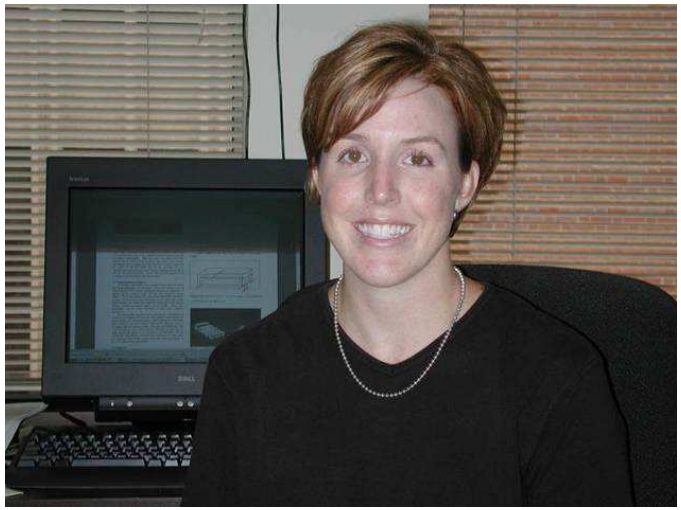


Marcie O'Malley

Assistant Professor
Mechanical Engineering and Materials Science
Rice University
Houston, TX

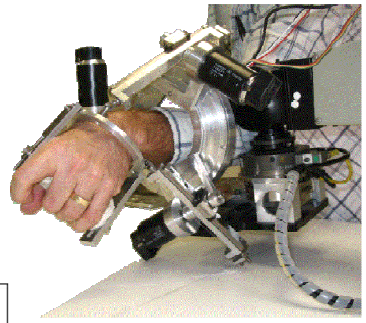
omalleym@rice.edu http://mahilab.rice.edu

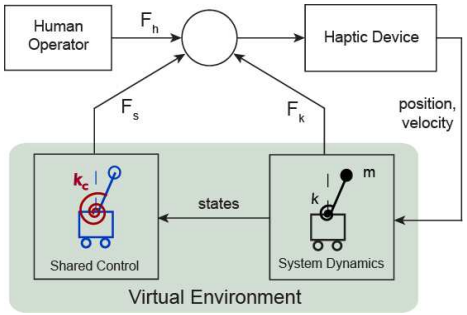
Research Interests

- Haptics
  - Hardware design
  - Control
  - Psychophysics
- Robotic-assisted rehabilitation
- Vision-based control
- Computational motor control
- Nanorobotic manipulation
- Physical HRI

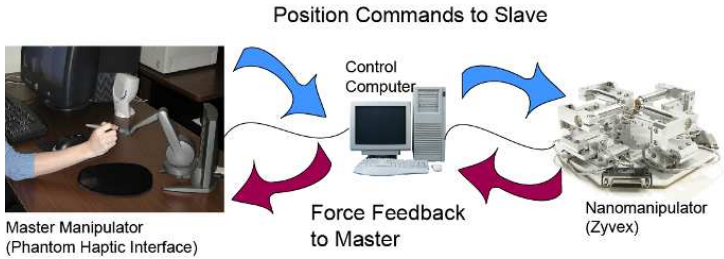
Research Highlights

Exoskeleton devices facilitate motor recovery post-stroke





Haptic guidance via shared control uses all states of system to be controlled



Nanomanipulation with vision-based force sensing and feedback

Honors

- NSF CAREER 2005
- ONR YIP 2004
- George R. Brown Award for Superior Teaching (Rice University) 2008

