deep learning has exploded, much due to its impressive performance in solving a plethora of difficult problems across a multitude of application domains including natural language processing, image understanding, and computer vision. Robotics, as a field within artificial intelligent, has also benefitted from the significant progress of deep learning, leading to solutions to challenges in sensory data processing and decision making. Much of the rapid development in deep learning is made possible by its tremendous power in learning representations from data, be it texts, audios, images, or videos, to extract features or uncover hidden structures. In this presentation, I will focus on our recent research in applying deep learning to autonomous robot navigation. Specifically, I will illustrate how deep learning has been exploited by our group to advance research in robot navigation, with example applications in robot localization, tracking, and visual robot mapping.

Keynote Speakers|主旨报告嘉宾

Prof. Dongrui Wu, IEEE Fellow
Huazhong University of Science and Technology, China

▼Room A
(Meeting ID: 674-7776-7108) | 11:00-11:40 | Feb. 11, 2023

Bio: Dongrui Wu received a B.E in Automatic Control from the University of Science and Technology of China, Hefei, China, in 2003, an M.Eng in Electrical and Computer Engineering from the National University of Singapore in 2006, and a PhD in Electrical Engineering from the University of Southern California, Los Angeles, CA, in 2009. He is now Professor and Deputy Director of the Key Laboratory of the Ministry of Education for Image Processing and Intelligent Control, School of Artificial Intelligence and Automation, Huazhong University of Science and Technology, Wuhan, China. Prof. Wu's research interests include brain-computer interface, machine learning, computational intelligence, and affective computing. He has more than 200 publications (10000+ Google Scholar citations; h=52). He received the IEEE Computational Intelligence Society (CIS) Outstanding PhD Dissertation Award in 2012, the IEEE Transactions on Fuzzy Systems Outstanding Paper Award in 2014, the North American Fuzzy Information Processing Society (NAFIPS) Early Career Award in 2014, the IEEE Systems, Man and Cybernetics (SMC) Society Early Career Award in 2017, the USERN Prize in Formal Sciences in 2020, the IEEE Transactions on Neural Systems and Rehabilitation Engineering Best Paper Award in 2021, and the Chinese Association of Automation Early Career Award in 2021. His team won the First Prize of the China Brain-Computer Interface Competition in four successive years (2019-2022).Prof. Wu is a Board of Governors (BoG) member and Associate Vice President for Human-Machine Systems of the IEEE SMC Society. He will be Editor-in-Chief of IEEE Transactions on Fuzzy Systems in 2023

Speech Title: Transfer Learning in EEG-based Brain-Computer Interfaces

Abstract: A brain-computer interface (BCI) enables a user to communicate with a computer directly using brain signals. Electroencephalograms (EEGs) used in BCIs are weak, easily contaminated by interference and noise, non-stationary for the same subject, and varying across different subjects and sessions. Transfer learning utilizes auxiliary data or knowledge from previous subjects/tasks (source domains) to facilitate the calibration for a new subject/task (target domain), and is a promising approach to cope with inter- and intra-subject variations. This talk will introduce several newly proposed transfer learning approaches for EEG-based BCIs.

Keynote Speakers|主旨报告嘉宾

Prof. Pierre M Larochelle, ASME Fellow
South Dakota School of Mines & Technology, USA

▼Room A
(Meeting ID: 674-7776-7108) | 11:40-12:10 | Feb. 11, 2023
Presenter Local Time: 20:40-21:10 | Feb. 10, 2023

Bio: Dr. Larochelle's research interests are centered on the study of open and closed spatial kinematic chains. These kinematic chains are the functional basis of robots, parallel kinematic machines, mechanisms and linkages. Specific areas of interest currently being investigated include autonomous walking machines, mobile robots, synthesis and analysis of spatial mechanisms for rigid body guidance; design of robotic mechanical systems for increased dynamic performance; optimal control of robotic mechanical systems; computer-aided design of spatial and spherical mechanisms; virtual reality as applied to the design of robotic mechanical systems; theoretical kinematics; and mechatronics. In addition, Dr. Larochelle is an expert in creativity & innovation within the engineering design process.

Speech Title: Spatial Free Form Additive Manufacturing of Lattice Structures

Abstract: In this talk the conceptualization and realization of a system that deploys an industrial robot arm platform for additive manufacturing of lattice structures is presented. Conventional 3D printers, especially those employing fused deposition modeling (FDM) processes, are restricted to depositing material in a single toolpath plane (e.g. x-y plane). To ameliorate this limitation, we have been exploring various kinematic architectures and motion planning methods. The focus of this study was to explore the feasibility of integrating commercial off the shelf (COTS) additive manufacturing technologies with a six degree of freedom industrial robot arm to yield a 3D additive manufacturing system with the capability to perform free-form six degree of freedom fused deposition modeling. Here, we utilized the general motion capabilities of an industrial robot arm to yield the ability to deposit material as desired in three dimensions. A Yaskawa Motoman SV3X six degree of freedom general purpose industrial robot arm was equipped with a fused deposition modeling extruder print head. This integration combined two mature technologies, industrial robot arms and FDM print heads, into a new system with new additive manufacturing capabilities that we call MotoMaker. Using the MotoMaker system a three-dimensional lattice structure generator for multi-plane fused deposition modeling printing was investigated. Experimental results show the achievable capabilities of the 3D lattice structure generator for use with the multi-plane platform. In this talk we summarize the knowledge gained and lessons learned in developing the MotoMaker robot platform for additive manufacturing of lattice structures.

Keynote Speakers|主旨报告嘉宾

Prof. Wilson Wang, Lakehead University, Canada

▼**Room B** (Meeting ID: 947-8872-9649) | 9:00-9:30 | Feb. 12, 2023
Presenter Local Time: 20:00-20:30

Bio: Dr. Wang received his BSc in Electro-Mechanical Engineering (SIT, China), MASc in Mechanical Engineering (Northeastern University, China), MEng in Industrial Engineering (University of Toronto), and PhD in Mechatronics Engineering (University of Waterloo). He was employed as a senior scientist at Mechworks Systems Inc. from 2002 to 2004, and then joined the faculty of Lakehead University in 2004. Now he is a professor in the Dept. of Mechanical Engineering, cross-appointed by Electrical and Computer Engineering. He is also an adjunct professor at the University of Waterloo.

Speech Title: Intelligent Diagnostics of Machinery Systems

Abstract: Reliable condition monitoring systems are critically needed in industries to recognize initial machinery defects so as to improve production quality, operation efficiency and safety. An intelligent monitoring system consists of modules such as data acquisition, signal processing, and diagnostics. This talk will address some recent research and development in gear fault detection. Smart sensor-based data acquisition systems are used to collect vibration signals wirelessly. Signal processing is a process to extract representative features from measurement for system analysis and fault detection in a gearbox. The related signal processing techniques should be robust to noise and sensitive to health associated features. Diagnosis is a procedure to classify features/patterns into different categories corresponding to different equipment health states. An evolving neural fuzzy technique is proposed for automatic diagnostic classification. Appropriate machine learning algorithms can be used to improve decision-making convergence and adaptive capability to accommodate different machinery conditions.

Invited Speakers|特邀报告嘉宾

Prof. Jiangping Hu
University of Electronic Science and Technology of China, China

▼Room A
(Meeting ID: 674-7776-7108) | 14:30-15:00 | Feb. 11, 2023

Bio: Jiangping Hu received the B.S. degree in applied mathematics and the M.S. degree in computational mathematics from Lanzhou University, Lanzhou, China, in 2000 and 2004, respectively, and the Ph.D. degree in modelling and control of complex systems from the Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing, China, in 2007. He has held various positions with the Royal Institute of Technology, Stockholm, Sweden, The City University of Hong Kong, Hong Kong, Sophia University, Tokyo, Japan, and Western Sydney University, Sydney, NSW, Australia. He is currently a Professor with the School of Automation Engineering, University of Electronic Science and Technology of China, Chengdu, China. His current research interests include distributed reinforcement learning, multi-robot control, and sensor fusion. He has published around 140 peer-reviewed papers receiving more than 6000 times.Dr. Hu has been IEEE Senior Member since 2015 and served as members of Technical Committee on Control Theory, Technical Committee on Cognitive Computing and Systems, Technical Committee on Fractional order system and control, Chinese Association of Automation; also served as an Associate Editor for KYBERNETIKA and an Associate Editor for Journal of Systems Science and Complexity.

Speech Title: Optimal control of lower limb exoskeleton systems via reinforcement learning methods

Abstract: Lower limb exoskeleton (LLE) has received considerable interests in strength augmentation, rehabilitation and walking assistance scenarios. This talk considered learning based control strategies for LLEs such that they can have the capability of controlling the affected leg to track the unaffected leg's motion naturally. Firstly, when the system information of an LLE is unknown, a data-driven control strategy is proposed by only using the measured system data. A leader-follower system was built to model the relationship between the two legs of the LLE. Critic-Actor neural networks were constructed to estimate the cost function and optimal controller. Secondly, when motion constrains were further considered for LLEs, a barrier transformation function was designed to transform the LLE dynamics with the state constraints to an unconstrained system and then an event-triggered control strategy was proposed for the LLE to reduce the computation cost. Finally, some simulation results and hardware test were given to demonstrate the proposed control strategies.

