IEEE ICMA 2022 Conference

Plenary Talk 1

Future of Robotics:
The Tri-Co (Coexisting-Cooperative-Cognitive) Robots

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Abstract:

Tri-Co Robots (Coexisting-Cooperative-Cognitive Robots) are those that can naturally interact and collaborate with the environment, including humans as well as other robots, and adapt to new situations. Coexistence will allow robots to ubiquitously and safely work alongside humans, considerably increasing our efficiency and quality of life. Cooperation will enable robots to collaborate and coordinate effectively with other agents through communication and interplay. Cognition will provide robots the resources to gather information, perceive and predict behaviors, and respond accordingly. This will all be achieved through state-of-the-art machine learning, control and planning algorithms. Key characteristics of Tri-Co Robots are plastic and dexterity, multi-modal perception, and working autonomously and collaboratively. In particular, the development of rigid-flexible-soft robots and efficient solution methods are essential to achieve adaptation to environmental uncertainty and compliant interactions with humans and other robots.

This talk will introduce the current research activities of robotics in China, especially the Tri-Robot Research Plan of NSFC (National Natural Science Foundation of China). It will discuss the primary scientific challenges and key scientific problems of the plan, mainly focusing on mechanism, perception and control. The talk will also forecast China's expected breakthroughs and goals in Tri-Co robot research. Finally, the talk will present recent research results of our group and discuss current and future challenges.

Prof. Han Ding received his Ph.D. degree in Mechatronics from Huazhong University of Science & Technology in 1989. Supported by the Alexander von Humboldt Foundation, he worked at University of Stuttgart, Germany in 1993. He obtained the National Distinguished Youth Scientific Fund in 1997 and was awarded the "Cheung Kong" Chair Professor at Shanghai Jiao Tong University in 2001. He was elected a member of Chinese Academy of Sciences in 2013.

Prof. Ding has long dedicated himself to research in the field of robotics and digital manufacturing, and has successfully combined both technologies. He published three academic books and more than 300 journal papers, and licensed more than 100 patents in China.

Prof. Ding is currently the chairman of Academic Committee of HUST and the director of the National Innovation Institute of Digital Design and Manufacturing. He is also a scientific committee member of the NSFC Tri-Co Robot major research program.

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Plenary Talk 2

Dense and Semantic SLAM via Deep Learning and Polarization Imaging

Hong Zhang, Ph.D.

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Abstract:

This talk will focus on recent research in robot SLAM (simultaneous localization and mapping) and, specifically, on the subject of building a dense and semantic representation of a scene through visual sensing. In autonomous robot navigation, an environment representation must be sufficiently dense for the robot to perform such critical tasks as path planning and collision avoidance. A recent trend in robot SLAM calls for this representation to contain semantic information about the objects in the scene in order to facilitate map construction and manipulation and to support human-robot interaction. Upon reviewing state-of-the-art research in dense and semantic SLAM, I will present our recent work on using deep learning and polarization imaging as a way of achieving dense and semantic mapping.

Hong Zhang received his B.S. from Northeastern University (Boston) in 1982, and Ph.D. from Purdue University in 1986, both in Electrical Engineering. Subsequently he conducted research at the University of Pennsylvania as a post-doctoral fellow before he joined the Department of Computing Science at the University of Alberta, Canada where he worked for over 30 years. Since October 2020, he has been a full-time faculty member in the Department of Electronic and Electrical Engineering at the Southern University of Science and Technology, in Shenzhen, China.

Professor Zhang's research interests include robotics, computer vision, and image processing, with over 200 publications in these areas. For the past 15 years, he has expended considerable effort in the study of mobile robot navigation. He was a principal investigator in the NSERC Canadian robotics network (NCRN) (2018-2023) - whose mandate is to develop the science and technologies to allow mobile robots to work in challenging environments, and to generate and communicate critical information to humans. He was also a PI with Centre for Autonomous Systems (2018-2022), a research initiative funded by Alberta government, to study issues and explore opportunities in autonomous and self-driving technologies. Among his many professional services, Professor Zhang is currently on a three-term as the Editor-in-Chief of IROS Conference Editorial Board (2020-2022), a flagship conference of the IEEE Robotics and Automation Society. In recognition of his research accomplishments, Professor Zhang is elected Fellow of the IEEE, and Fellow of the Canadian Academy of Engineering.

