



 **ICCAR**  
Singapore | April 20-23, 2020

# CONFERENCE PROGRAM

The 6th International Conference on  
Control, Automation and Robotics

Co-Sponsored by



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# About ICCAR

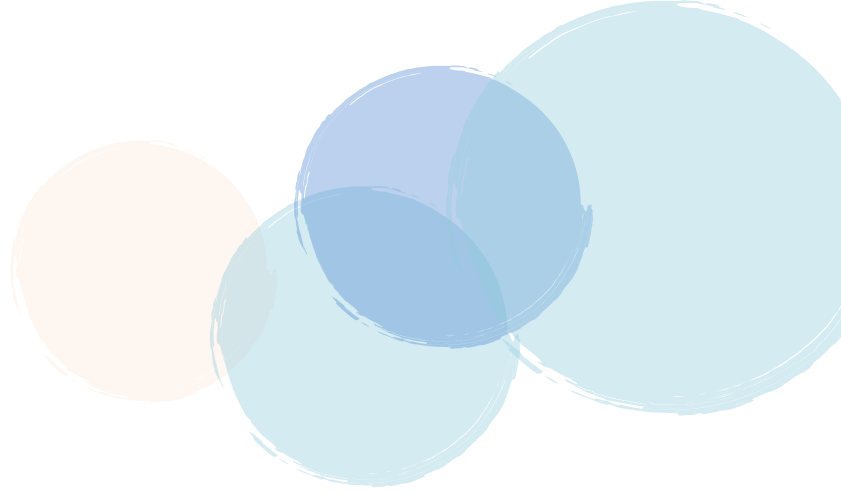
ICCAR was previously held in Beijing, China in 2019, Auckland, New Zealand in 2018, Nagoya, Japan in 2017, Hong Kong in 2016 and Singapore in 2015.

On the theoretical side, this conference features papers focusing on intelligent systems engineering, distributed intelligence systems, multi-level systems, intelligent control, multi-robot systems, cooperation and coordination of unmanned vehicle systems, etc. On the application side, it emphasizes autonomous systems, industrial robotic systems, multi-robot systems, aerial vehicles, underwater robots and sensor-based control.

For the first time ever, ICCAR affords the delegates unparalleled opportunities to interact and network with qualified professionals from throughout the world.

## Basic protective measures against the COVID-19 from WHO

- Wash your hands frequently
- Maintain social distancing
- Avoid touching eyes, nose and mouth
- Practice respiratory hygiene
- If you have fever, cough and difficulty breathing, seek medical care early
- Stay informed and follow advice given by your healthcare provider



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# Welcome

It gives us immense pleasure to invite you to attend The 6th International Conference on Control, Automation and Robotics (ICCAR 2020). The conference focuses on the trending, highly popular, but exciting and extremely challenging areas from our keynote speakers of leading scientists and a variety of authors around the world. The outcome of our deliberations will play a crucial role in progress achieved in these areas. The conference was scheduled in Singapore this year. Unfortunately, the entire world now is struggling against the virulent pandemic COVID-19. Today we are witnessing the unbounded global spread of the disease and each of us is affected. We hope all of you can stay healthy.

The conference brings together researchers looking for opportunities for conversations that cross the traditional discipline boundaries and allows them to resolve multidisciplinary challenging problems. It is the clear intent of the conference to offer excellent mentoring opportunities to participants. Although we cannot meet each other physically, through this online platform, we trust that you still will be able to share the state-of-the-art developments and the cutting-edge technologies in these broad areas.

We have an exciting four days planned. There will be over 100 oral presentations divided into 17 parallel sessions, around 30 poster presentations, 3 keynote speakers, 3 invited speakers and 1 tutorial session.

Special thanks are extended to our colleagues in program committee for their thorough review of all the submissions, which is vital to the success of the conference, and also to the members in the organizing committee and the volunteers who had dedicated their time and efforts in planning, promoting, organizing and helping the conference. Last but not least, our special thanks go to speakers as well as all the authors for contributing their latest researches to the conference.

In closing, we thank you for participating in ICCAR 2020 and we hope you enjoy the next four days.