Invited Speakers|特邀报告嘉宾

Prof. Chen Chun-Hsien,
Nanyang Technological University, Singapore

▼**Room A** (Meeting ID: 674-7776-7108) | 15:00-15:30 | Feb. 11, 2023

Bio: Chun-Hsien CHEN is Full Professor, Director of the Design Stream, and Professor-in-Charge of the Design & Human Factors Lab in the School of Mechanical & Aerospace Engineering, Nanyang Technological University, Singapore. He received his BS degree in Industrial Design from National Cheng Kung University, Taiwan, MS and Ph.D. degrees in Industrial Engineering from the University of Missouri-Columbia, USA. He has several years of product design & development experience in the industry. His teaching and research interests are design science in product design and development; engineering/design informatics for managing/ supporting digital design & manufacturing; and human factors and management of human performance. He has more than 280 publications in these areas. Prof. Chen has served as a Technical Reviewer for *National Science and Technology Awards* (Singapore), *National Research Foundation of Korea*, *The Knowledge Foundation (KK) HÖG 16 Project, Sweden*, and a Judge for *Pin Up Design Awards* (South Korea), an Advisory Board member for **ISTE** (*International Society of Transdisciplinary Engineering*), an Advisory Committee member for the various international conferences held in USA, Europe, Brazil, China, Korea, Malaysia, Hong Kong and Taiwan.

Speech Title: Informatics Enabled Human-Centric Smart Product-Service Systems

Abstract: Technology, consumer sophistication and business globalization have led to a highly competitive business environment which demands faster new product (tangible or intangible) introduction and more complex and value-added, customized products. Since the primary role of product design is to bridge users and technological systems in contexts of product use, it is increasingly important to focus on human-centric concerns, such as understanding the users' behaviour, needs and requirements of different social and cultural segments. As these human-centric factors become more important in product design and development along with increasing complexity from technological advances such as networking and embedded technologies, multi-disciplinary information management becomes critical for achieving high product integrity. Yet, because of the complexity, uncertainty and cross-disciplinary nature of human and societal factors, formal mechanisms for incorporating these factors consistently into the product design and development process have not been well established. In this regard, Smart Product-Service System (Smart PSS) is emerging as an IT-driven value cocreation business strategy by integrating smart, connected products and its generated digitalized and e-services into a single solution to meet individual customer needs in a sustainable manner, especially important in the era of Industry 4.0 and beyond.

Invited Speakers|特邀报告嘉宾

Prof. Guowu Wei, University of Salford, UK

▼**Room A** (Meeting ID: 674-7776-7108) | 15:30-16:00 | Feb. 11, 2023
Presenter Local Time: 7:30-8:00 | Feb. 11, 2023

Bio: Dr Guowu Wei is a Reader of Robotics at the University of Salford, UK. He has been working in the fields of robotics, manipulation and grasping, bio-robotics, rehabilitation robotics, computational mechanics, and mechanisms in the past 20 years, he has published over 135 peer-reviewed papers and holds over 15 patents. His research was funded by EPSRC, EU-FP7, ICUK, NSFC, and Royal Academy of Engineering with total grants of over £4M. He has supervised and co-supervised 25 PhDs and 8 visiting scholars. He is a recipient of 17 awards from academic bodies, international conferences, and journals, including the IEEE ROBIO 2011 'C.M. Ho Best Paper in Biomimetics—Finalist', the ICBE 2019 'International Bionic Innovation Competition Award', the IWBE 2021 'Best Paper in Bionic Healthcare Award', and the "2021 Best Reviewers Award" from Journal of Mechanical Design. Dr Wei is the Executive Deputy Chair of the IFToMM Member Organization (MO) United Kingdom (UK), and was elected Vice-Chair of the Youth Commission of the International Society of Bionic Engineering (ISBE). He also serves as Topic Editor, Academic Editor and Associate Editor for five International Journals including the Robotica, Journal of Mechanical Engineering Science (Proc. IMechE Part C), and Applied Bionics and Biomechanics, and as Associate Editor for two top IEEE conferences, i.e., Intelligent Robots and Systems (IROS) and IEEE International Conference on Robotics and Automation (ICRA). He served as programme chair, session chair, scientific committee and programme committee member for over 50 international conferences.Dr Wei's current research focuses on bio-robotics, bio-inspired healthcare and assistive robotics and technology, grasping theory, multi-fingered robotic hand, robotic devices for surgical and rehabilitation applications, origami engineering, computational dynamics, metamorphic mechanisms/robotics, and reconfigurable mechanisms/robotics.

Speech Title: Using bio-inspired design and development to improve the performance of robotic systems

Abstract: Researchers in the field of robotics increasingly agree that the ideas from biology and self-organization can lead to better design and development of autonomous robots. As nature becomes a more useful teacher for the new generation of robot development, biologically inspired (bio-inspired) robotics has gradually enabled researchers to develop novel robots for real-world applications with the desirable properties of biological organisms, such as adaptivity, versatility, and dexterity. Using the design and development of an anthropomorphic robotic finger with innate human-finger-like biomechanical advantages as an example, in this talk, we would like to demonstrate how the bio-inspired design and development can be exploited to improve the performance of robotic system. In this talk, a bioinspired anthropomorphic robotic

finger will be firstly presented, which embeds human finger musculoskeletal features in the design. Based on this design, three human-finger-like biomechanical advantages, i.e., variable joint stiffness associated with the ligamentous structure, enlarged feasible force space associated with the extensor mechanism, and augmented force-velocity workspace associated with the flexible tendon sheath are systematically investigated through theoretical modelling and experimental verification. Then, grasping tests and comparisons are conducted with four three-fingered robotic hands (one with the robotic finger proposed, one with hinge joints, one with linear extensors, and one with rigid tendon sheaths) and the human hands of six subjects to handle various objects on flat, rough, and soft surfaces. The results show that with the biomechanical advantages embedded in the biomimetic structures, even without the complex control or sensing system, the robotic fingers can generate comparable grasping performance of human fingers.

Invited Speakers|特邀报告嘉宾

Assoc.Prof. Wenfeng Hu,
Central South University, China,

▼**Room A** (Meeting ID: 674-7776-7108) | 9:30-10:00 | Feb. 12, 2023

Bio: Dr. Wenfeng Hu is currently an Associate Professor at the School of Automation, Central South University, Changsha, China. He received the B.Sc. degree in information and computing science from Chongqing University of Technology, Chongqing, China, in 2009, the M. Eng. degree in computer software and theory from Chongqing University, Chongqing, China, in 2012, and the Ph.D. degree in mechanical and biomedical engineering from City University of Hong Kong, Hong Kong, in 2016. In 2015 and 2016, he won the Outstanding Academic Performance Award in City University of Hong Kong, in 2019, he was awarded the "Zadeh Best Conference Paper Award Finalist" in IEEE ICCSS 2019 Conference, in 2021, he was awarded the "HNAAI Outstanding Master's Thesis Award" (as the supervisor). He has published more than 30 papers in the top peer-reviewed journals, including IEEE TAC, Automatica, and IEEE Transactions on Cybernetics, and 3 papers were among the 1% Highly Cited Paper by ESI.His current research interests include multi-agent systems, networked control systems, event-triggered control, and high-speed train control and scheduling.

Speech Title: The development of event-triggered control in multi-agent systems and some related issues.

Abstract: In this talk, starting with the overview of the fundamental principle of event-triggered control, we introduce the brought challenging issues of the event-triggered control of multi-agent systems. Then, we introduce the idea of event-triggered control to the coordinated control of multi-agent systems by considering the consensus of homogeneous multi-agent systems and cooperative output regulation of heterogeneous multi-agent systems with event-triggering communication. Moreover, we will talk about some new issues, development, and other applications in event-triggered control of multi-agent systems. In the end, we will give an outlook on the new topics and trend for the event-triggered control of networked control systems theory and techniques

Invited Speakers|特邀报告嘉宾

Asst. Prof. Bin Wei
Texas A&M University, USA

▼**Room A** (Meeting ID: 674-7776-7108) | 10:00-10:30 | Feb. 12, 2023
Presenter Local Time: 20:00-20:30 | Feb. 11, 2023

Bio: Dr. Wei obtained his PhD in Mechanical Engineering (robotics) from Ontario Tech University in Canada in 2016. After that, he did his post-doctoral research in control of robotics in the department of mechanical engineering at York University in Canada.He is currently an assistant professor in the department of mechanical and industrial engineering at Texas A&M University – Kingsville, USA.His research focuses on control theory, dynamical systems, robotics, and synchronization.

