

IEEE ICMA 2018 Conference

Plenary Talk 1

**Self-Optimization for Industry 4.0:
An Effective Distributed and Asynchronous
Method**

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Abstract. Pushed by advancements in Internet of Things and Industry 4.0, recent trends of technological development in manufacturing include interoperability, virtualization, decentralization, and performance. A noble goal is effective “self-optimization” of autonomous systems consisting of multiple machining to process various parts. Such optimization, however, is difficult since discrete decision variables are generally involved, and problem complexity increases drastically as problem sizes increase. Coordination of asynchronous optimization processes then poses further theoretical as well as implementation challenges. In this talk, a distributed and asynchronous coordination approach is presented. In the approach, individual subproblems are solved by subsystems locally in an asynchronous manner, and prices are dynamically adjusted to balance supply and demand through a novel and accelerated updating process. The convergence of the method is proved by using a novel version of the Lyapunov stability theory. The method is then used to solve manufacturing planning and scheduling problems. Numerical testing on selected problems with or without sequence-depend setup times demonstrate that the method converges, is efficient and scalable, and that the dream of self-optimization for practical factories with near-optimal performance is achievable.

Bio Sketch. Peter B. Luh received his B.S. from National Taiwan University, M.S. from M.I.T., and Ph.D. from Harvard University. He has been with the University of Connecticut since 1980, and currently is the SNET Professor of Communications & Information Technologies. He is also a member of the Chair Professors Group, Center for Intelligent and Networked Systems (CFINS) in the Department of Automation, Tsinghua University, Beijing; and a member of the Thousand-Talent Program, the State Key Laboratory of Synthetical Automation for Process Industry, Northeastern University, Shenyang, China. Professor Luh is a Life Fellow of IEEE, and a member and the Chair (2018-19) of IEEE TAB Periodicals Committee. He was the VP of Publications of the IEEE Robotics and Automation Society (RAS, 2008-2011), the founding Editor-in-Chief of the IEEE Transactions on Automation Science and Engineering (2003-2007), and the Editor-in-Chief of IEEE Transactions on Robotics and Automation (1999-2003). His research interests include intelligent manufacturing systems, smart power systems, and smart and green buildings. He received RAS 2013 Pioneer Award for his pioneering contributions to the development of near-optimal and efficient planning, scheduling, and coordination methodologies for manufacturing and power systems. He also received RAS 2017 George Saridis Leadership Award for his exceptional vision and leadership in strengthening and advancing Automation.

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Plenary Talk 2

The world is not a safe place!
Safe Robots for Dangerous Jobs

Prof. Darwin G Caldwell, FREng

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Abstract:

The world is not a safe place! It is a multifaceted, unstructured, dynamic and dangerous environment. Sometimes events occur, both through natural disaster e.g. earthquake, weather, volcanoes, climate, fire, etc. and following human intervention e.g. nuclear, chemical, biological, oil and gas refining/exploration, mining, excavation, etc. that place people at extreme direct and indirect risk. Under such circumstances there is a massive safety driven need for robots to enter the domain and assist, augment or replace humans.

But operation in these potentially devastated outdoor or human engineered environments, using tools designed for humans deployment, requires robots that have human or human/animal-like levels of **agility, compliance, dexterity, robustness, reliability** and **movement/locomotion**. The challenges for both the software and the mechatronics are therefore immense.

This presentation will explore the core mechatronic technologies needed to create and operate humanoid (**COMAN, COMAN+** and **WalkMan**), quadruped (**HyQ** and **HyQ-real**) and “centaur” quadruped (**HalfMan**) robots in complex, unstructured and destructed environments, and will demonstrate how many key loco-manipulation tasks may be addressed.

Prof. Darwin G Caldwell, FREng is Deputy Director of the Italian Institute of Technology (IIT), and Director of the Dept. of Advanced Robotics at IIT. He is or has been an Honorary Professor at the Universities of Manchester, Sheffield, Bangor, Kings College London and Tianjin University, China. His research interests include; innovative actuators, force augmentation exoskeletons, medical, rehabilitation and assistive robotic technologies, dexterous manipulators, haptics, humanoid and quadrupedal robotics (**iCub, cCub, COMAN, WalkMan, HyQ, HyQ2Max, HalfMan, COMAN+**). He is the author or co-author of over 500 academic papers, and 19 patents and has received awards and nominations from many international journals and conferences. Caldwell is a past chair of the IEEE Robotics and Automation Chapter (UKRI), a past co-chair of the IEE (IET) Robotics and Mechatronics PN. He is on the editorial advisory board of Science Robotics, Senior Editor for the Journal of Medical Robotics Research, Editor for Frontiers in Robotics and AI, and on the editorial boards of the International Journal of Social Robotics and Industrial Robot. Prof. Caldwell is a Fellow of the Royal Academy of Engineering.

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Plenary Talk 3

Cell surgery Robotics

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Abstract:

There exists an increasing demand for developing new technologies that can have earlier diagnosis and treatment of diseases at cell level, thereby achieving long term patient survival. Cell surgery robotics is an entirely new emerging theme that is enabled with specially designed automated micromanipulation tools to perform surgical diagnosis and treatment with image feedback, and can be processed on large-scale single cells. This talk will introduce our recent development of using robotics combined with micro-engineering tools including optical tweezers, micro-needles and electromagnetic devices, as special end-effectors to accomplish various tasks of cell manipulation, diagnosis and micro-surgery at the single cell level. With this emerging technology, we have achieved numerous cell surgery operations such as single cell transportation and rotation, single cell biopsy and microinjection, and target delivery of cells using magnetic actuation. The new technologies for automated cell surgery will permit many new unforeseen applications previously thought impossible, and profoundly affect surgical treatment and precision medicine.

Dr. Dong Sun is currently a chair professor and head of the Department of Mechanical and Biomedical Engineering, City University of Hong Kong, where his current research focuses on bio/medical robotics for biological cell manipulation and cell surgery. He studied in Tsinghua University of Beijing and the Chinese University of Hong Kong, and then joined the University of Toronto, Canada for post-doc research. After short-time working experience in Canadian industry, he returned to Hong Kong in 2000 and became an Assistant Professor in the City University of Hong Kong.

Dr. Sun is among the leading contributors worldwide in pioneering work in robotic manipulation of biological cells, which has recently become an emerging area of robotics for biomedical applications and offered fundamental advances in precision medicine. His research has breakthrough in the use of combined robotics and various micro-engineering tools including optical tweezers, micro-needles and electromagnetic devices to achieve cell manipulation, diagnosis and micro-surgery at the single cell level. With his emerging technology, a new robotics theme “cell surgery robotics” has been recently formed, which will permit many new unforeseen applications previously thought impossible.

Dr. Sun received numerous awards, including best paper awards from the international journal and conferences as well as industrial awards such as Hong Kong Awards for Industry. His patented research of intelligent sensor has been used in the E-Channel auto-pass systems of customs in Hong Kong. He serves on the editorial boards of several academic journals, and organizes several international flagship conferences including the world largest intelligent robot conference (IROS). He is a member of the Biomedical Division, Science and Technology Committee of Education Ministry of China (国家教育部科技委生物医学学部委员), and a member of Research Grant Council of Hong Kong. He is a fellow of the IEEE and a fellow of the Hong Kong Institute of Engineers.