## **General Conference Chair**

**Dr. Ferial El-Hawary, Life Fellow IEEE**

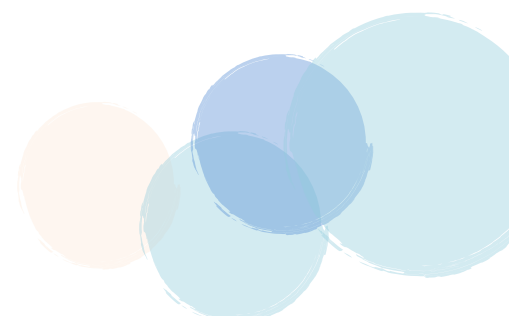
F.El-Hawary@ieee.org

TEL: (902) 449-5110

www.ferialdal.ca



# Conference at a Glance



| SUNDAY<br>19 APRIL  | MONDAY<br>20 APRIL                      | TUESDAY<br>21 APRIL                     | WEDNESDAY<br>22 APRIL                      | THURSDAY<br>23 APRIL                        |
|---|---|---|--|---|
| 9:30AM-11:30AM<br>Test Session 1<br>Test Session 2              | 9:00AM-9:05AM<br>Opening Remarks        |   | 9:00AM-10:00AM<br>Tutorial                 |   |
|   | 9:05AM-9:50AM<br>Keynote Speech I       | 10:00AM-10:30AM<br>Invited Speech I     | 10:00AM-10:30AM<br>Break                   | 10:00AM-11:30AM<br>Session 15<br>Session 16 |
|   | 9:50AM-10:35AM<br>Keynote Speech II     | 10:30AM-11:00AM<br>Invited Speech II    | 10:30AM-12:00PM<br>Session 9<br>Session 10 |   |
|   | 10:35AM-10:50AM<br>Break                | 11:00AM-11:15AM<br>Break                |  |   |
|   | 10:50AM-11:35AM<br>Keynote Speech III   | 11:15AM-11:45AM<br>Invited Speech III   |  |   |
| 11:30AM-1:00PM<br>Break   | 11:35AM-1:30PM<br>Break                 | 11:45AM-1:30PM<br>Break                 | 12:00PM-1:30PM<br>Break                    | 11:30AM-1:30PM<br>Break                     |
| 1:00PM-3:00PM<br>Test Session 3<br>Test Session 4               | 1:30PM-3:00PM<br>Session 1<br>Session 2 | 1:30PM-3:00PM<br>Session 5<br>Session 6 | 1:30PM-3:00PM<br>Session 11<br>Session 12  | 1:30PM-3:00PM<br>Session 17                 |
| 3:00PM-4:00PM<br>Break  | 3:00PM-4:00PM<br>Break                  | 3:00PM-4:00PM<br>Break                  | 3:00PM-4:00PM<br>Break                     | 3:00PM-4:00PM<br>Break                      |
| 4:00PM-6:00PM<br>Test Session 5<br>Test Session 6<br>KN&IS Test | 4:00PM-5:30PM<br>Session 3<br>Session 4 | 4:00PM-5:30PM<br>Session 7<br>Session 8 | 4:00PM-5:30PM<br>Session 13<br>Session 14  | 4:00PM-5:20PM<br>Poster 1<br>Poster 2       |

# Organizing Committee



## Conference Chair

Ferial El-Hawary, Dalhousie University, Canada / IEEE Life Fellow

## Conference Co-Chair

Shuzhi Sam Ge, National University of Singapore, Singapore / IEEE Fellow, IFAC Fellow, IET Fellow, IES Fellow

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Dan Zhang, Beijing Jiaotong University, China

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Chih-Hsing Liu, National Cheng Kung University, Taiwan

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Choosak Pornsing, Silpakorn University, Thailand

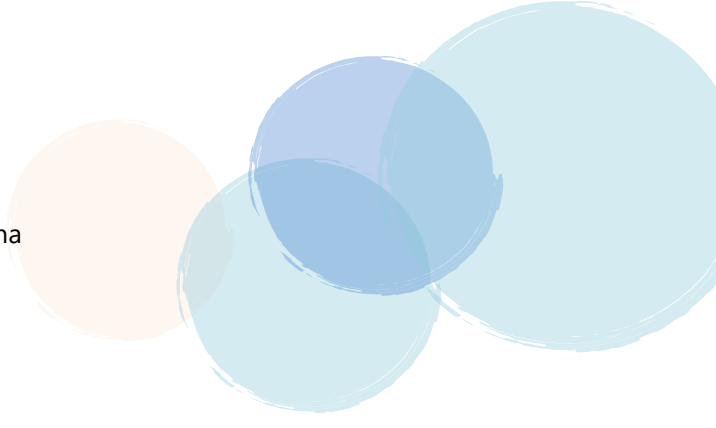
Chunshan Yang, Guilin University of Aerospace Technology, China

Dante Elias, Pontificia Universidad Católica del Perú, Peru

Eduardo Bejar, Pontifical Catholic University of Peru, Peru

Emese Gincszainé Szádeczky-Kardoss, Budapest University of Technology and Economics, Hungary

G. Panda FNAE, Indian Institute of Technology, Kharagpur, India



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Ibai Inziarte Hidalgo, Aldakin Automation S.L., Spain  
Javier Sanjuan de Caro, Universidad del Norte, Colombia  
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John Lozano, Pontifical Catholic University of Peru, Peru  
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Jun He, Shanghai Jiao Tong University, China  
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Mohamed Hussien, UTM, Malaysia  
Mustafa Doğan, Istanbul Technical University, Turkey  
Nenad Popovich, Auckland University of Technology, New Zealand  
Ning Sun, Nankai University, China  
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Przemyslaw Orłowski, West Pomeranian University of Technology Szczecin, Poland  
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Rolf Wanka, University of Erlangen-Nuremberg Erlangen, Germany  
Roman Neruda, Institute of Computer Science, Czech Academy of Sciences, Czech Republic  
Ruan Gopura, University of Moratuwa, Sri Lanka  
Serdar Biroğul, Duzce University, Turkey  
Sergei Semakov, Moscow Institute of Physics and Technology and Moscow Aviation Institute, Russia  
Steve Vanlanduit, University of Antwerp, Belgium  
Syuan-Yi Chen, National Taiwan Normal University, Taiwan  
Takanori Miyoshi, Toyohashi University of Technology, Japan  
Toyomi Fujita, Tohoku Institute of Technology, Japan  
Tran Thi Hong, Thai Nguyen University of Technology, Viet Nam  
Tzong-Hann Shieh, Feng Chia University, Taiwan  
Ulrich Berger, Brandenburg University of Technology Cottbus, Germany  
Utkal Mehta, University of the South Pacific, Fiji  
Valentina Emilia Balas, Aurel Vlaicu University of Arad, Romania