Speech Title: Overall framework of stability analysis of equilibrium states of nonlinear dynamics

Abstract: The equilibrium state of a dynamical system can be divided into equilibrium point and limit cycle. In this talk, I will present the stability analysis of the equilibrium point and limit cycle of dynamical systems through different and all possible approaches as well as the differences among them. I hope this talk can provide a systematic guideline and overall framework to study the stability of equilibrium point and limit cycle of nonlinear dynamics.

Invited Speakers | 特邀报告嘉宾

Assoc.Prof. Guangcheng Zhang,
University of Shanghai for Science and Technology, China

▼**Room B** (Meeting ID: 947-8872-9649) | 9:30-10:00 | Feb. 12, 2023

Bio: Dr. Guangcheng Zhang is currently an Associate Professor at the School of Mechanical Engineering of University of Shanghai for Science and Technology. He was awarded the bachelor and mater degrees from Nanjing University of Aeronautics and Astronautics at 2012 and 2014 respectively, then he was awarded the PhD degree from University of Nottingham, UK at 2018. Dr. Zhang has international academic studying and working experiences and his research focuses on hydraulic energy saving technology, vibration control, and millimeter wave radar technology.

Speech Title: Comprehensive mPoint: A Method for 3D Point Cloud Generation of Human Bodies Utilizing FMCW MIMO mm-Wave Radar

Abstract: In this report, comprehensive mPoint, a method for generating 3D (range, azimuth, and elevation) point cloud of human targets using a Frequency-Modulated Continuous Wave (FMCW) signal and Multi-Input Multi-Output (MIMO) millimeter wave radar is proposed. Distinct from traditional method, a comprehensive mPoint method considering both the static and dynamic characteristics of radar reflected signals is utilized to generate a high precision point cloud, resulting in more comprehensive information of the target being detected. The radar possessing 60–64 GHz FMCW signal with two sets of different dimensional antennas is utilized in order to experimentally verify the results of the methodology. By using the proposed process, the point cloud data of human targets can be obtained based on six different postures of the underlying human body. The human posture cube and point cloud accuracy rates are defined in the report in order to quantitively and qualitatively evaluate the quality of the generated point cloud. The potential applications for the proposed method will also be discussed in the speech.

Parallel Session 1 | 平行分会 1

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 1: Intelligent robot and engineering application 平行分会 1：智能机器人与工程应用 Session Chair: Assoc.Prof. Kai Wu, South China University of Technology, China	February 11th	Saturday 16:30-18:45 Room ID: 674-7776-7108
MR-018 **16:30-16:45**	A Reliable Docking Mechanism and Close-Range Docking Algorithm for Modular Reconfigurable Robots Presenter: Bin Huang Fudan University, China Abstract-Docking between modules is a key issue for modular self-reconfigurable robots. Reconfigurability allows modular robots to form new structures and gain functionality that a single module does not have. In this paper, a docking mechanism is designed for a chained modular mobile robot. The docking mechanism is compact in structure and reliable in operation and can provide stable rigid coupling between modules. In addition, a docking method based on infrared sensors is proposed for self-reconfigurable wheeled robots. Experiments are carried out on two vehicles to verify the effectiveness of the method.	
MR-026 **16:45-17:00**	Research on gesture guidance and teaching of cooperative robot based on nine-axis AirMouse Wang Chu, Xiao Juliang, Xiang Dong, Zheng Heqiang, Sun Terigen Presenter: Wang Chu Harbin Institute of Technology, China Abstract-With the development of science and technology, cooperative robot has become a new trend. Because the teaching technology directly determines the efficiency of the robot, researchers have made such efforts to design some effective robot teaching systems. However, there are still some problems such as difficult programming, high cost and limitation of sensor itself. Therefore, this thesis proposes a cooperative robot teaching system based on nine-axis AirMouse. Magnetometer, gyroscope and acceleration sensor are used to collect operator's gestures, and the robot will be guided according to these gestures. This system can achieve a simple, intuitive and efficient robot control method, which can select the most suitable mode according to working conditions and is easy to operate at the same time.	
MR-044 **17:00-17:15**	Study on the coherent course project for robot engineering major Wende Ke, Yongsheng Ma, Yiming Rong, Dong Lu, Chengzhi Hu, Yexu Huang Presenter: Wende Ke	

	Southern University of Science and Technology, China Abstract-Robot engineering is a newly approved engineering major in China in recent years, and its talent training focuses on whether students have the ability to analyze problems, be innovative and solve real problems in the robot. This paper describes the necessity of using coherent course project to test what students have learned, how to design the coherent course project and analyze its implementation. The designs of coherent course projects we have carried out can be taken as the reference for the related majors in universities.
MR-047 **17:15-17:30**	Human Robot Interaction with Triboelectric Nanogenerator for Tactile Sensing Chenxing Li, Yansong Wu,Yinlong Liu, Fabian Schreier, Zhenshan Bing, Alois Knoll, Shahram Eivazi Presenter: Chenxing Li University of Tübingen, Germany Abstract-The key success factors for Human Robot Inter_x005faction (HRI) interfaces heavily depend on the robot sensing technologies such as vision and touch sensors. In this paper we investigate the use of Nanogenerator technologies as a sensing device for robotic applications. The particular property that we explore here deals with Triboelectric Nanogenerator (TENG) sensor in which an electric signal can be generated automatically once the sensor is mechanically triggered. We propose to use TENG as a tactile sensor so robot is able to interact with human safely. The result shows that the TENG sensor is sensitive enough for a robotic safety task. The robot arm can stop when contacting the human hand and attempt to find a new way to reach a desired goal. Our experiment uncovers opportunities to use TENG sensors for real-time HRI applications.
MR-062 **17:30-17:45**	Development of BIM semantic robot autonomous inspection and simulation system Bangzhen Huang, Haiou Liao, Yangtao Ge, Wentao Zhang, Haoran Kang, Zirui Wang, Jing Wu Presenter: Bangzhen Huang Southern University of Science and Technology, China Abstract-Building information modeling (BIM) has been widely used in the construction industry. By coordinating the collaboration of diverse construction participants, architectural design and project management has been improved efficiency. The application of BIM has been extended with the application of mobile robots in construction intelligence and automation. The abundance of precise geometric and semantic information provided by the BIM model could assist and even directly guide the robot to complete various tasks more precisely and productively. In this paper, We proposed a method to use BIM to deploy the robot system simply and efficiently for building progress monitoring. In our method, BIM is utilized not only to provide robots with

	environment geometric and semantic information but also generate detailed actions for construction tasks to guide robots to perform inspection. The results have proved that by our method, the robot system has quickly performed a independent navigation in the new environment and simultaneously update the progress information without exploring the map in advance.
MR-102 **17:45-18:00**	A Positioning Method based on Kalman Filter for FAST Feed Support Cable Inspection Robot Xiangyu Sun, Gangfeng Liu, Xuehe Zhang, Changle Li, Jie Zhao Presenter: Xiangyu Sun Harbin Institute of Technology, China Abstract-In this paper, a positioning system developed for cable inspection robot system which works on feed support cables of Five-hundred-meter Aperture Spherical radio Telescope (FAST) is introduced. The positioning system consists of wheeled odometers and a Real-tme kinematic(RTK) based Global Navigation Satellite System (GNSS). Firstly, the cable with fixed ends and free suspension in the middle is modeled, and the influence of wind on the cable in FAST site is analyzed. Then, the data of the four odometers on the robot are processed, and the odometer information is fused with GNSS information through Kalman filtering. Then the best position estimation of the cable inspection robot is determined. A simulation is finally established to verify the proposed robot positioning method. The result shows that the method can work pretty well under the real working situation.
MR-121 **18:00-18:15**	A Framework for Online and Offline Programming of Multi-Robot Cooperative Motion Planning Senyu Mo, Yisheng Guan, Yihui Li, Xiaohan Chen Presenter: Senyu Mo Guangdong University of Technology, China Abstract-A multi-robot system has more flexibility than a single robot, but cooperative path planning between multi-robot systems is still laborious. Offline programming(OLP), which can automatically generate robotic programs based on workpiece models, is a key technology for accelerating the intelligent manufacturing revolution. Most of these OLP softwares support a limited number of robots and lack support for multi-robot coop-erative programming and reality interaction, which prevents the robot's advantages from being utilized and results in a common user programming experience. Therefore, this paper proposes a general offline programming framework based on SolidWorks, which enables the robot to be configured for programming following user needs. This framework provides a path-tracking function that, when combined with SolidWorks assembly and motion study, greatly simplifies the process of cooperative path planning. To increase the effectiveness of offline programming, a topic communication mechanism is used to establish a method for the framework to communicate with external devices and to obtain

