

Robotic Induction of Neuromodulation in Human Motor System

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Abstract

This talk will introduce the speaker's recent research effort that aims to apply a systems engineering approach to designing and assessing rehabilitation robots. The research approach is threefold: (1) design and control of high-precision mechanisms, (2) modeling of human functions, and (3) understanding of interaction between human and robots. The goal of the research is to develop theories, methods, and tools to understand the mechanisms of neuromotor adaptation in human-robot physical interaction. A project supported by the U.S. National Science Foundation is introduced that aims to understand temporal dynamics of cortical facilitation with afferent stimulation for the assessment of stroke rehabilitation. A robotic device that combines magnetic brain stimulation and peripheral mechanical stimulation has been developed to reproduce paired associative simulation (PAS). Subjects receive this mechanical stimulation and magnetic brain stimulation with various time intervals between two in order to induce long-term potentiation. The research reveals that precise timing control of actuation is the key for successful robotic neuromodulation, not the speed of response. Mechanical stimulation and induced adaptation can also improve sensory and motor performance in dexterous manipulation tasks.

Bio: Jun Ueda received the B.S., M.S., and Ph.D. degrees from Kyoto University, Kyoto, Japan, in 1994, 1996, and 2002 all in Mechanical Engineering. From 1996 to 2000, he was a Research Engineer at the Advanced Technology Research and Development Center, Mitsubishi Electric Corporation, Hyogo, Japan. He was an Assistant Professor of Nara Institute of Science and Technology, Japan, from 2002 to 2008. During 2005-2008, he was a visiting scholar and lecturer in the Department of Mechanical Engineering, Massachusetts Institute of Technology. He joined the G. W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology as an Assistant Professor in 2008 where he is currently an Associate Professor and Woodruff Faculty Fellow. He is also the Director of Robotics PhD Program at Georgia Tech. He received a Fanuc FA Robot Foundation Best Paper Award in 2005, IEEE Robotics and Automation Society Early Academic Career Award in 2009, and Advanced Robotics Best Paper Award in 2015. Dr. Ueda has published more than 100 peer-reviewed journal papers, conference papers and book chapters. He has issued 13 international and U.S. patents.