Vanel Lazcano, Universidad Mayor, Chile  
Venkatarangan Mj, PES University, India  
Weijun Zhu, Zhengzhou University, China  
Wen-Chung Chang, National Taipei University of Technology, Taiwan  
Weng Kin Lai, Tunku Abdul Rahman University College, Malaysia  
Xiaobing Mao, Wuhan University of Technology, China  
Xiaocong Zhu, Zhejiang University, China  
Xiaofang Wang, Beijing Institute of Technology, China  
Xingyu Jiang, Shenyang University of Technology, China  
Yan Song, Anhui Agricultural University, China  
Yao Yan, University of Science and Technology of China, China  
Ying Chen, Jiangnan University, China  
Ying-Chih Lai, National Cheng Kung University, Taiwan  
Ying Shi, Changchun Institute of Technology, China  
Yoshifumi Morita, Nagoya Institute of Technology, Japan  
Young-Seon Jeong, Chonnam National University, South Korea  
Yuhong Zhang, Jilin Jianzhu University, China  
Yunna Tian, Beijing Institute of Technology, China  
Yupeng Yuan, Wuhan University of Technology, China  
Yu-Sheng Lu, National taiwan normal university, Taiwan  
Zareena Kausar, Air University, Pakistan  
Zhaochen Zhang, Taishan Medical University, China  
Zhengping Zhao, Fuyang Normal University, China  
Zhi Qing Huang, Beijing University of Technology, China  
Zhi-Ming Wang, University of Science and Technology Beijing, China  
Zhumadil Baigunchekov, Satbayev University, Kazakhstan

# Preparation for Online Conference



## Time Zone

### **Singapore Time (GMT+8)**

You're suggested to set up the time on your computer in advance.

## Platform

### **ZOOM**

Video Tutorials:

<https://support.zoom.us/hc/en-us/articles/206618765-Zoom-Video-Tutorials>

GIF Tutorial:

<http://iccar.org/zoom.html>

Chinese Tutorial:

<http://iccar.org/files/Zoom-manual-CN.pdf>

## Test before Formal Meeting

### **Date: April 19, 2020**

Prior to the formal meeting, presenters shall join the test room to ensure everything is on the right track. Please check your test time at page 9.

## Equipment Needed

- A computer with internet connection and camera
- Headphones

## Environment Needed

- A quiet place
- Stable internet connection
- Proper lighting and background

## Q&A Room

If you have any problems about the online operating during the conference days, please enter the Q&A room

**Meeting ID: 309-882-535**



# Presentation Guideline



## Voice Control Rules

- The host will mute all participants while entering the meeting.
- The host will unmute the speakers' microphone when it is turn for his or her presentation.
- Q&A goes after each speaker, the participant can raise hand for questions, the host will unmute the questioner.
- After Q&A, the host will mute all participants and welcome next speaker.

## Oral Presentation

- Timing: a maximum of **15 minutes** in total, including 3 minutes for Q&A. Please make sure your presentation is well timed.
- It is suggested that the presenter email a copy of his/her video presentation to the conference email box as a backup in case any technical problem occurs.

## Poster Presentation

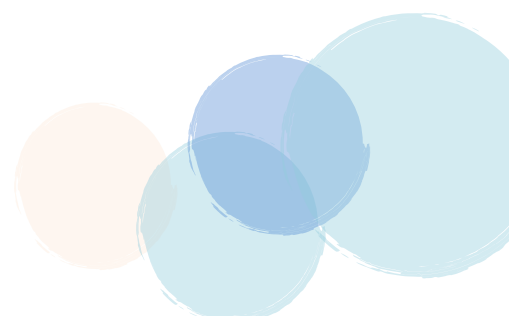
All the posters will be shown for **5 minutes** in the poster presentation room. Q&A goes after each poster shown.

## \*Conference Recording

The whole conference will be recorded. We appreciate you proper behavior and appearance.

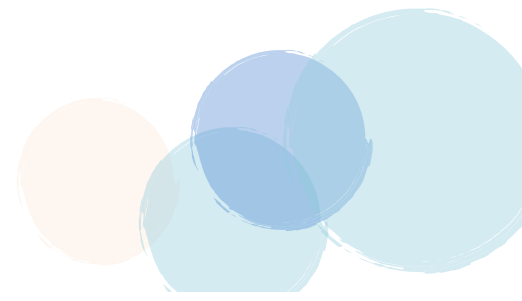
\* The recording will be used for conference program and paper publication requirements. The video recording will be destroyed after the conference and it cannot be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose. It will only be recorded by the staff and presenters have no rights to record.