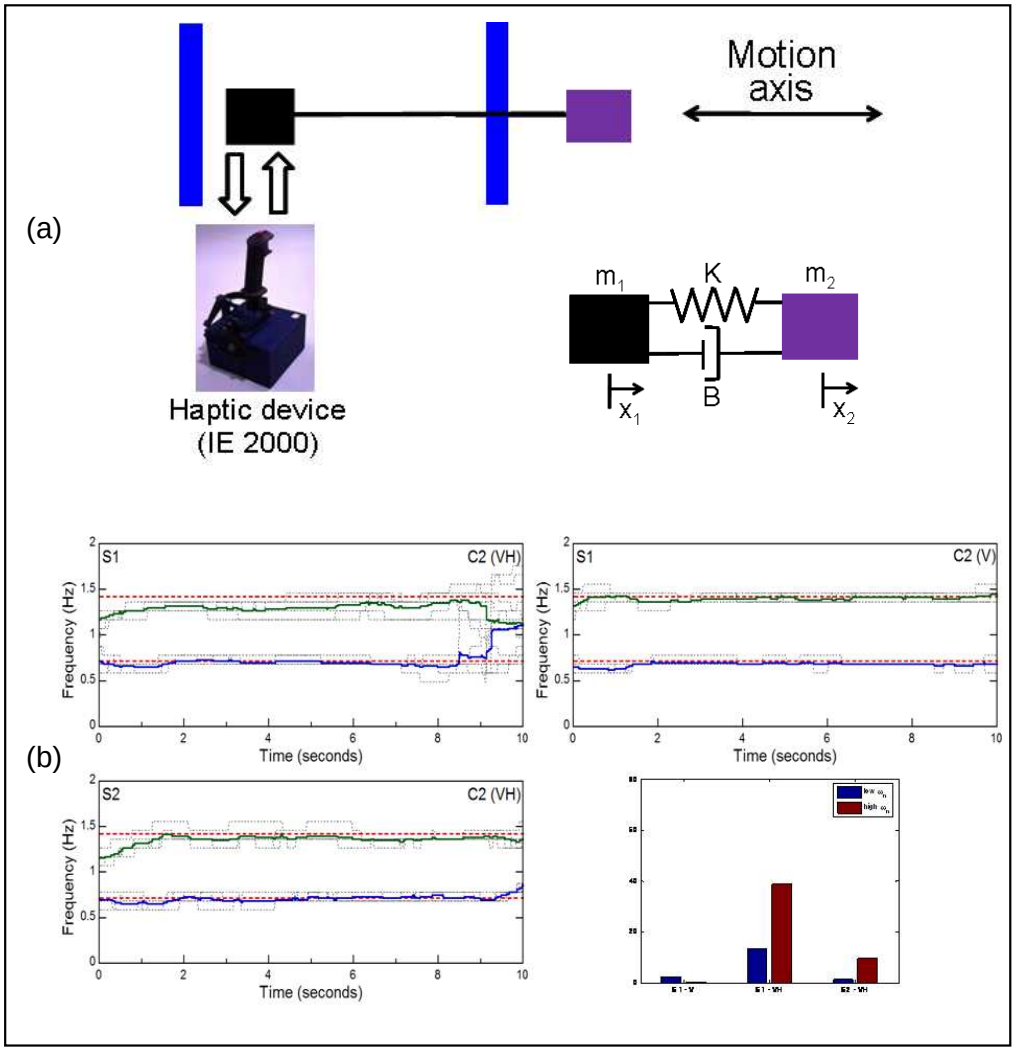
Professional Activities

- ASME DSCD Robotics TC Co-Chair (and next Chair)
- IEEE Haptics TC Co-Chair
- IEEE Transactions on Haptics Associate Editor
- ASME/IEEE Transactions on Mechatronics Associate Editor (2009+)

Human Motor Adaptation in Rhythmic Tasks

M.K. O'Malley, Rice University, omalleym@rice.edu

- There is evidence that humans adapt their control scheme (and internal models) when manipulating dynamic systems, and that the process is influenced by the feedback (visual and/or haptic) available
- For new training strategies (such as shared control), a deeper understanding of human motor control and adaptation is desired.
- We demonstrate the rate at which humans identify the dynamics of a resonant second order system
- We investigate the importance of feedback, magnitude, and phase cues for identification and adaptation



(a) Participants excite a virtual second order system along a horizontal axis using an IE2000 haptic joystick