	sensor data to help program through teaching and other means. Then, a dual robots cooperation experiment is conducted to confirm the viability and simplicity of the framework.
MR-007 **18:15-18:30**	APF-RRT*: An Efficient Sampling-based Path Planning Method with the Guidance of Artificial Potential Field Benshan Ma, Chao Wei, Qing Huang, Jibin Hu Presenter: Benshan Ma Beijing Institute of Technology, China Abstract-"Path planning is a decisive module of mobile robots and its time efficiency significantly affects the safety of the robots. Sampling-based methods have achieved great success in the robotic path planning domain. However, poor time efficiency is still a serious limitation when they are applied to a crowded environment. In this paper, we combine the RRT* algorithm and artificial potential field(APF) technic and propose an efficient sampling-based path planning method named APF-RRT*. Utilizing the prior knowledge of the mission and the environment, we construct APFs for the start point, the goal point, the reference path, and the obstacles. Then we modify the random sampling step of the RRT* algorithm. With the guidance of APF, the random sample points are closer to the optimal path, and useless sample points greatly decrease. Results show that the proposed APF-RRT* outperforms state-of-the-art sampling_x005fbased methods in convergence rate, sampling effectiveness, and time efficiency."
MR-135 **18:30-18:45**	A Sampling-based Next-Best-View Path Planner for Environment Exploration Qishuai Liu, Yufan Jiang, Ying Li Presenter: Qishuai Liu Zuxia robotics Inc., China Abstract-A new path planner to explore the surrounding environment algorithm is presented for the aerial robot. This algorithm combines Next-Best-View (NBV) sampling and frontier exploration together to find unknown large areas. We first compute the nearby area, namely the frontier area, which can guide the exploration direction for the robot roughly, then a node tree representing the NBV of the robot is generated for the robot to follow. Next, a continuous trajectory-generated method is proposed where a B-spline curve representing the robot trajectory can follow these selected viewpoints in the history tree. We evaluate the effect of our algorithm in a simulated environment.

Parallel Session 2|平行分会 2

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 2: Electronic and signal processing 平行分会 2：电子与信号处理 Session Chair: Prof. Guowu Wei, University of Salford, UK	February 11th	Saturday 16:30-18:30 Room ID: 947-8872-9649
MR-020 **16:30-16:45**	Structure Design of Heating Films with Magnetic Field Suppression for Atomic Sensors Chuanming Yin, Xiangyang Zhou, Zihao Lv, Zhanchao Liu Presenter: Chuanming Yin Beihang University, China Abstract-Atomic sensors have inherent advantages in small size and high accuracy because their sensitive elements are atoms. To increase the strength of the output signal with such a small size, the tem-perature of the vapor cell is increased to get a higher polarized atomic density. However, the cell is usually heated by an electric heater, generating an additional magnetic field. Non-magnetic heating technology of the cell in atomic sensors is a crucial issue, especially the magnetic-sensitive one. This paper proposes a six-teen pole magnetic moment structure of coil used in the heating film for magnetic-sensitive atomic sensors. Firstly, based on the derivation of Biot-Savart law, the relationship between the mag-netic field and the different types of the coil is established to achieve a smaller field. According to the relationship, the struc-ture of different coils is designed for the suppressed magnetic field. Finally, an electromagnetic simulation is carried out to verify the effectiveness of the designed structure. The results show that the circular coils with a compensation line reduces the magnetic field at 2 mm height from 713 pT/mA to 539 pT/mA compared with the square coil with a compensation line.
MR-029 **16:45-17:00**	Evaluation of the Running Status of Ball Bearings Using Ultrasonic Signals Shengchao Chen, Bo Wang, Guanghua Xu, Jiachen Kuang Presenter: Shengchao Chen Xi'an Jiaotong University, China Abstract-Rolling bearings are key components of rotation machinery, and their failure will result in severe consequences. The lubricating film is important for the normal function of rolling bearings and can be used as a sensitive indicator of the running status of the bearing. The ultrasonic detection method can directly monitor the lubricant film state of the bearing, leading to its capacity of finding the abnormality of rolling bearings at the earliest. This paper presents an attempt to monitor the

	running status of ball bearings using ultrasonic signals. First, the ultrasonic reflection coefficient method based on the spring model is applied to indicate the lubricant film distribution of the ball bearing. Then, under ultrasonic monitoring, a series of experiments are conducted on the test ball bearing with varying operational parameters and different degrees of pitting fault. Finally, the corresponding relationship between the ultrasound-indicated lubricant film distribution and the running status of the bearing is explored. The experimental results suggest that the processed ultrasonic signal has good consistency with the changes in the lubricating status of the bearing, as well as achieving the sensitive detection of pitting fault.
MR-050 **17:00-17:15**	Table-top platform of a large scale underwater swarm Rong Fu, Yang Ding Presenter: Rong Fu Beijing Computational Science Research Center, China Abstract-Hydrodynamic interactions are critical in fish schooling. However, how they can be utilized in underwater swarm robots has not been sufficiently analyzed and the existing systems were not suitable to address this issue. Therefore, we have developed a table-top experimental platform by modifying miniature toy submarines (MTSs) as underwater vehicles. We used a camera, machine learning algorithms, and 2.4 GHz wireless communication module to track and individually control up to 45 MTSs in real time. The underwater swarm can achieve cohesive and stable formations similar to fish school motions, which forms the basis for the analysis of collective behavior and strategies in actual hydrodynamic environments.
MR-070 **17:15-17:30**	Automatic Extrinsic Calibration for Lidar-Photoneo Camera Using a Hemispherical Calibration Board Yangtao Ge, Chen Yao, Zirui Wang, Haoran Kang, Wentao Zhang, and Jing Wu Presenter: Yangtao Ge Southern University of Science and Technology, China Abstract-The reliability of the extrinsic parameters of 3D Light Detection and Ranging (LiDAR) and camera is a prereq-uisite to ensure the common operation of intelligent perception systems. Compared with structured light cameras, monocular or binocular cameras commonly used in intelligent perception systems cannot provide rich and high-precision environmental information. Therefore, the extrinsic parameter calibration be-tween the structured light camera and the lidar is very necessary for the information fusion between both. Here we propose a novel method for extrinsic parameters calibration between structured light camera and 3D lidar to enhance the intelligent perception capacity. The hemispherical surface

	on the calibration board can provide enough effective point clouds, so that the accurate coordinates of the center of the sphere can be stably fitted. And the extrinsic parameters can be solved by considering the centers of the sphere as reference points. To demonstrate the performance of this method, we value it by rotation error and translation error, using the ground truth value obtained from the simulation environment established by gazebo. The experimental results show that our method can get more reliable and accuracy extrinsic parameters between the structured light camera and lidar comparing toward the original method when the transformation is not pure translation.
MR-085 **17:30-17:45**	DeepQRE：a QRE System based on Deep Learning Shun Zhang, Quansheng Dou Presenter: Shun Zhang Shandong Technology and Business University, China Abstract-Many data analysts nowadays are proficient in their fields but lack programming skills. As a result, a lot of them are able to provide examples of data changes but not the required queries. Systems that can manage Query Reverse Engineering(QRE) difficulties are consequently becoming more and more important. Given a database and the output table itself, these systems must be able to pinpoint the query that produced it. By synthesizing SQL queries and R-based table manipulation programs, SQUARES, a tool for program synthesis based on input and output samples, helps data analysts with the extraction and transformation of data.Without any prior knowledge of schema or SQL experience, the user only needs to upload a data report (for example, as a spreadsheet), and the system will automatically compute and provide the queries that can produce that report from the database.
MR-156 **17:45-18:00**	S-PS Resonant Topology of Wireless Power Transfer in Dorsal Root Ganglion Stimulation Zeyu Jiang Presenter: Zeyu Jiang The University of Queensland, Australia Abstract-Chronic pain is taking a heavy toll on contemporary society. Recent breakthroughs in people's comprehension of the pivotal role that dorsal root ganglion (DRG) plays in the formation as well as maintenance of chronic pain have made tremendous strides forward, contributing to the spring up of dorsal root ganglion stimulation (DRGS). By lessening hyperexcitability of the neuropathic DRG, DRGS takes precedence over conventional spinal cord stimulation (SCS) in many respects, including clinical efficacy in hard-to-target anatomies, stimulus precision and the possibility of realizing paresthesia-free analgesia. As to power transfer strategies, wireless power transfer (WPT), which comprises a power