# Test Sessions at a Glance



|                    | Time        | Session     |   | Paper ID   | Meeting ID  |
|--------------------|-------------|-------------|---|--|-------------|
| Sunday<br>19 April | 9:30-11:30  | 1           | 9:30-10:30                                      | A012 A017 A022 A030<br>A031 A047 A071 A073-A A089        | 754-910-845 |
|                    |             |             | 10:30-11:30                                     | A133 A138 A140 A156 A165<br>A175 A2005 A2015 A2021       |             |
|                    |             | 2           | 9:30-10:30                                      | A0007 A0011 A0012 A038<br>A070 A074 A083 A084            | 110-795-216 |
|                    |             |             | 10:30-11:30                                     | A087 A096 A114 A124<br>A126 A176 A2010 A2017             |             |
|                    | 13:00-15:00 | 3           | 13:00-14:00                                     | A009, A015, A0015, A019<br>A023 A029 A041 A045 A049      | 754-910-845 |
|                    |             |             | 14:00-15:00                                     | A063, A072-A, A109, A116<br>A123, A166, A174, A182, A183 |             |
|                    |             | 4           | 13:00-14:00                                     | A011 A037 A040 A042<br>A074 A086 A097 A103 A112 A098     | 110-795-216 |
|                    |             |             | 14:00-15:00                                     | A115 A117 A119 A125 A129<br>A180 A185 A2013 A2014        |             |
| 16:00-18:00        | 5           | 16:00-17:00 | A002 A032 A058 A065<br>A085 A090 A131 A137 A141 | 754-910-845  |             |
|                    |             | 17:00-18:00 | A151 A158 A163 A170<br>A181 A184 A168 A169      |  |             |
|                    | 6           | 16:00-17:00 | A006 A0008 A0009<br>A020 A024 A035 A057         | 110-795-216  |             |
|                    |             | 17:00-18:00 | A135 A142 A145<br>A147 A148 A157, A2022         |  |             |
|                    | 7           | 16:00-17:00 | Keynote Speech Test                             | 640-0883-8555  |             |
|                    | 8           | 17:00-18:00 | Invited Speech Test                             |  |             |

# Plenary Sessions at a Glance



|                       | Time        | Item               | Topic  | Meeting ID    |
|-----------------------|-------------|--------------------|--|---------------|
| Monday<br>20 April    | 9:00–9:05   | Opening Remarks    | Ferial El-Hawary<br>Dalhousie University, Canada   | 640-0883-8555 |
|                       | 9:05–9:50   | Keynote I          | Distributed Control of Multiagent Systems: Theory and Applications<br>Hamid Reza Karimi<br>Politecnico di Milano, Italy  |               |
|                       | 9:50–10:35  | Keynote II         | Localization and Control in GPS Denied Environment<br>Lihua Xie<br>Nanyang Technological University, Singapore   |               |
|                       | 10:50–11:35 | Keynote III        | Development and Fusion of Artificial Intelligence and Robotics<br>Shuzhi Sam GE<br>National University of Singapore, Singapore   |               |
| Tuesday<br>21 April   | 10:00–10:30 | Invited Speech I   | Design and Application of Force-Sensing Robotic Systems for Micromanipulation<br>Qingsong Xu<br>University of Macau, China   | 640-0883-8555 |
|                       | 10:30–11:00 | Invited Speech II  | A Class Model-Based Control Techniques Used in Electro-hydraulic System and Wearable Exoskeleton<br>Qing Guo<br>University of Electronic Science and Technology of China, China              |               |
|                       | 11:15–11:45 | Invited Speech III | Towards Condition Monitoring and Prognosis of Railway Tracks<br>Andrew Keong Ng<br>Singapore Institute of Technology, Singapore  |               |
| Wednesday<br>22 April | 9:00–10:00  | Tutorial           | Deep Learning of Dynamic Neural and Fuzzy-Neural Networks for Modeling and Intelligent Control of Nonlinear Dynamic Systems<br>Antonio Moran<br>Pontifical Catholic University of Peru, Peru | 640-0883-8555 |



# Opening Remarks

## Conference Chair

**Ferial El-Hawary**

**Dalhousie University, Canada**

**IEEE Life Fellow**

Dr. Ferial El-Hawary (M'82-S'86-F'99) received the B.Eng. degree from University of Alexandria, and the M. Sc. from the University of Alberta, Edmonton, Canada, in Electrical Engineering; and the Ph.D. in Oceans Engineering from Memorial University of Newfoundland, Canada. Dr. El-Hawary is President of BH Engineering Systems Ltd. She served on the Faculty of Engineering at Dalhousie University, where she established and directed the Modeling & Signal Analysis Research Laboratory. Sustained research contribution devoted to OCEANS Application with significant impact on defense, navigation and Oil & Gas exploration. She has published widely in IEEE Journals. She is Editor-in-Chief of The Ocean Engineering Handbook and served as Associate Editor of IEEE Oceanic Engineering Journal. With more than twenty-five years experience in teaching Electrical and Signal Processing for Oceanic Engineering applications, she has made significant and sustainable contributions in promoting and developing continuing education programs. She is the founder of the Modeling and Signal Analysis Research Laboratory at the Faculty of Engineering at Dalhousie University, and founder of BH Engineering Systems Ltd., specializing in technology transfer and professional development courses, linking academic innovations to industrial needs Ferial has been invited by many of the IEEE International Conferences and University Institutions as a Plenary Speaker. Recently, invited by the World Ocean Council (WOC/SOS'19), Muscat, Oman, Feb. 2019, invited by HKUST Univ. Hong Kong, January 2018, talk on: "Overview of Robotics Evolutions Emphasizing Underwater Applications" and Invited by the World Ocean Council (WOC/SOS'17), Halifax, NS, Canada, December, 2017 Also, she was invited by Guangdong Univ. Guangzhou, China, April, 2017, talk on: "Overview of Robotics Evolutions Emphasizing Underwater Applications".