(b) Participants are able to adapt to varying resonant frequencies

Societal Implications

- Improve outcomes of rehabilitation protocols (stroke, TBI, Parkinsons, MS, CP, SCI, etc)
- Facilitate effective and efficient training for new manual control tasks (defense, surgery, sport, etc)

Accomplishments to Date

- Feedback (visual, haptic) affects the rate of adaptation
- Sensory channels can be exploited for information exchange (illusions, skin stretch, proprioception, sensory substitution)
- Humans integrate several cues when manipulating dynamic systems in order to achieve resonance

Challenges

- Requires cross-disciplinary interactions from divergent fields (neuroscience, robotics, dynamics, control systems, cognitive psychology, physical medicine…)
- Depends on human (and animal) studies which are time consuming, and can be difficult to conduct while maintaining valid experiment design

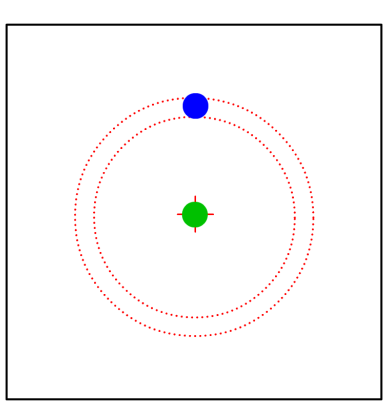
5/10/20 Year Vision

- FIVE years: Understand human adaptation when manipulating dynamic systems
- TEN years: Influence the rate of adaptation by manipulating virtual environment dynamics, sensory channels, and feedback modalities
- TWENTY years: Enable natural control of smart prosthetics

Robotic Motor Improvement Measures

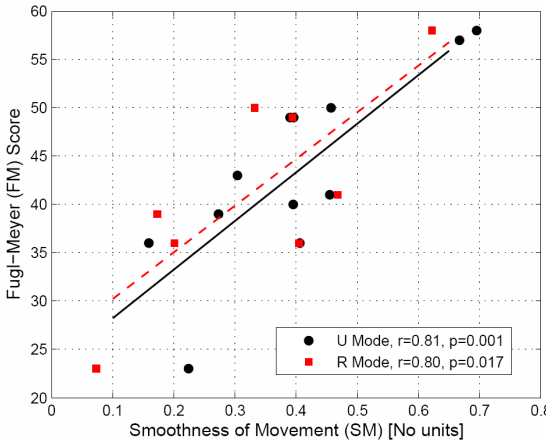
M.K. O'Malley, Rice University, omalleym@rice.edu

- Robotic rehabilitation shows promise for improving motor coordination post-stroke
- Clinical measures are time consuming to acquire and suffer from subjectivity
- Robotic motor improvement measures that characterize smoothness of movement are well-correlated to widely accepted clinical measures like Fugl-Meyer
- Robotic measures can be used to provide personalized rehabilitation, or infer patient progress over smaller time intervals



Patient seated at the robotic rehabilitation setup

Smoothness of movement shows positive linear correlation to Fugl-Meyer score for our pilot study



Societal Implications

- Improve outcomes of rehabilitation protocols (stroke, TBI, Parkinsons, MS, CP, SCI, etc)
- Create synergies between communities (Physical therapists and engineers)
- Provide means for personalized medicine / tuning of protocol

Accomplishments to Date

- Robotic measures can be acquired in real-time
- Robotic measures that assess movement quality correlate well with several clinical measures
- Robotic measures can predict with some dependability clinical measures

Challenges

- Requires cross-disciplinary interactions from divergent fields (neuroscience, robotics, dynamics, control systems, cognitive psychology, physical medicine…)
- Heterogeneity of impairment affects generalizability of results

5/10/20 Year Vision

- FIVE years: demonstrate personalization of rehabilitation based on robotic measures
- TEN years: theorize mechanisms of motor recovery from computational motor control perspective
- TWENTY years: design protocols to speed motor recovery and coordination