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Keynote Lectures

Keynote 1: "Development of Electro-Hydraulic Control Systems for the Hard Rock Tunnel Boring Machine"

The tunnel boring machine (TBM) is large-scale equipment which can achieve the construction of the tunnel in a fast, safe and environment-friendly way. According to the application geology, the TBM can be categorized into the soft earth or the hard rock machines. The hard rock TBM is specially developed for building the tunnel through hard dirt or rocky environment. Because of large and complicated loading conditions, the efficient rock breaking and the walking motion control are the two key technical challenges for the hard rock TBM. This talk will focus on solving these problems through developing electro-hydraulic control systems for the TBM's cutter head system and walking system. The cutter head system of hard rock TBM is supposed to break the rock in tunnel with high driving capability. Therefore, a compound driving scheme is developed for the cutter head system. Through the coordination control of variable frequency electric motors, hydraulic motors andhydro viscous clutches, this compound driving system achieves large torques, low impact and high efficiency. The walking system of the hard rock TBM should be able to cope with changing conditions of surrounding rocks. A rock recognition scheme based on the gripper cylinder pressure control strategy is developed for the support subsystem. To reduce the disturbing forces caused by the attitude adjustment, a district electro-hydraulic control system is proposed for the advancing subsystem. The newly developed walking electro-hydraulic control systems have been applied in two hard rock TBMs and using these machines, we have obtained a satisfactory walking speed in the water project of the

Songhua River in Jilin province of China.

Huayong Yang received a PhD degree from the University of Bath in 1988, and joined the Department of Mechanical Engineering at the Zhejiang University in 1989. He is now a Professor and the Director of the State Key Laboratory of Fluid Power and Mechatronic Systems, Zhejiang University.

Prof. Yang is a prolific researcher with 149 invention patents, authored and co-authored 3 academic books and over 240 technical papers published in international journals and conferences. He is active in major international conferences related to both fluid power and mechatronics. He has served as technical/program Committee members of numerous international conferences, such as 2011 IEEE/ASME International Conference on Advanced Intelligent Mechatronics, and the IPC Co-Chair of 2013 IFAC Symposium on Mechatronic Systems. His research interests include motion control and energy saving of mechatronic systems, development of fluid power component and system, integration of electrohydraulic system and engineering application. He was appointed as a Cheung Kong Chair Professor by Ministry of Education of China in 2005. He is a member of the Academic and Advisory Committees of 7 State Key Laboratories of Tsinghua University, Zhejiang University, Shanghai Jiaotong University, Huazhong University of Science and Technology, Harbin Institute of Technology, Central South University and Chongqing University.

Prof. Yang was a recipient of the first prize of the National Scientific and Technological Progress in 2012 and the second prize in 2003. He is a Fellow of Chinese Mechanical Engineering Society and was elected as a member of the Chinese Academy of Engineering in 2013.

Keynote 2: "Robotic Assistance for Improving Surgeries and Therapies"

This presentation will explore some of the potentials of robotics technologies for improving healthcare by making surgeries and therapies more efficient – we will consider prostate brachytherapy and beating-heart surgery as two examples. In permanent implant brachytherapy, needles loaded with radioactive seeds are used to reach planned locations in the prostate, where the seeds are deployed. Accurate seed placement is a key factor that influences the effectiveness of the procedure. However, current manual techniques can place seeds with an accuracy of only about 5 mm. This is a substantial error given the average prostate size and narrows the scope of brachytherapy to primarily treating the entire prostate gland for patients with localized prostate cancer. We will discuss mechatronic technologies for precisely steering a needle towards its intended location in a controlled manner.

While operating on a beating heart would offer many benefits to patients, performing a surgical task on the beating heart requires superhuman skills as the surgeon must manually track the heart's motion while performing the surgical task. With advances in surgical robotics, we can now envision a robot-assisted surgical system that first synchronizes the surgical robot’s motion with the beating heart’s motion and then lets the surgeon operate through teleoperation on a seemingly motionless point on the heart. We will present such a system that relies on image guidance, heart motion prediction and predictive feedback control to enable beating-heart surgery.

Mahdi Tavakoli is an Associate Professor in the Department of Electrical and Computer Engineering, University of Alberta, Canada. He received his PhD degree in Electrical and Computer Engineering from the University of Western Ontario, Canada, in 2005. In 2006, he was a post-doctoral researcher at Canadian Surgical Technologies and Advanced Robotics (CSTAR), Canada. In 2007-2008, he was an NSERC Post-Doctoral Fellow at Harvard University, USA. Dr. Tavakoli's research focuses on haptics and teleoperation control, medical robotics, and image-guided surgery. Dr. Tavakoli is an Associate Editor of Journal of Medical Robotics Research and the lead author of Haptics for Teleoperated Surgical Robotic Systems (World Scientific, 2008).

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