Ferial has been a devoted IEEE volunteer for over 30 years by serving IEEE and Oceanic Engineering Society (OES) with many different capacities as: IEEE-Board of Directors, Board MGA (2008-2009), IEEE-Honorary Membership Committee and IEEE Fellows Committee member. Served IEEE/OES Administrative Committee Member as OES Vice-President International Activities, and OES Membership Committee Chair. Ferial is recognized for her leadership in establishing many of the OES Chapters Globally. Served many of IEEE OCEANS Conferences as General Chair and Co-Chair, as well as IEEE Section Congress'08.

Ferial is the recipient for many awards recognizing her contributions with devoting services to IEEE and some of its Technical Societies: She is the recipient of 2017 -"Murugan Memorial Award" for her contributions to the Canadian Atlantic Section and IEEE, the IEEE-Systems Man & Cybernetics Society (SMC) Outstanding Contribution Award, 2008, IEEE- Educational Activities Board (EAB) Meritorious Achievement Award in Continuing Education, 2007, Marine Technology Society (MTS) Ocean Engineering Compass International Award, 2005, the J.J. Archambault IEEE/Eastern Canada Council Merit Award, 2002, IEEE Third Millennium Medal, 2000, IEEE/RAB Achievement Award, 1999 IEEE/OES Distinguished Service Award, 1997, Fellow of MTS, 1985, Fellow of the Engineering Institute of Canada (EIC),1997 and She is a Fellow of IEEE since 1999.

# Keynote Speech Abstracts



Hamid Reza Karimi is a professor of Applied Mechanics with the Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy. His current research interests include control systems and mechatronics with applications to automotive control systems, vibration systems and wind energy. Prof. Karimi is currently the Editor-in-Chief of the Journal of Cyber-Physical Systems, Editor-in-Chief of the Journal of Machines, Editor-in-Chief of the International Journal of Aerospace System Science and Engineering, Editor-in-Chief of the Journal of Designs, Section Editor-in-Chief of the Journal of Electronics, Section Editor-in-Chief of the Journal of Science Progress, Subject Editor for Journal of The Franklin Institute and a Technical Editor, Moderator for IEEE TechRxiv or Associate Editor for some international journals, such as the IEEE Transactions on Industrial Informatics, the IEEE Transactions on Fuzzy Systems, the IEEE Transactions on Neural Networks and Learning Systems, the IEEE Transactions on Circuits and Systems-I: Regular Papers, the IEEE/ASME Transactions on Mechatronics, the IEEE Transactions on Systems, Man and Cybernetics: Systems, Information Sciences, IFAC-Mechatronics, International Journal of Robust and Nonlinear Control.

## Keynote Speech I

*"Distributed Control of Multiagent Systems: Theory and Applications"*

April 20, 2020 | 9:05AM-9:50AM

Meeting ID: 640-0883-8555

### Hamid Reza Karimi

Politecnico di Milano, Italy

[Google Scholar with h-index of 74](#)

From both theoretical and practical aspects, the problem of distributed cooperative control design for multiagent systems has received increasing attentions in recent years due to its advantages, compared with the traditional centralized systems, including more flexibility, decentralization, stronger robustness. Some practical research impacts could be utilization of multiagent systems in intelligent manufacturing (Industry 4.0), structural control systems, emergency patient transportation, robotics, for instance.

The objective of this talk is to present some challenges and recent results on distributed cooperative control systems or distributed model predictive control (DMPC) of multiagent systems for consensus, e.g. robotics, with a focus on advanced controller design strategy developments under communication control protocol. Specifically, development of the output-feedback consensus control is proposed for heterogeneous linear multi-agent systems in presence of disturbance and nonuniform sampling process, moreover, joint design of self-triggered mechanism and DMPC is addressed for unconstrained linear multi-agent systems. The talk will be concluded with some concluding remarks on both technical and practical aspects of distributed control systems for consensus problems of multiagent systems.



Lihua Xie received the B.E. and M.E. degrees in electrical engineering from Nanjing University of Science and Technology in 1983 and 1986, respectively, and the Ph.D. degree in electrical engineering from the University of Newcastle, Australia, in 1992. He was a faculty with the Department of Automatic Control, Nanjing University of Science and Technology from 1986 to 1989. Since 1992, he has been with the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, where he is currently a professor and the Director of the Delta-NTU Corporate Laboratory for Cyber-Physical Systems. He served as the Head of Division of Control and Instrumentation from July 2011 to June 2014. His research areas include robust control, networked control, compressive sensing, localization and unmanned systems. He has been listed as a highly cited researcher by Thomson Reuters and Clarivate Analytics annually since 2014. He is currently an Editor-in-Chief of Unmanned Systems and Associate Editor of IEEE Transactions on Control of Network Systems. He has served as an Editor of IET Book Series on Control and Associate Editor of IEEE Transactions on Automatic Control, IEEE Transactions on Control Systems Technology, Automatica, IEEE Transactions on Circuits and Systems-II, etc. He was an IEEE Distinguished Lecturer (2011-2014) and an elected member of the Board of Governors of IEEE Control System Society (Jan. 2016- Dec. 2018). He is Fellow of IEEE, Fellow of IFAC, and Fellow of Chinese Automation Association.

