IEEE ICMA 2019 Conference

Keynote Speech

Biological Cell Surgery Automation

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Abstract:

Interest has grown rapidly over the last decade in biological research and clinical applications involving manipulation and processing of single cells. In research labs a variety of single cell processes are routinely conducted including removal of cell organelles, transfer of RNA, DNA and proteins into the cell and removal of human embryonic cells formed during cell cleavage, amongst others. Currently, much of this cell processing work is carried out manually by highly skilled technicians. This presentation summarizes some of our recent work directed towards the automation of biological micro-scale tasks using robotic technology. The work presented will address control and automation methods utilized to achieve automation of single cell surgery sub-tasks as well as other cell processing automation methods.

James K. Mills is with Department of Mechanical and Industrial Engineering, University of Toronto. He received the PhD in Mechanical Engineering, specializing in robotic control. His recent research interests include: 3D MEMS robotic assembly, meso-scale machine design, control and automation of micro-scale biological tasks. He has published over 450 papers. He has been an Invited Visiting Professor at the Centre for Artificial Intelligence and Robotics in Bangalore, India, a Visiting Professor at the Hong Kong University of Science and Technology, Chinese University of Hong Kong and the City University, Hong Kong.

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Plenary Talk 1

CPS Driven Control System

Tianyou Chai, Ph.D.

Director of National Research Center for Metallurgical Automation Technology,
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Abstract:

China has abundance of mineral resources such as magnesite, hematite and bauxite, which constitute a key component of its economy. The relatively low grade, and the widely varying and complex compositions of the raw extracts, however, pose difficult processing challenges including specialized equipment with excessive energy demands. The energy intensive furnaces together with widely uncertain features of the extracts form hybrid complexities of the system, where the existing modeling, optimization and control methods have met only limited success. Currently, the mineral processing plants generally employ manual control and are known to impose greater demands on the energy, while yielding unreasonable waste and poor operational efficiency. The recently developed Cyber-Physical System (CPS)

provides a new key for us to address these challenges. The idea is to make the control system of energy intensive equipment into a CPS, which will lead to a CPS driven control system.

This talk presents the syntheses and implementation of a CPS driven control system for energy-intensive equipment under the framework of CPS. The proposed CPS driven control system consists of four main functions: (I) setpoint control; (II) tracking control; (III) self-optimized tuning; and (IV) remote and mobile monitoring for operating condition. The key in realizing the above functions is the integrated optimal operational control methods to implement setpoint control, tracking control and self-optimized tuning together seamlessly. This talk introduces the integrated optimal operational control methods we proposed.

Hardware and software platform of CPS driven control system for energy-intensive equipment is then briefly introduced, which adopts embedded control system, wireless network and industrial cloud. It not only realizes the functions of computer control system using DCS (PLS), optimization computer and computer for abnormal condition identification and self-optimized tuning, but also achieves the functions of mobile and remote monitoring for industrial process.

Then, using fused magnesium furnace as an example, a hybrid simulation system for CPS driven control system for energy-intensive equipment developed by our team is introduced. The results of simulation experiments show the effectiveness of the proposed method that integrates the setpoint control, tracking control, self-optimized tuning and remote and mobile monitoring for operating condition in the framework of CPS.

The industrial application of the proposed CPS driven control system is also discussed. It has been successfully applied to the largest magnesia production enterprise in China, resulting in great returns. Finally, future research on the CPS driven control system is outlined.

Tianyou Chai received the Ph.D. degree in control theory and engineering in 1985 from Northeastern University, Shenyang, China, where he became a Professor in 1988. He is the founder and Director of the Center of Automation, which became a National Engineering and Technology Research Center and a State Key Laboratory. He is a member of Chinese Academy of Engineering, IFAC Fellow and IEEE Fellow. His current research interests include modeling, control, optimization and integrated automation of complex industrial processes.

He has published 200 peer reviewed international journal papers. His paper titled *Hybrid intelligent control for optimal operation of shaft furnace roasting process* was selected as one of three best papers for the Control Engineering Practice Paper Prize for 2011-2013. He has developed control technologies with applications to various industrial processes. For his contributions, he has won 4 prestigious awards of National Science and Technology Progress and National Technological Innovation, the 2007 Industry Award for Excellence in Transitional Control Research from IEEE Multiple-conference on Systems and Control, and the 2017 Wook Hyun Kwon Education Award from Asian Control Association.

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Plenary Talk 2

Does the progress of robotics pass through soft materials?

Cecilia Laschi, Ph.D.

