IEEE ICMA 2023 Conference

Keynote Speech

Considerations and Introspections on the Development of Nursing-care Robots

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Abstract:

Along with the acceleration of population aging, the expectation to nursing-care robots is increasing. The development of nursing-care robots has become a hot topic in the field of robotics. At the current state of the art, most nursing-care robots are single functional products, each robot can only accomplish a specific task, such as transfer, mobility

assistance, meal assistance, bathing, diaper care and so on. This is because the current robotics technology is not yet sufficient to develop multifunctional robots with practical application significance. Even though the robots only have a single function, they are still suffering from poor operability, inadequate service and insufficient safety, making them “promising but cannot be sold”. So, currently the practical choice is still to develop single functional robots that are convenient and effective for practical use. On the other hand, the decline in physical function of the elderly often manifests the loss of multiple living abilities. So, in the long run, development of multifunctional nursing-care robots is the trend. This report will first introduce the state of the art of the technologies and applications of single functional nursing-care robots. Then, it discusses the trends and core technologies involved in the development of multifunctional robots, and finally, presents the work of the speaker’s team towards multifunction.

Shijie Guo received his doctor degree in engineering from Tokyo Institute of Technology in 1992. He was selected as a distinguished expert by the National Thousand Talents Program (Long-term Innovation) in 2015. He is currently a professor at Hebei University of Technology and a part-time professor at Fudan University. He is the head of the Hebei Key Laboratory of Robot Perception and Human–Robot Interaction and the Director of the Engineering Research Center of the Ministry of Education for Intelligent Rehabilitation Devices and Detection Technologies. He also serves as the deputy director of the Academic Committee of Hebei University of Technology and editor-in-chief of Journal of Hebei University of Technology. His main social positions include Counselor of the Government of Hebei Province and member of the Tianjin Municipal Committee of the Chinese People's Political Consultative Conference. He has long been engaged in the research of key technologies and applications of human-interaction robots, including robotic e-skin, electroactive polymer artificial muscles, nursing-care robots, rehabilitation robots, exoskeleton robots, etc. The intelligent system of robot skin tactile sensing developed by his team was selected as the "Innovation China" pioneer technology by China Association for Science and Technology in 2020. The piggyback transfer robot developed by him won the Gold Medal at the 8th China Entrepreneurial Design & Innovation Competition of Elderly Welfare Equipment in 2021. In 2022, as the principal investigator, he won First Prize for Science and Technology Progress in Hebei Province.

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Plenary Talk 1

Robotics and AI for Real-world Challenges

Kazuhiro Kosuge

Chair Professor

Department of Electrical and Electronic Engineering

Director

JC STEM Lab of Robotics for Soft Materials

The University of Hong Kong

Deputy Director

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Hong Kong

Abstract:

Current AI cannot provide a complete solution for robotics, although AI is a useful tool for real-world challenges that cannot be solved by traditional methods. We will discuss how AI can be applied to solve real-world problems. Inspired by a dance partner robot developed for the Aichi Expo in 2005, a co-worker robot "PaDY" was developed for the automotive assembly process. Intention estimation was a key to these collaborative robots. AI has also led to the development of robotic applications in manufacturing, such as computer vision for bin picking, grasp planning, robot motion planning, and assembly of textureless industrial parts using visual servoing. Recent advances in AI are making it possible to tackle the manipulation of soft materials. The JC STEM Lab of Robotics for Soft Materials funded by the Hong Kong Jockey Club Charities Trust covers this new field for future manufacturing applications.

Dr. Kazuhiro Kosuge is Chair Professor of Robotic Systems in the Department of Electrical and Electronic Engineering at the University of Hong Kong. He is an IEEE Life Fellow, JSME Fellow, SICE Fellow, RSJ Fellow, JSAE Fellow and a member of the Engineering Academy of Japan. He has served as President of the IEEE Robotics and Automation Society (2010-2011), IEEE Division X Director (2015-2016), and IEEE Vice President for Technical Activities (2020). He received Medal of Honor, Medal with Purple Ribbon from Japan in 2018, a national honor in recognition of his prominent contributions to academic and industrial advancements.

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Plenary Talk 2

Hearables: From promoting general wellbeing to doctorless hospitals

Danilo P. Mandic, Ph.D.

Professor

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Abstract:

Commercial wellbeing, gaming applications and future health systems all require the means to assess the neural and physiological function of a user. Ideally, this should be achieved in a 24/7 fashion, in the community, and in a self-administered and unobtrusive fashion. Hearables, that is, in-ear sensing of neural function and vital signs, are such an emerging solution. Our current Hearables system is based on an earplug with embedded electrodes, optical, mechanical and temperature sensors. I will show how this can be can used to reliably measure the Electroencephalogram (EEG), Electrocardiogram (ECG), pulse, respiration, temperature, and behavioural cues. We also show that unlike standard wearables, such an inconspicuous Hearables earpiece benefits from the stable position of the ear canal with respect to vital organs, to provide robust recordings in everyday situations. We further demonstrate how combining data from multiple sensors within such an integrated wearable device improves both the accuracy of measurements and the ability to deal with artefacts in real-world scenarios. The unique ability to stream neural and physiological data in real time makes Hearables a promising solution for the integration with smart environments and in future eHealth.