	transmitter and receiver, is introduced to circumvent the flaws of classic embedded batteries, involving infection risks, lead leakage and the indispensability of frequent battery-replacement surgeries, etc. WPT enables the DRG stimulator to be powered and recharged in an unburdened and far safer manner, in which S-PS resonant topology in magnetic resonance coupling is highlighted. Through the study of its modeling and performance analysis in the DRGS-WPT system, it can be concluded that S-PS resonant topology gains an edge over four classical resonant topologies (i.e. SS, PP, SP and PS) in not only transfer range, power transfer efficiency (PTE), with the maximum PTE of nearly 70% at the range of 50 mm, but also safety profile particularly in limited thermal radiation thanks to its high transfer efficiency and moderate voltage gain, all in accordance with the intent of improved adherence to clinical standards. Hopefully, through more in-depth research, the proposed DRGS-WPT system can illuminate the dark road ahead for those who are the perennial victims of intractable chronic pain one day.
MR-171 **18:00-18:15**	Architectural Design and Dynamic Deployment Scheme of Edge Computing Based vCDN Buhua Chen, Ge Chen, Buyang Shen, Chengbin Shen, Ping Yang, Kunlun Li, Huaizhi Yao Presenter: Buhua Chen China Telecom Research Institute, China Abstract-Because of the growing popularity of short videos, VR/AR, big data, IoT and artificial intelligence, there is currently a huge increase in the demand for transmission. It is difficult to manage all real-time, short-term hot data through a traditional CDN alone in terms of storage, computing, and interaction. In order to address the connectivity issues caused by real-time hot content, we propose an overview architecture and a dynamic deployment method for vCDNs based on edge computing. According to the experimental findings, the virtual machine and container-based vCDNs are more flexible than the physical CDN in terms of automatic deployment capabilities and the container based vCDN has the same performance as the physical CDN when configured with the same CDN cache software and hardware configuration. Besides, the evolution suggestions of the edge computing based vCDN are given.
MR-186 **18:15-18:30**	Hierarchical Visual Localization and Measurement Method for Outdoor Large-scale Environment Aoran Xing, Yita Wang, Xuehai Li, Suqin Chen,Wei Li Presenter: Aoran Xing Southern University of Science and Technology, China Abstract-The current large-scene environment recognition technology is mainly used in the field of automatic driving, providing environmental

	information for self-driving cars. It has relatively high localization and navigation capabilities and can make efficient driving decisions. This paper proposes a set of hierarchical visual measurement methods based on binocular stereo vision system. Deep learning target detection algorithm is deployed to provide a visual solution for automatic loading and unloading of container ports which are typical large-scale environments and require a perceptual measurement system to locate and measure containers. Experimental results are presented to verify the feasibility and performance of our proposed method.

Parallel Session 3|平行分会 3

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 3: Robot system design and control 平行分会 3：机器人系统设计与控制 Session Chair: Prof. Yu Liu, Northeastern University, China	February 12th	Sunday 10:40-12:25 Room ID: 674-7776-7108
MR-017 **10:40-10:55**	Multi-mode Planning for a Low-cost Robot Effective Exploration Ruijiao Li, Jian Xu, Hongbin Fang Presenter: Ruijiao Li Fudan University, China Abstract-Exploring unknown environment and creating an accurate map is one of the most important capabilities for a autonomous robot. For a robot to efficiently explore unknown environment, it needs to make optimal decisions to select a proper direction to goals and create waypoints to guide the robot to move towards goals based on gathering information about the environments. This work aims to develop an effective exploration approach for a low-cost mobile robot. We proposed a multi-mode exploration strategy for a robot to work in different scenarios like corridors, rooms, tunnels, open spaces etc. Our approach considers the exploration planning hierarchically-global targets and local targets (also named frontier points) to reduce the cost and improve efficiency. The directions to global targets are restricted by virtual grids and sequenced waypoints of subspace. the local planning is maintained with frontier exploration and sample based planning methods. The planner also obtain the semantic information about environments and obstacles for mapping strategy. Our approach follows the divide-and-conquer thought which makes it possible for autonomous mobile robots to perform exploration effectively with limited computing resource such as tiny modular robots or swarm robots.
MR-019 **10:55-11:10**	Xiaotian-Hybrid: A Novel Wheeled-Quadruped Platform Ruijiao Li, Jian Xu, Hongbin Fang Presenter: Taiheng Ren Southern University of Science and Technology, China Abstract-Wheeled robots and legged robots are two primary classes of mobile robots, possessing different features and excel in different aspects. Wheeled robots can reach higher speed on flat ground with relatively high energy efficiency, while legged robots can move reliably on uneven terrain and overcome obstacles.In this paper, we design a wheeled-quadruped robot "Xiaotian_x005fHybrid", which combines the advantages from both wheeled and legged mechanisms and can switch moving mode between driving and stepping to achieve balance between efficiency and traversability. In addition, quadruped robots are always hard to assemble and disassemble due to the complex power transmission system on their legs and non-standard connection parts with hard-to-reach screws. We apply the

	idea of bottom-up modular design to make each essential part of the robot isolated from others, and therefore improving maintainability.
MR-035 **11:10-11:25**	Developing of Automatic Gasket Gluing Robot For a Tractor Company Suphanut Plengkham, Natchapon Busyakanistha, Nathanicha Promsuwan, Nattanan Santiudommongkol, Ratchatin Chancharoen Presenter: Suphanut Plengkham Chulalongkorn University, Thailand Abstract-Humans are still the primary laborer to apply gasket glue on the brake cases and inspect the tractor's assembly quality in the tractor factory, Siam Kubota Corporation Company Limited. Because working with manual labor still has human errors, the researchers desire to improve the process by using image processing technology and automation to build a machine vision to control the gluing quality on the brake cases and the assembly inspection. For the automatic glue extrusion, a cartesian robot was chosen. The image processing technology was also used to indicate an initial point to start applying glue, and G-code was used to control the robot to move along the designed path on the brake case. Then the glue extrusion robot was tested with two experiments: applying the glue on the sample, which has a surface like the real brake case called Sample 1, to evaluate the performance of the image processing and using the glue on the printed image of the brake case called Sample 2 to determine the performance of the robot in terms of accuracy and precision. This has resulted in the deviation of the gluing distance error process at a 95% confidence interval got; the mean dimension on the actual surface Sample 1 is 0.73±0.04 mm width and 0.72±0.27 height, and the performance of the robot within the exact surface dimension Sample 2 has a mean distance of 1.04±0.1 width and 1.06±0.20 height.
MR-056 **11:25-11:40**	A Light-Weight Quasi-Direct Drive Collaborative Robot Arm Yuntian Zhao, Binxin Huang, Shiyuan Lin, Zheng Zhu, Zhenzhong Jia Presenter: Yuntian Zhao Southern University of Science and Technology, China Abstract-Robot arms are widely used in industrial production and many other applications. However, its widespread application in our daily life, which involves contact-rich human-robot environment interactions, is limited by its actuation paradigm, backdrivability, and compliance. These boarder potential appli_x005f_x0002_cations requires the arm to have good compliance and force control performance, as well as reactive and dynamic manipulation capabilities. In this paper, we propose a novel quasidirect drive(QDD) robot arm with extraordinary compliance,backdrivability, and force-transparency. Compared to active force control, e.g. impedance control, our robot arm's compliance is the natural result of proprioceptive actuation. Our robot arm is also simpler and lighter. This provides possibility of installing the arm on mobile platforms to increase its overall workspace. This paper discusses the robot mechatronics design, modeling and control, system integration and experiments. The result proves our proposed design is promising for

	human-robot-environment interactions.
MR-097 **11:40-11:55**	Attitude Control of an All-Wheel-Drive Rover with Integrated Active Suspension System Siyuan Yin, Wenhui Wang, Longteng Hu, Zheng Zhu, and Zhenzhong Jia Presenter: Wenhui Wang Southern University of Science and Technology, China Abstract-The attitude control is critical for omni-directional vehicles (ODVs) or mobile robots, especially when negotiating with uneven rocky terrains. To improve the pose control capa_x005fbility and traversability performance, some ODVs and rovers are equipped with active suspension system, through which one can improve the robot's stability and maneuverability, thereby optimizing the robot's body posture in real time. In this paper,we design an all-wheel-drive, all-wheel-steering ODV named Big Mars Rover (BMR) with integrated active suspension system consisting of independent active suspensions and passive rockertype differential mechanism. We propose body attitude optimization methods based on hill-climbing and simulated annealing algorithms. We also build a simplified simulation model for BMR and conduct various experiments to verify the feasibility of different attitude optimization methods. The results suggest our BMR has very good body posture adjustment capability over uneven terrains while our attitude control strategies are reliable, demonstrating the effectiveness for future hardware experiments.
MR-129 **11:55-12:10**	Experimental study on the effect of singularity on the stiffness modelling of industrial robots Dehua Gao, Jiaquan Li, Huan Zhao, Kai Wu, Junpei Zhong Presenter: Dehua Gao South China University of Technology, China Abstract-Robot stiffness modelling is essential in robot control. An accurate stiffness model can effectively improve the positioning accuracy of the robot and significantly enhance the robot's performance in various works. Three critical experimental data are important to establish a robot stiffness model: the deformation of end effector, external load, and robot pose. Normally, the robot poses with singularity are considered to be avoided for stiffness modelling. However, it is unclear whether the robot pose close to the singularity has an effect on the modelling accuracy. This paper investigated the influence of the robot poses on the stiffness modelling. Condition number was adopted to describe the degrees of singularity. A series of poses were designed according to the distribution of the condition number. Experiments were designed to exert different loads on the robot to collect the deformations and loading forces. Virtual joint modelling (VJM) approach was used to establish the stiffness model with the experimental data. The influence of the condition number on the modelling accuracy was discussed. The results indicated that the stiffness model has a significant relative error at the position with high singularity. Condition number can be used as a reference index for the