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Abstract:

Though a young discipline, robotics progressed rapidly and pervaded our lives more than we perceive, becoming a tool we cannot do without in manufacturing. Futuristic scenarios have been proposing robots in daily life of citizens and professionals for decades, creating expectations that have not yet been matched. What are the realistic scenarios that robotics technologies enable today? What are the abilities that robots still miss to match expectations for extensive application and healthier and safer human life?

Largely inspired by the observation of the role of soft tissues in living organisms, the use of soft materials for building robots is recognized as one of the current challenges for pushing the boundaries of robotics technologies and building robotic systems for service tasks in natural environments. The study of living organisms sheds light on principles that can be fruitfully adopted to develop additional robot abilities or to facilitate more efficient accomplishment of tasks, because living organisms exploit soft tissues and compliant structures to move effectively in complex natural environments.

Robots have a great potential for becoming part of our lives, for responding to current societal challenges, for contributing to economic growth. New materials and new forms of machine intelligence are key directions for the future robotics progress.

Cecilia Laschi is Full Professor at the BioRobotics Institute of Scuola Superiore Sant'Anna in Pisa, Italy, where she serves as Rector’s delegate to Research. She graduated in Computer Science at the University of Pisa in 1993 and received the Ph.D. in Robotics from the University of Genoa in 1998. In 2001-2002 she was JSPS visiting researcher at Waseda University in Tokyo.

Her research interests are in the field of soft robotics, a young research area that she pioneered and contributed to develop at international level, including its applications in marine robotics and in the biomedical field. She has been working in humanoid robotics and neurorobotics, at the merge of neuroscience and robotics.

She is in the Editorial Boards of several international journals. She serves as reviewer for many journals, including *Nature* and *Science*, for the European Commission, including the ERC programme, and for many national research agencies.

She is senior member of the IEEE, of the Engineering in Medicine and Biology Society (EMBS), and of the Robotics & Automation Society (RAS), where she served as elected AdCom member and currently is Co-Chair of the TC on Soft Robotics. She founded and served as General Chair for the IEEE-RAS First International Conference on Soft Robotics in Livorno, in April 24-28, 2018.

She is founding member of RoboTech srl, spin-off company of the Scuola Superiore Sant’Anna, in the sector of edutainment robotics.

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Plenary Talk 3

The New Wave in Robot Grasping

Ken Goldberg, Ph.D.

Professor and Director

William S. Floyd Jr. Distinguished Chair in Engineering

Department Chair, Industrial Engineering / Operations Research (IEOR)

Director, AUTOLAB and CITRIS "People and Robots" Initiative Founding Member, Berkeley AI Research (BAIR) Lab Joint Appointments: EECS, Art Practice, School of Information (UC Berkeley) and Radiation Oncology (UC San Francisco Medical School).

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Abstract:

Robots are about to become far more dextrous based on a new wave in research that combines classical mechanics, stochastic, and deep learning.
Despite 50 years of research, robots remain remarkably clumsy, limiting their reliability for warehouse order fulfillment, robot-assisted surgery, and home decluttering. The First Wave of grasping research is purely analytical, applying variations of screw theory to exact knowledge of pose, shape, and contact mechanics. The Second Wave is purely empirical: end-to-end hyperparametric function approximation (aka Deep Learning) based on human demonstrations or time-consuming self-exploration. A "New Wave" of research considers hybrid methods that combine analytic models with stochastic sampling and Deep Learning models. I'll present this history with new results from our lab on grasping diverse and previously-unknown objects and discuss exciting future research including cloud and fog robotics.

Ken Goldberg is an artist, inventor, and UC Berkeley Professor focusing on robotics. He was appointed the William S. Floyd Jr Distinguished Chair in Engineering and serves as Chair of the Industrial Engineering and Operations Research Department. He has secondary appointments in EECS, Art Practice, the School of Information, and Radiation Oncology at the UCSF Medical School. Ken is Director of the CITRIS "People and Robots" Initiative and the UC Berkeley AUTOLAB where he and his students pursue research in machine learning for robotics and automation in warehouses, homes, and operating rooms. Ken developed the first provably complete algorithms for part feeding and part fixturing and the first robot on the Internet. Despite agonizingly slow progress, he persists in trying to make robots less clumsy. He has over 250 peer-reviewed publications and 8 U.S. Patents. He co-founded and served as Editor-in-Chief of the IEEE Transactions on Automation Science and Engineering. Ken's artwork has appeared in 70 exhibits including the Whitney Biennial and films he has co-written have been selected for Sundance and nominated for an Emmy Award. Ken was awarded the NSF PECASE (Presidential Faculty Fellowship) from President Bill Clinton in 1995, elected IEEE Fellow in 2005 and selected by the IEEE Robotics and Automation Society for the George Saridis Leadership Award in 2016.
More information can be obtained in http://goldberg.berkeley.edu