ABSTRACT

Mechatronic Systems for the Repair and Training of Human Sensorimotor Control
Dr Marcia O'Malley, Rice University, Houston, Texas, USA

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The mission of the Mechatronics and Haptic Interfaces (MAHI) Lab at Rice University is to design, manufacture, and test mechatronic or robotic systems to model, rehabilitate, enhance, or augment the human sensorimotor control system. We are broadly focused on developments in machine design, control, and experimental methods in haptics research. Specifically, we employ a systems engineering approach, exploring the effects of force feedback on human performance in man-machine interactions with virtual and remote environments. In this talk, I will discuss several research thrusts in the lab.

First, I will discuss work in robotic rehabilitation of the upper extremity following stroke and incomplete spinal cord injury. We have developed a range of techniques for ensuring active engagement of the participant in therapeutic interventions with robotic devices. Objective measures of motor impairment can provide frequent feedback to the participant regarding their performance during therapy. Control architectures can require initiation or sustained input from the user in order to generate desired movements. Further, controllers can be designed to adapt to the user's changing capabilities, which may be dependent on position or direction of movement. Results from a variety of ongoing clinical evaluations will be discussed in relation to these topics.

Second, I will discuss our work in the area of haptic guidance, or shared control between a robot and a human user. I will talk about our experiences in determining appropriate guidance algorithms and architectures based on task analysis and determination of successful human motor control strategies. I'll discuss the various types of guidance we have analyzed, and our outcomes for a number of tasks and architectures. Finally, I will discuss our work in sensory feedback for smart prosthetics, and the role of tactile and kinesthetic feedback for enhancing performance in positioning and manual control tasks. These research efforts embody the collaborative, interdisciplinary nature of my group's research in biorobotics, haptics, neural engineering, and robotic rehabilitation.

About:

Marcia O'Malley received the B.S. degree in mechanical engineering from Purdue University in 1996, and the M.S. and Ph.D. degrees in mechanical engineering from Vanderbilt University in 1999 and 2001, respectively. In 2001 she joined the Mechanical Engineering and Materials Science Department at Rice University, where she is currently an Associate Professor and directs the Mechatronics and Haptic Interfaces Lab. She holds a joint appointment in Computer Science at Rice, and is an Adjunct Associate Professor in the Departments of Physical Medicine and Rehabilitation at both Baylor College of Medicine and the University of Texas Medical School at Houston.

Additionally, she is the Director of Rehabilitation Engineering at TIRR-Memorial Hermann Hospital, and is a co-founder of Houston Medical Robotics, Inc. At Rice, her research addresses issues that arise when humans physically interact with robotic systems, with a focus on training and rehabilitation in virtual environments. In 2008, she received the George R. Brown Award for Superior Teaching at Rice University. O'Malley is a 2004 Office of Naval Research Young Investigator and the recipient of the NSF CAREER Award in 2005. She received the Best Paper Award at the 2011 IEEE World Haptics Conference in Istanbul, Turkey. She is the former chair of the IEEE Technical Committee on Haptics and was on the founding editorial board for the IEEE Transactions on Haptics. She currently serves on the editorial board of the ASME/IEEE Transactions on Mechatronics.