## Keynote Speech II

### *"Localization and Control in GPS Denied Environment "*

April 20, 2020 | 9:50AM-10:35AM

Meeting ID: 640-0883-8555

### **Lihua Xie**

Nanyang Technological University, Singapore

**IEEE Fellow, Fellow of IFAC, and Fellow of Chinese Automation Association**

The capability of localization is of great importance for many applications such as Internet of Things and operation of unmanned systems. GPS has been widely used for positioning and navigation. However, in indoor environments and many outdoor environments such as urban canyon and forest, GPS may not be available or unreliable. Hence, it has been a lot of interest in developing technologies and algorithms for localization in such environments. In this talk, we shall discuss some recent research on this topic. We shall discuss localization leveraging on various technologies including WiFi, UWB and vision. In particular, we shall introduce recently developed distance based cooperative localization including consensus based approach and graph optimization based approach, leveraging on UWB technologies. We shall also discuss simultaneous relative localization and formation control of multi-robot systems, and demonstrate their applications in unmanned ground and aerial vehicles.



## Keynote Speech III

### *"Development and Fusion of Artificial Intelligence and Robotics "*

April 20, 2020 | 10:50AM-11:35AM

Meeting ID: 640-0883-8555

#### **Shuzhi Sam Ge**

National University of Singapore, Singapore

**IEEE Fellow, IFAC Fellow, IET Fellow, IES Fellow**

I received the B.Sc. degree from Department of Automatic Control, Beijing University of Aeronautics and Astronautics (BUAA), Beijing, China, in July 1986, and the Ph.D. degree and the Diploma of Imperial College (DIC) from Mechanical Engineering and Electrical Engineering Departments, Imperial College of Science, Technology and Medicine, University of London, London, United Kingdom, in January 1993. From May 1992 to June 1993, I was engaged in postdoctoral research at Leicester University, UK, working on Robust Full Flight Envelope Control of Aero-Engines in collaboration with Lucas Aerospace Ltd and University of Southampton and The University of Strathclyde, United Kingdom. I have been with the Department of Electrical & Computer Engineering, The National University of Singapore, Singapore as a Lecturer from July 1993 to June 1998, a Senior Lecturer from July 1998 to June 2000, an Associate Professor from July 2000 to December 2004, and a Full Professor from January 2005- Present. A Senior Faculty Fellow, NUS Graduate School for Integrative Science and Engineering (NGS), the National University of Singapore, 2003-Present. I had the privileged of visiting a number of distinguished research groups and universities including Laboratoire de'Automatique de Grenoble (LAG), Grenoble, France; Department of Electrical & Electronics Engineering, The University of Melbourne, Melbourne, Australia ; Shanghai Jiaotong University, Shanghai, China, Concordia University, Canada, University of Western Australia, City University of Hong Kong, Yale University, USA, Harbin Institute of Technology, and many other invitations yet to fulfill.

Artificial Intelligence (AI) and Robotics are the words of today in research, industry, and funding agencies as they are revolutionizing our works and daily lives. In this lecture, we first give the development of AI. A brief introduction of industrial robots releasing us from the hard labour, works of mobile robots with much larger operating space in comparison with industrial robots, and the era of social robots becoming parts of the daily lives in education, healthcare, finance, and entertainment are then introduced. Recent intelligent robotics development is shifting from industrial robots to social robots. The social robots are intelligent, cooperative, and socially interactive, and they are not robots that are sociable only, but intelligent robotic beings who are parts of the society with social responsibility. AI brings social robot vision to its greatest extent, which enables social robots to present themselves with emotional voice and posture. It has become increasingly apparent that social interaction and communication with themselves, humans, and surroundings are necessary requirements in many applications. With the continuous development of human society, people are more and more longing for the vision that robots can collaborate and co-work with human beings in the foreseeable future for productivity, service, and operations. After an introduction of the development of AI and robots, I shall emphasize on the fusion of AI and Robotics, as well as recent works of our team and vision of the future in this field.



# Invited Speech Abstracts



**Qingsong Xu is a Full Professor with the Department of Electromechanical Engineering, Faculty of Science and Technology, University of Macau, and Director of Smart and Micro/Nano Systems Laboratory. He was a Visiting Scholar at the University of California, Los Angeles (UCLA), USA, the RMIT University, Melbourne, Australia, the National University of Singapore, Singapore, and the Swiss Federal Institute of Technology (ETH Zurich), Switzerland. His current research area involves mechatronics, robotics and mechanisms, control and automation, smart and micro/nano systems, micro/nano-manipulation robots and applications, etc. Prof. Xu is a Senior Member of IEEE. He has published 3 monographs in Springer and Wiley and over 280 technical papers in international journals and conferences. His publications have been cited by over 6600 times in Google Scholar with h-index of 46. He currently serves as a Technical Editor of IEEE/ASME Transactions on Mechatronics, Associate Editor of IEEE Transactions on Automation Science and Engineering, and Associate Editor of IEEE Robotics and Automation Letters.**

## Invited Speech I

*"Design and Application of Force-Sensing Robotic Systems for Micromanipulation"*

April 21, 2020 | 10:00AM-10:30AM

Meeting ID: 640-0883-8555

### Qingsong Xu

University of Macau, China

Robotic micromanipulation systems are demanding devices to realize automated manipulation of tiny samples. Majority of existing robotic micromanipulation systems work based on displacement sensing and control. The lack of force sensing prevents the wide application of the devices. In modern biomedical sciences, there is an increasing demand for automated micromanipulation systems with force sensing and control capabilities. The development of force-sensing microinjector and microgripper devices enable extensive robotic applications involving biological field with guaranteed safety and accuracy. This presentation reports our recent work on design and development of new force-sensing robotic micromanipulation systems for biological micromanipulation applications. The challenging problems will be addressed and future work will be discussed.