	design of stiffness modelling. And the range of this reference index was given for the experimental robot in this study.
MR-094 **12:10-12:25**	Tomato Crop Identification and Recognition for an Autonomous Agricultural Robotic System Quinn Sahai, Bryan Gilliam, Balasubramaniyan Chandrasekaran Presenter: Balasubramaniyan Chandrasekaran Florida Polytechnic University, USA Abstract-Using computer vision techniques for robotic systems made for use in agricultural settings is optimal for identifying plants yielding fruit ready to be harvested. In this study, a system for identifying objects by comparing them to an image with a single shape and measuring the total difference between them is proposed as a base for a larger system that can correctly identify the stage of maturity of tomato fruit growing on a plant based on the difference in size and shape from a base image. This was performed by a program that compares a template image with a basic shape, such as a circle or square, and counts the number of pixels yielded in a generated image that highlights the difference between the template image and another test image. Another idea proposed in this study is a program that counts objects in an image by using a technique that involves splitting an image into a celled grid. This information can be implemented into a robotic system, such as a Turtlebot, to assist in object/crop detection in an agricultural setting.

Parallel Session 4|平行分会 4

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 4: Machine vision and measurement 平行分会 4：机器视觉与测量 Session Chair: Assoc.Prof. Xiaohua Xia, Chang'an University, China	February 12th	Sunday 10:10-12:10 Room ID: 947-8872-9649
MR-010 **10:10-10:25**	Similarity Contrastive Capsule Transformation for Image-text Matching Bin Zhang,Ximin Sun, Xiaoming Li, Shuai Wang, Dan Liu, Jiangkai Jia Presenter: Ximin Sun State Grid Digital Technology Holding Co.,Ltd/State Grid Xiongan Financial Technology Group Co.,Ltd, China Abstract-Image-text matching plays a critical role in bridging the vision and language, which attracts a lot of attention. Most prior works are devoted to making progress through global alignment between image and text or local alignment between words and regions. However, the scalar-based score is not sufficient to infer the complex relationship between image and text. In this paper, we propose a novel Similarity Contrastive Capsule Transformation (SCCT) network to infer the image-text similarity with capsule clustering. Specifically, we can through capsule network to encode the relationship between word-region score vector and phrase_x005fregion score vector, then get more accurate predictions with a dynamically changing number of capsules. We conduct extensive experiments on Flickr30K and MSCOCO, which shows our superiority over state-of-the-arts methods
MR-041 **10:25-10:40**	DeepEar: A deep convolutional network without deformation for ear segmentation Yuhan Chen, Wende Ke, Qingfeng Li, Dongxin Lu, Yan Bai, Zhen Wang Presenter: Yuhan Chen Southern University of Science and Technology, China Abstract-With the cross-application of robotics in various fields, machine vision has gradually received attention. As an important part in machine vision, image segmentation has been widely applied especially in biomedical image segmentation, and many algorithms in image segmentation have been proposed in recent years. Nowadays, traditional Chinese medicine gradually received attention and ear diagnosis plays an important role in traditional Chinese medicine, the demand for automation in ear diagnosis becomes gradually intense. This paper proposed a deep convolution network for ear segmentation (DeepEar), which combined spatial pyramid block and the encoder-decoder architecture, besides, atrous convolutional layers are applied throughout the network. Noteworthy, the output ear image from

	DeepEar has the same size as input images. Experiments shows that this paper proposed DeepEar has great capability in ear segmentation and obtained complete ear with less excess region. Segmentation results from the proposed network obtained Accuracy = 0.9915, Precision = 0.9762, Recall = 9.9723, Harmonic measure = 0.9738 and Specificity = 0.9955, which performed much better than other CNN-based methods in quantitative evaluation. Besides, this paper proposed network basically completed ear-armor segmentation, further validated the capability of the proposed network. [Manuscript received 10 31 2022; revised 11 25 2023; accepted 01 03 2023.]
MR-082 **10:40-10:55**	Advanced Real Time Embedded Book Braille System Vasile Dan, Ioan Naşcu, and Silviu C. Folea Presenter: Vasile Dan Technical University of Cluj-Napoca, Romania Abstract-Reading is an activity that leads to acquiring information and developing a person's knowledge. Therefore, everyone should have equal access to the same sources of information. Unfortunately, blindness is a disease that restricts the affected people from reading books that are not converted into Braille. This paper describes a novel solution for the real-time conversion of any text into Braille. The system will rely on image processing and a camera to gather the raw text data from any book in physical format. Furthermore, e-books and documents in any digital format, Braille Ready Format (BRF), Portable Embosser Files (PEF), TXT, PDF, or PNG, can be provided for Braille conversion. Image enhancement algorithms, neural networks, and Optical Character Recognition (OCR) algorithms are used to extract accurate content. The process is controlled by a Raspberry Pi 4. A refreshable Braille mechanism, based on an Arduino Due microcontroller, is used to display the dots for each character. The algorithms are implemented to work with the mechanical structure design that was created to reduce the cost and give the user a complete reading experience of any book.
MR-105 **10:55-11:10**	Research on surface defect detection technology of long-distance and long-span FAST cable Xin Tong, Xuehe Zhang, Gangfeng Liu, Changle Li, Jie Zhao Presenter: Xin Tong Harbin Institute of technology, China Abstract-Aiming at the problems of large cable span, small number of defect samples and complex background environment in the FAST cable defect detection task, a set of real-time defect detection algorithms based on convolutional neural network is proposed to realize the accurate location and classification of defects. It can achieve a good detection effect for defects with multiple angles and sizes, especially suitable for medium and long distances. The algorithm is verified on the dataset, and its recognition accuracy can reach 91.7%. Equipped on the hardware inference platform, it

	fully meets the efficiency and accuracy requirements of FAST cable inspection site, can be used in actual cable quality inspection tasks, and can be widely promoted to real-time defect detection of various high-altitude hanging cables.
MR-144 **11:10-11:25**	Hybrid feature based 6D pose tracking under binocular vision for automated micro-assembly Tianyu Xie, Xianmin Zhang, Hai Li, Jianqin Zhang Presenter: Tianyu Xie South China University of Technology, China Abstract-6D tracking is important in robotic based assembly of the MEMS. This paper presents a 6D pose tracking method using hybrid feature for automated micro-assembly. Firstly, the micro-assembly system which mainly comprises of a parallel positioning robot that can largely rotate around three axes, a serial 6-axis robot for manipulation, and a binocular micro-vision modular is built. To realize tracking of the 6D pose under large rotation, a hybrid feature based tracking scheme that can be used under multi-view is developed. Experiments are conducted to verify the performance of the proposed method. The results show that the tracking performance can be effectively improved by simultaneously using the point feature and line feature. Besides, the averaged translation error and rotation error are smaller than 0.031 mm and 0.3 degree, respectively.
MR-032 **11:25-11:40**	Dumping Point Localization of Autonomous Excavation Based on Vision in Trenching Tasks Jiangying Zhao, Yongbiao Hu, Peng Tan, Xiaohua Xia, Zhiyang Feng, Lei Zhang Chang'an University, China Abstract-To solve the problem of the precise position of the dumping points in autonomous excavation, a method of dumping point localization is proposed by using a pose estimation system of monocular vision markers in the excavator coordinate system. Firstly, a marker and a camera are used to establish a pose system prototype of the dumping point for the autonomous excavation. Then, based on the principle of pose estimation, a visual marker detection system is designed, and the position error analysis of pose estimation is proposed. Finally, the field test shows that the proposed localization method can precisely obtain the position of the dumping point.
MR-016 **11:40-11:55**	Detection for Tiny Screw and Screw Hole by Semantic Segmentation Model Wanhao Niu, Haowen Wang, Chungang Zhuang Presenter: Wanhao Niu Shanghai Jiao Tong University, China Abstract-Automatic detection for screws and screw holes is crucial for the automatic assembly and disassembly of screws on the production line. The

	mainstream detection schemes mainly include vision-based methods, deep learning based methods in an end-to-end fashion, and the combinations of the two. In this paper, we suggest that semantic segmentation models combining with post processing can boost the performance of the positioning and identification of screws and screw holes on the mobile phone PCB. In our experiment, the semantic segmentation modelcorrectly detected all screws and screw holes in stable condition;in vibrating conditions, the detection accuracy is 99.7%. The high detection accuracy of our method ensures the subsequent stable automatic assembly and disassembly of screws while promoting the efficiency of production lines, which can reduce the burden of repetitive work of workers effectively.
MR-174 **11:55-12:10**	Autonomous Driving Peripheral and Central Vision Region Selection For Semantic Segmentation Ahmed Abdelkader, Mohamed Abdelwahab, Fady Ibrahim, Mohamed Abdelaziz Presenter: Ahmed Abdelkader Ain Shams University, Egypt Abstract-Recently, there has been a lot of interest in autonomous cars and fully autonomous cars are anticipated to hit the roads soon. Vehicle understanding of the surrounding environment is one of the most important autonomous driving tasks and this task is done using segmentation based on deep convolutional neural network which is always accompanied with a very high computational load. in this paper we proposed a method to reduce the computation time by mimicking the human eye vision in term of dividing the wide field of view in to two zones the Peripheral vision and the central vision. The Peripheral vision included the entire field of view of the camera while the central vision was selected based on the path and lateral acceleration of the vehicle whether it was moving to the right, left or straight ahead. The results showed a great improvement in the computational time.