Danilo P. Mandic is a professor in signal processing with Imperial College London, UK, and has been working in the areas of statistical signal processing, machine learning, and bioengineering. He is a Fellow of the IEEE and member of the Board of Governors of International Neural Networks Society (INNS). He has received five best paper awards in Brain Computer Interface, runs the Smart Environments Lab at Imperial, and has more than 500 publications in international journals and conferences. Prof Mandic has received the 2019 Dennis Gabor Award by the International Neural Networks Society (for outstanding achievements in neural engineering), and the President Award for Excellence in Postgraduate Supervision at Imperial. He received the 2018 Best Paper Award in IEEE Signal Processing Magazine and the Outstanding Paper Award in IEEE ICASSP 2021. His work on Hearables appeared in IEEE Spectrum, MIT Technology Review and has led to several granted patents in this area.

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Plenary Talk 3

Occupational Exoskeletons

Improving Worker Health and Industrial Efficiency

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Abstract:

Workers commonly perform manual handling tasks such as lifting, pushing, pulling or carrying heavy loads but this can often lead to injury. Globally, over 30% of workers must perform some form of Manual Material Handling (MMH), while 63% have work that involves repetitive (low load) movements, and 46% are exposed to awkward body postures. As a result, every year more than 40% of workers suffer from lower back or neck/shoulder pain. This makes Musculo-Skeletal Disorders (MSD), the leading cause of work-related health problems. This has important impacts on the worker, their employer and society in

general due to: sickness absence, injuries and disability, increased costs, higher employee turnover, and lower productivity. It can lead to injuries that can have a lifelong debilitating effect. In the EU it is estimated that 2% of GDP is lost due to work-related MSDs.
Exoskeletons are personal assistive technologies (wearable devices) that can provide a level of additional mechanical power, or endurance to the human body. Hence they can reduce the biomechanical load, allowing users to perform tasks that they might otherwise find too physically demanding. Recently with increased awareness of workplace health and safety needs exoskeletons and wearable technology have been seen as a viable option in the prevention of Musculo-skeletal injuries. Manufacturing, and related industries such as automotive, assembly/disassembly, transportation systems, construction, logistics, aviation, and healthcare are now starting to see the opportunities for various forms of exoskeletons and assistive devices.
This presentation will explore the background to MSDs, and the global development of exoskeletons. Subsequently it will focus on systems developed at IIT such as the XoSoft, XoTrunk, XoShoulder and XoElbow. I shall explore the factors influencing their design and operation, and the potential uses, benefits and challenges afforded by the use of occupational exoskeletons. Finally, I shall demonstrate their use in real world applications, how this has lead to spin-off commercial activities, analyse where, and how, this technology can be applied and where further development is needed.

Prof. Darwin G Caldwell is Founding Director of the Istituto Italiano di Tecnologia (IIT) in Genova, and Director of the Dept. of Advanced Robotics (ADVR) at IIT. He holds a B.Sc (1986) and Ph.D. (1990) in Robotics from the University of Hull and an M.Sc in Management (1996) from the University of Salford. He has pioneered developments in compliant and variable impedance actuation, Soft and Human Friendly Robotics and the creation of 'softer', safer robots, that draw on developments in materials, mechanisms, sensing, actuation and software. These developments have been fundamental to advances in humanoids, quadrupeds, medical robotics and exoskeletons. Key robots developed by his team include: iCub, a child-sized humanoid robot; COMAN, a controllably compliant humanoid designed to safely interact with people and have more natural (loco)motion; , a human-robot symbiotic system capable of robust locomotion and dexterous manipulation in rough terrain and harsh environments. In addition to his research in legged robots, Prof. Caldwell also works extensively to develop wearable and haptic systems including whole body exoskeletons such as the XoSoft, XoTrunk, XoShoulder and XoElbow and in surgical and rehabilitation robotics where his team have developed systems such as the CALM (Computer Aided Laser Microsurgery) systems, the Cathbot, Cathbot-Pro and SVEI (for catherization and tissue type detection) and the Arbot (Ankle rehabilitation robot).
Caldwell is or has been an Honorary professor at the Universities of Manchester, Sheffield, Bangor and King's College London in the UK, and Tianjin University in China. He has published over 700 papers, has over 25 patents and has received over 50 awards/nominations at international conferences and events. He is a Fellow of the Royal Academy of Engineering (FREng - UK’s National Academy) and the IEEE (FIEEE) and a Chartered Engineer (CEng).