**Qing Guo is a full professor in School of Aeronautics and Astronautics, University of Electronic Science and Technology of China. Dr. Guo is also the Academic and Technical Leaders Reserve Candidates of Sichuan Province, China, the IEEE Senior member, the Youth Expert Group Leader of Fluid Control Engineering Branch, the member of Fluid Transmission and Control Branch, Hydraulic Branch, Chinese Mechanical Engineering Society. From December 2013 to December 2014, he was an academic visitor with Center for Power Transmission and Motion Control, Department of Mechanical Engineering, University of Bath, UK. His research interests include Fluid Transmission and Control, Exoskeleton Robot, and Aircraft Guidance and Control. He has published more than 50 papers as the first and corresponding authors.**

## Invited Speech II

*"A Class Model-Based Control Techniques Used in Electro-hydraulic System and Wearable Exoskeleton"*

April 21, 2020 | 10:30AM-11:00AM

Meeting ID: 640-0883-8555

### Qing Guo

University of Electronic Science and Technology of China, Chengdu, China

Electro-hydraulic systems (EHSs) are currently widely used in mechatronic control engineering as they have a superior load efficiency compared with motor drive systems. However, there exist model uncertainties in EHS involving hydraulic parametric uncertainty and unknown external load, which will degrade the motion performance and stability of the closed loop control system. The hydraulic parametric uncertainty is mostly caused by unknown viscous damping, load stiffness, variable fluid volumes, physical characteristics of valve, bulk modulus and oil temperature variations, while the external load is often reflected as a dynamic driven force of mechanical system. In this speech, a class model-based control techniques such as linear robust controller, parametric adaptive controller, nonlinear backstepping controller are tried to be used in electro-hydraulic system. In addition, to handle hydraulic parametric uncertainty and unknown external load, parametric estimation and extended state observer, high-gain state observer, etc. are adopted in the control design of electro-hydraulic system. To address the input constraint problem, a model recovery antiwindup compensator embedded in an unconstrained controller is designed to suppress the control saturation of a servo valve. To address the output constraint problem, a prescribed performance constraint control and a full-state error constraints control with Barrier Lyapunov function are adopted in EHS to restrict the tracking position error of the cylinder position to a prescribed accuracy and guarantee the dynamic and steady position response in a required boundary under these uncertain nonlinearities. Then the Lower Limb exoskeleton is introduced, which has two key problems: the model identification and the robust control, since the control performance and system stability of human-robot coordinated movement are often declined by some model parametric uncertainties. A neighborhood field optimization is proposed to identify the unknown model parameters of an exoskeleton for the design of a model-based controller. A robust control scheme is constructed to improve the dynamic tracking performance of human-robot training mode in the presence of the identification error. Finally, the model identification results and comparative tracking performance of the proposed scheme are verified by an experimental platform of Two-DOF lower limb exoskeleton with human-robot cooperative motion.



**Dr. Andrew Ng is an Associate Professor with Singapore Institute of Technology. He is the Deputy Programme Director of the BEng (Honours) and MEngTech in Sustainable Infrastructure Engineering (Land), which focuses on railway engineering and total preventive maintenance. He is a Chartered Engineer with the UK Engineering Council and serves on the committees of various local and international professional engineering institutions, such as Institute of Electrical and Electronics Engineers (IEEE), Institution of Engineers Singapore (IES), Institution of Engineering and Technology (IET), and Institution of Railway Signal Engineers (IRSE). He is a Senior Member of IEEE and IES, as well as a Consultant and Advisor to startups and multinational corporations. In addition, Dr. Ng is a Principal Investigator of several grants amounting to more than half a million Singapore dollars. He holds one international patent and has more than 20 publications as both first and corresponding author. His research and development innovations have also garnered him several prestigious awards, such as Amity Researcher Award, Young Investigator Award, and National Instruments Editor's Choice Engineering Impact Award. Furthermore, Dr. Ng has been frequently quoted and interviewed by news media on railway transportation issues and current affairs.**

## Invited Speech III

### *"Towards Condition Monitoring and Prognosis of Railway Tracks "*

April 21, 2020 | 11:15AM-11:45AM

Meeting ID: 640-0883-8555

### **Andrew Keong Ng**

Singapore Institute of Technology, Singapore

Railway transportation is a common mode of moving people, animals, and goods from one place to another. Condition monitoring and prognosis are essential to improve railway reliability, availability, maintainability, and safety. They also provide good basis for effective asset maintenance and management, thereby reducing downtime and maintenance costs. This keynote presentation will elaborate the concept and importance of condition monitoring and prognosis, particularly of railway track including track geometry and rail defects, which play a critical role in railway safety. Different railway track condition monitoring and prognostic methods and technologies that are available in academia and industry will also be discussed. Lastly, future developments in this area will be highlighted.