Parallel Session 5|平行分会 5

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 5: Intelligent system design and optimization 平行分会 5：智能系统设计与优化 Session Chair: Dr. Weitao Wu, Zhejiang University, China	February 12th	Sunday 14:00-16:00 Room ID: 674-7776-7108
MR-038 **14:00-14:15**	Smart Trash Classification Machine Pathaphon Wiriwithya, Siwach Rungnarongruck, Sasapol Pongamphai, Saranyapong Puapattanakul, Ratchatin Chancharoen Presenter: Pathaphon Wiriwithya Chulalongkorn University, Thailand Abstract-Smart trash classification machine is a machine vision made to handle the problem of unsorted trash from its primary source. The machine is made to classify trash in a short time with high efficiency and consists of two components. The first component is software for constructing an algorithm using the TensorFlow library, built in the Python programming language, to produce an image of trash and store it in the library. The image will be divided into six types based on their characteristics and shape and will be automatically analysed using the deep learning ImageNet model. When the safety light curtain sensor detects trash, a signal is sent to the RGB camera, which captures an image of the trash. The acquired image will then be analysed by algorithm software that is compared to the library image in the database and then sends a signal to the hardware component indicating the type of trash. The second component is hardware, which consists of an RGB camera, light curtain safety sensors, a bin-driving motor, and garbage sorting bins.	
MR-059 **14:15-14:30**	Guaranteed Gaussian Process Predictive Control for Lipschitz Nonlinear System with Input and State Constraints Jinxin Zhang, Hongze Wang Presenter: Jinxin Zhang Institute of Automation, Chinese Academy of Sciences, China Abstract-Though model predictive control can systematically handle the control problem of multi-input multi-output system under state and input constraints, it heavily depends upon the model of the controlled system. The non-parametric nature of the Gaussian Process endows it with the flexibility of modeling various practical systems and, more importantly, the ability to provide the level of confidence in its predictions, which makes it preferable to the model predictive control. Therefore, in this paper, these two approaches are combined into a whole scheme, called the Gaussian Process Predictive Control, which can make the system avoid some relatively uncertain areas, through incorporating the variance into the	

	objective function.Then with some mild assumptions, the closed system stability and recursive feasibility is guaranteed theoretically, and validated by a standard simulation example.
MR-126 **14:30-14:45**	Trilateration System Based on Bluetooth Distance Measurement Principle Jinxin Zhang, Hongze Wang Presenter: Wenzhao Shu Dongguan University of Technology and Yanshan University, China Abstract-With the development of indoor positioning space, the demand for indoor positioning is increasing day by day. Indoor positioning solutions (IPS) have been applied in many scenarios, such as intelligent business super intelligent buildings intelligent hospitals and so on. Low power consumption of Bluetooth can be seen everywhere in life. Compared with other technologies, it has obvious advantages such as high availability, high positioning accuracy and low power consumption. In this paper we focus on a Bluetooth ranging solution by studying the Phase Based Distance Estimation (PSDE) principle, establishing Multiple Connections between the base station and the tag, then solving for the tag coordinates based on the Trilateral Ranging(TR) principle, and also proposing a data error handling approach for range error solving. Through trilateral positioning, we can obtain the tag's position and visualize the map using the drawing display. According to the data results, the absolute distance between the tag's calculated position and the actual position is no more than 1m. Applying the above solution approach, Bluetooth ranging can effectively improve the positioning accuracy and provide new ideas for the application of ranging solutions in positioning.
MR-132 **14:45-15:00**	Wavelet Scattering Cyclostationarity Representation for Machine Intelligent Fault Diagnosis Chao Liu, Tianyu Han, Xi Shi Presenter: Chao Liu Shanghai Jiao Tong University, China Abstract-Machine intelligent fault diagnosis(IFD) model con-sists of a feature extractor and a pattern classifier. As ma-chine fault information is conveyed by the cyclostationarity of the monitored signals, the feature extractor should capture the monitored signal’ s cyclostationarity to ensure feeding the classifier with diagnostic-relevant features. Conventional cyclo-stationarity representations, e.g., cyclic spectral correlation(CSC), cyclic modulation spectrum(CMS), and multi-scale envelope spec-trogram(MuSEnS), are unstable to signal deformation caused by working condition variability. As a result, the IFD model taking conventional cyclostationarity representation as the fea-ture extractor will deteriorate when working condition variation occurs. This current work formulates wavelet scattering as a novel cyclostationarity representation and verifies

	its stability to working condition variability theoretically and experimentally to remedy this gap.
MR-159 **15:00-15:15**	A Retrofitted Dynamic Window Approach with Pivot Point Control for Maneuring Inland Vessels on Constrained Surfaces Dingrui Wang, Yanyun Zhang, Peter Slaets Presenter: Dingrui Wang The Hong Kong University of Science and Technology (Guangzhou), China Abstract-Inland waterways play an important role in the transportation of goods and passengers. But maneuvering vessels in this type of restricted area can be challenging due to the limited maneuverability and the presence of obstacles. Hence, these areas can be abstracted as constrained surfaces. The dynamic window approach (DWA) is a path planning strategy for real-time navigation in constrained environments that considers dynamic constraints. While the pivot point concept is a useful technique which analyze the spot that vessels rotate around. Concerning these two concepts, this paper proposes a real-time local path planning algorithm named retrofitted dynamic window approach (RDWA) for maneuvering inland vessels on constrained surfaces. The algorithm retrofitted the DWA to satisfy the control behavior constraints stemming from the limited maneuverability. Further, the pivot point technique is leveraged to enable the vessel to pivot around desired points. The algorithm is evaluated by simulations, which demonstrate the approach can pivot the vessel around a number of pre-defined points for more than 90 degrees and form an arc motion trajectory in less than three minutes.
MR-1001 **15:15-15:30**	Structure Keeping Control for Heterogeneous Formations Based on Consistency Theory and Graph Theory Anxu Wang, Fuqi Jing, Xiaowei Huang, Chengye Gong, Shu Xu Presenter: Anxu Wang China Nanhu Academy of Electronics and Information Technology, China Abstract-This paper studies the formation control problem of heterogeneous formations of UGV/UAVs in the collaborative reconnaissance scenario. It is required that UAVs in the formation keep tracking the UGV and the structure of the heterogeneous formation keep stable. First, the kinematics and dynamics of the UAV and UGV are modeled, and graph theory is introduced to establish a cooperative control model of heterogeneous formation. Then, the overall movement trajectory of the formation is described by the UGV. And based on the distributed observer of the state of UGV, a distributed formation tracking controller is constructed for each UAV. Finally, an experiment on real UGV/UAVs formation is given to verify the effectiveness of the designed controller. Two motion conditions, around 8 and around a circle, are designed. The experimental results show that the control method proposed in this paper can make the UAV swarm perform

	better when tracking. And compared with other methods, heterogeneous formation can maintain a more stable structure.
MR-006 **15:30-15:45**	Model Predictive Control Design of a 3-DOF Robot Arm Based on Recognition of Spatial Coordinates Zhangxi Zhou, Yuyao Zhang, Yezhang Li Presenter: Zhangxi Zhou University of Liverpool, United Kingdom Abstract-This paper uses Model Predictive Control (MPC) to optimise the input torques of a Three-Degrees-of-Freedom (DOF) robotic arm, enabling it to operate to the target position and grasp the object accurately. A monocular camera is firstly used to recognise the colour and depth of the object. Then, the inverse kinematics calculation and the spatial coordinates of the object through coordinate transformation are combined to get the required rotating angle of each servo. Finally, the dynamic model of the robotic arm structure is derived and the model predictive control is applied to simulate the optimal input torques of servos to minimise the cost function.
MR-180 **15:45-16:00**	Sub-micron Level 3D Vision Measurement System Suqin Chen, Aoran Xing, Xuehai Li, Yita Wang, Wei Liu Presenter: Suqin Chen Southern University of Science and Technology, China Abstract-The current mainstream localization techniques are not suitable for indoor cooperative UAV swarm no matter the accuracy or the independency. An indoor UWB coordination system is proposed to compensate the accumulated errors of inertial coordination unit (IMU) system to achieve centimeter level localization for the indoor cooperative UAV swarm. Several algorithms are deployed to optimize the location result to make it more accurate and robustized.