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Plenary Talk 3

From Robotics to Prosthetics and Back Again

Antonio Bicchi, Ph.D.

Professor and Chair

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Abstract:

In recent years, robotic technologies have been providing definite advances to assist people in need of physical help, including rehabilitation and prosthetics. Working in fields where humans are placed right at the center of the technology, on the other hand, is helping refocus our robotics research itself. In prosthetics, the goal is to have an artificial limb to move naturally and intelligently enough to perform the task that users intend, without requiring their attention. By abstracting this idea, a robot of the future can be thought as a physical ``prosthesis'' of its user, with sensors, actuators, and intelligence enough to interpret and execute the user intention, translating it in a sensible action of which the user remains the owner.

In the talk I will present examples of human-robot integration, as in prosthetics and rehabilitation, augmentation with exoskeletons and supernumerary limbs, and shared-autonomy robotic avatars, with the robot executing the human's intended actions and the human perceiving the context of his/her actions and their consequences.

Antonio Bicchi is a scientist interested in robotics and intelligent machines. After graduating in Pisa and receiving a Ph.D. from the University of Bologna, he spent a few years at the MIT AI Lab of Cambridge before becoming Professor in Robotics at the University of Pisa. In 2009 he founded the Soft Robotics Laboratory at the Italian Institute of Technology in Genoa. Since 2013 he is Adjunct Professor at Arizona State University, Tempe, AZ. He has coordinated many international projects, including four grants from the European Research Council (ERC). He served the research community in several ways, including by launching the World Haptics conference and the IEEE Robotics and Automation Letters. He is currently the President of the Italian Institute of Robotics and Intelligent Machines.

He has authored over 500 scientific papers cited more than 25,000 times. He supervised over 60 doctoral students and more than 20 postdocs, most of whom are now professors in universities and international research centers or have launched their own spin-off companies. His students have received prestigious awards, including three first prizes and two nominations for the best theses in Europe on robotics and haptics. He is a Fellow of IEEE since 2005. In 2018 he received the prestigious IEEE Saridis Leadership Award.

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Plenary Talk 4

Doing Manipulation in Clutter

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Abstract:

Robots are slowly being deployed outside of hard automation factory floors, for use-cases in logistics and in everyday settings. A key challenge for such applications is the need to interact with a physical world that is semi- or unstructured. In this presentation we will discuss the design of systems for manipulating objects in significant clutter. Clean-up of tables, assisting in meal preparation, and sorting return objects are all examples of scenarios where a service robot has to interact with objects in the presence of clutter. We will describe our strategy for recognizing / describing objects, how to plan a (multi-) grasp strategy for interacting with objects and finally how to ensure robust execution in the presence of uncertainty. Several new methods will be presented, and we will also show the performance of these methods for multi real-world applications.

Henrik I Christensen is the Qualcomm Chancellor's Chair of Robot Systems and the Director of the Contextual Robotics Institute at UC San Diego. He is also a distinguished Professor of Computer Science. Dr. Christensen uses a systems approach to study robotics and intelligent systems. For a given problem there is a need for a solid mathematical foundation, an effective algorithm, a real-world implementation and evaluation in a realistic setting.

Dr. Christensen has published close to 400 contributions across robotics, computer vision and artificial intelligence. He has served on numerous editorial boards and is the principal editor of the US National Robotics Roadmap (2009, 2013, 2016 and 2020). He was the founder of the EU Network of Excellence in Robotics and has founded multiple successful research centers prior to joining UC San Diego. He serves as an advisor to companies and government agencies across four continents. He has also co-founded four companies including Robust.AI and ROBO-Global.