# Tutorial Abstract



**Dr. Antonio Moran** obtained the Doctor and Master degrees in Mechanical Systems Engineering from Tokyo University of Agriculture and Technology, Japan, where he has been associate professor and scientific researcher in the Laboratory of Robotics and Control Systems. He has been president of the IEEE Robotics and Automation Society RAS, Peru Chapter, and obtained the 2014 Best Society Award in the International Conference in Robotics and Automation ICRA held in Hong Kong, China. Dr. Moran is a visiting professor at Tokyo University of Agriculture and Technology, Japan, Technological University of Ilmenau, Germany, and Stockholm University, Sweden. He is a professor at the Graduate School of Pontifical Catholic University of Peru, and technical manager of Technova SAC, company providing engineering solutions to industry. His research interests include computational intelligence, integration of neural networks, fuzzy logic and genetic algorithms, learning systems, mobile robots, nonlinear systems modeling and control, and their industry applications.

*"Deep Learning of Dynamic Neural and Fuzzy-Neural Networks for Modeling and Intelligent Control of Nonlinear Dynamic Systems"*

April 22, 2020 | 9:00AM-10:00AM

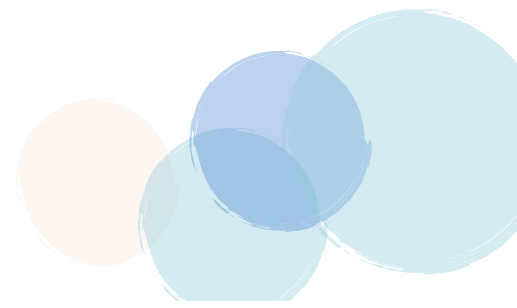
Meeting ID: 640-0883-8555

## **Antonio Moran**

Pontifical Catholic University of Peru, Peru

Dynamic neural networks are a special type of networks having feedback connections which allow them to exhibit a dynamic behavior for processing sequential and time-varying patterns. They have been applied to solve diverse real-world problems involving temporal and dynamic characteristics. The tutorial presents the designing and training of dynamic neural networks: Back Propagation Through Time BPTT and Dynamic Back Propagation DBP algorithms are derived and used to train dynamic neural networks in supervised or reinforcement learning schemes. Dynamic neural networks are used for the modeling and control of dynamic systems. Static and dynamic feedback controllers are trained considering the internal dynamics of the system, as well as fuzzy-neural networks are designed considering human knowledge and experience. The concept of incremental learning is applied for assuring the successful training of neural networks from simple to complex tasks. Neural networks are applied for the autonomous control of car-like and trailer-type mobile robots.

# Parallel Sessions at a Glance



|                       | Time        | Session | Topic  | Paper ID                            | Meeting ID  |
|-----------------------|-------------|---------|--|-------------------------------------|-------------|
| Monday<br>20 April    | 13:30-15:00 | 1       | Robot Motion and Path Planning                 | A009 A015 A049<br>A116 A174 A182    | 754-910-845 |
|                       |             | 2       | Advanced Electronic Technology and Application | A2005 A175 A2015<br>A133 A156 A030  | 110-795-216 |
|                       | 16:00-17:30 | 3       | Power Machinery and Vehicle Engineering        | A072-A A183 A045<br>A063 A109 A0015 | 754-910-845 |
|                       |             | 4       | Control Theory and Control Engineering         | A019 A166 A176<br>A038 A029 A123    | 110-795-216 |
| Tuesday<br>21 April   | 13:30-15:00 | 5       | Design of Intelligent Control System           | A011 A112 A040<br>A098 A180 A185    | 754-910-845 |
|                       |             | 6       | Biomedical Electronics and Systems             | A083 A114 A0012<br>A0007 A0011 A096 | 110-795-216 |
|                       | 16:00-17:30 | 7       | Intelligent Robot and Engineering Application  | A037 A086 A115<br>A117 A125 A2013   | 754-910-845 |
|                       |             | 8       | Mechanical Design Manufacturing and Automation | A035 A020 A142<br>A0009 A024 A0008  | 110-795-216 |
| Wednesday<br>22 April | 10:00-11:30 | 9       | Intelligent Robot and Engineering Application  | A073-A A042 A031<br>A071 A138 A140  | 754-910-845 |
|                       |             | 10      | Aerospace and Launch Engineering               | A165 A012 A047<br>A089 A2021 A017   | 110-795-216 |
|                       | 13:30-15:00 | 11      | Applied Mechanics and Industrial Automation    | A057 A135 A157<br>A145 A147 A148    | 754-910-845 |
|                       |             | 12      | Signal Acquisition and Analysis                | A097 A103 A022<br>A119 A129 A2014   | 110-795-216 |

|                      |             |     |   |                                   |             |
|----------------------|-------------|-----|---|-----------------------------------|-------------|
|                      | 16:00-17:30 | 13  | Communication and Information System                | A181 A002 A137<br>A184 A170 A065  | 754-910-845 |
|                      |             | 14  | Computer and Information Science                    | A032 A085 A141<br>A158 A163 A169  | 110-795-216 |
| Thursday<br>23 April | 10:00-11:30 | 15  | Machine Vision and Applications                     | A070 A087 A2017<br>A084 A2022     | 754-910-845 |
|                      |             | 16  | Robot Design and Control                            | A023 A124 A126<br>A2010 A074 A041 | 110-795-216 |
|                      | 13:30-15:00 | 17  | Machine Vision and Applications                     | A131 A058 A090<br>A151 A168       | 754-910-845 |
|                      | 16:00-17:20 | P-1 | Mechanical and Control Engineering                  |                                   | 110-795-216 |
|                      |             | P-2 | Modern Electronic Technology and Control Automation |                                   | 754-910-845 |