Parallel Session 6|平行分会 6

All schedules will be scheduled in Beijing Time (GMT+8) 日程时间安排均为北京时间

Session 6: Mechanical and electronic monitoring system 平行分会 6：机械与电子监测系统 Session Chair: Assoc.Prof.Haibo Liu, Dalian University of Technology, China	February 12th	Saturday 14:00-16:00 Room ID: 947-8872-9649
MR-003 **14:00-14:15**	Prototyping to Mass Production: Automated CAD Model and G-Code Optimization Framework for Industrial 3D Printing Fandi Peng Presenter: Fandi Peng Hong Kong University of Science and Technology (HKUST), China Abstract-3D printing has the potential to be widely applied in mass production with customization. However, iterating the computer-aided design (CAD) models and printing configurations to obtain the desired object mostly remains atedious trial and error process. Various automation techniques have been proposed to facilitate the CAD model creation process and a few of them are designed specifically for 3D printing. We propose an automation framework for industrial 3D printing, which translates both constraints and requirements into technical parameters for corresponding geometric optimization for CAD models and G-code generation for the printing tasks. This framework aims to further close the gap between rapid prototyping and mass production for industrial 3D printing.	
MR-009 **14:15-14:30**	Design of underwater vehicle for ship draft observation Jingyuan Zhu, Meng Han, Hongliang Zhang, Lan Qi, Lianyu Zhao, Chenglin Wang Presenter: Jingyuan Zhu Tianjin University of Technology, China Abstract-Underwater Vehicles are very important underwater operation equipment, and a new underwater is designed in order to realize the measurement of the ship draft. The design is based on the ROV(Remote Operated Vehicle)structure, and the mobile power supply and the upper computer are mounted on the underwater vehicle body, aiming to accomplish the task of disconnecting the underwater vehicle from the cable under complex sea conditions. In this paper, the system communication and power supply scheme design, thruster arrangement, the center of gravity and floating center position design, and 3D model design are completed in turn to obtain a structural design scheme of the underwater vehicle based on the actual engineering background. Subsequently, the strength check of the overall frame was carried out based	

	on ANSYS WORKBENCH, which proved that the material selection and structural design met the reliability requirements. Finally, the hydrodynamic characteristics of the robot were analyzed using ANSYS CFD.
MR-011 **14:30-14:45**	A Dual-Pump Energy-Efficient Electro-Hydraulic Drive with Extended Velocity Range Jeremy Beale, Damiano Padovani Presenter: Damiano Padovani Guangdong Technion-Israel Institute of Technology, China Abstract-This paper addresses some challenges of expanding the velocity range of energy-efficient, electro-hydraulic actuators to enable low-velocity operations for extended periods of time.Our main research question is how to avoid low-speed functioning of the hydraulic pumps while maintaining a simple and cost-effective system design. We propose a dual-pump drive equipped with a mechanical-hydraulic switching valve that smoothly disconnects one pump from the hydraulic actuator when low-velocity is desired for the actuator. We validated this approach on a metal forming machine using simulation. Our results show that the proposed system can replace conventional single-pump drives in relevant applications because the overall system's behavior remains as expected, but the hydraulic pumps always rotate fast enough to avoid critical issues due to overheating, control instability, and low efficiency. The proposed drive is also torque-limiting, which means that downsizing of the electric motor is possible in favor of the system cost-effectivenessand compactness.
MR-012 **14:45-15:00**	Optimal strategy of disassembly process in electric vehicle battery based on human-machine collaboration re-manufacturing Guoxian Wang, Jiaxu Gao, Jinhua Xiao Presenter:Jiaxu Gao Wuhan University of Technology, China Abstract-The automatic disassembly of electric vehicle battery has always been a key issue in the field of electric vehicle battery recycling. This paper proposes an optimal strategy of disassembly process in electric vehicle battery based on human-machine collaboration re-manufacturing, which combines with artificial intelligence algorithms to complete the identification and positioning of operational targets, optimize the sequence of man-machine operation tasks, and improves the efficiency and safety of the disassembly process. Finally, the research prospects for the implementation of the overall strategy and the future development direction are proposed.
MR-013 **15:00-15:15**	A genetic algorithm-based optimization approach for disassembly tool selections toward electric vehicle battery disassembly

	Guoxian Wang, Hongjing Wu, Jinhua Xiao Presenter: Hongjing Wu Wuhan University of Technology, China Abstract-The electric vehicle battery of new energy vehicles has ushered in the first batch of decommissioning. In order to reduce its impact on the environment, the recovery and disassembly of the electric vehicle battery has received extensive attention. In view of the problems that the disassembly of new electric vehicle batteries still adopts manual operation and the robot cannot complete the disassembly task independently, and they need to select appropriate tools during the disassembly process, a genetic algorithm-based evaluation method for the selection of tools in the recycling and disassembly of electric vehicle batteries is proposed. The optimization model of disassembly tools is established, and then the proposed model is further studied and prospected.
MR-118 **15:15-15:30**	Design and Kinematics Analysis of 3-PUU Translational Parallel Machine Eka Marliana, Latifah Nurahmi , Arif Wahjudi, I Made Londen Batan, Guowu Wei Presenter: Eka Marliana Institut Teknologi Sepuluh Nopember, Indonesia Abstract-The 3-PUU (Prismatic and Universal joints) translational parallel machine is one of the three-degree-of-freedom (DOF) parallel manipulators, which was previously introduced by Tsai & Joshi in 2002. Since it performs 3-DOF and pure translation motion, this mechanism can be used as a welding robot that only needs to move in a translation manner. This paper discusses the kinematics and singularity analysis of a 3-PUU parallel machine composed of three identical PUU limbs. A constraint equation is computed based on the algebraic geometry method, and it solves the forward kinematics solutions. Based on the computation, it reveals that there are four solutions of the forward kinematics problem. The workspace of each solution of forward kinematics is plotted. The singularity conditions are obtained by computing the zero set of the determinant of the Jacobian matrix, then mapped onto the workspace. The analysis shows that the singularities occur when the moving platform altitude is null and at the highest. Additionally, a numerical simulation with trapezoidal trajectory input has been proposed to verify the kinematics analysis results.
MR-123 **15:30-15:45**	Coupling of an automatic landslide warning system for retaining walls for road infrastructure protection David Steven Cuicupuza Curipaco, Pedro Luis Godoy Jerónimo, Angel Tacas Diaz, Giovene Perez Campomanes, Sario Angel Chamorro Quijano, Mohamed Mehdi Hadi Mohamed, Diego Cajachagua Guerreros Presenter: Angel Tacas Diaz Universidad Continental, Peru

	Abstract-This research presents the design of an early warning system against landslides for road infrastructure, through mechatronic systems with IOT communication, which will help in the prevention of road accidents with a quick response. The system can be coupled to existing walls or in the process of construction, and shows the application of force and infrared sensors. The system is divided into 3 processes that will help a quick response with autonomy in each process. The detection stage of a possible landslide is given by force and infrared sensors, which will check if it is a massive landslide sending an alert to the control center, in the second process will be the rectification of the landslide by force and infrared sensors that will send a signal that there is a larger landslide, and the last process is the alert through the sensors located in the crown of the wall, which will send a visual and audible alert of a massive landslide meters before the landslide. The design of the proposed system provides an alternative of safety against landslides with a methodology that couples the already existing retaining walls or new projects with the addition of the proposed system for road infrastructures with the purpose of preventing damage events through the alert and it is expected that in future research the proposed design can be improved.
MR-153 **15:45-16:00**	Universal Five-Axis RTCP Adaptive Dispensing Interpolation System Based on Dual NURBS Yichong Lin, Di Li, Minghao Cheng Presenter: Yichong Lin South China University of Technology, China Abstract-This paper proposed a five-axis RTCP adaptive dispensing interpolation algorithm based on dual NURBS curves, to meet the requirement for high dispensing efficiency in the electronic industry. A universal RTCP transformation algorithm is used to transform the programming trajectory to the machine tool control point trajectory for five-axis machines with different configurations. The machine tool control point trajectory and the dispenser head trajectory are fitted by dual NURBS curves separately. The predictor-corrector method solves the curve position parameter at the corresponding time. The corresponding position relationship between the dual curves is determined according to the parameter synchronization relationship, which solves the adaptively adjusted dispensing frequency. A dispensing processing experiment is designed, and results show that the algorithm in this paper can achieve shorter processing time than dual NURBS equidistant dispensing under process constraints.