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Advanced Platform Technology Center

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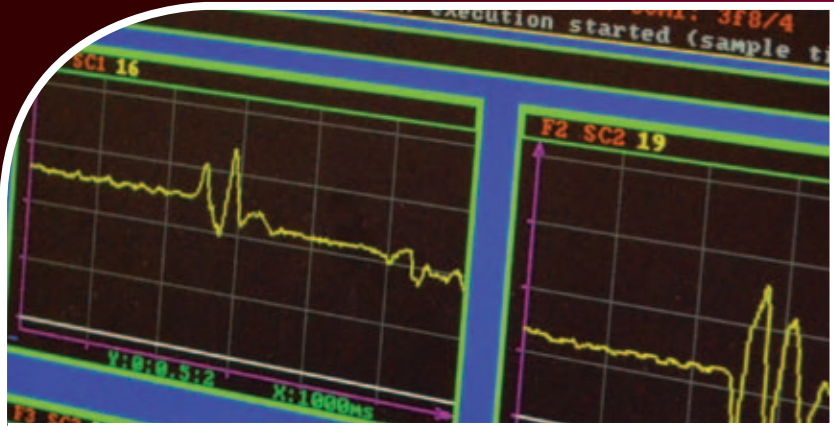
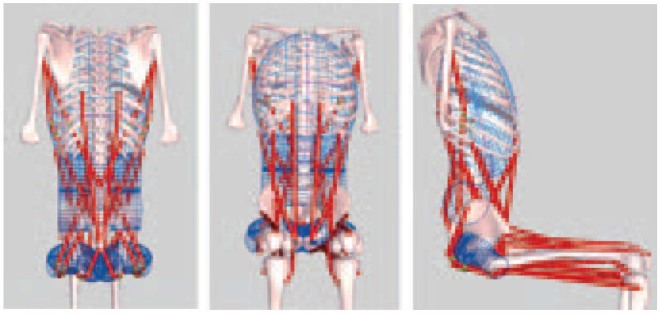


PROJECT OVERVIEW

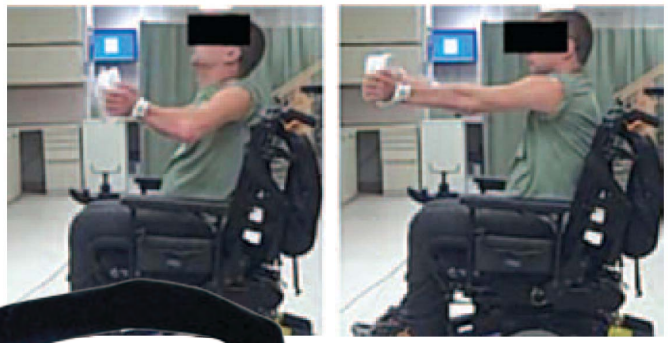
Seated Balance and Trunk Control

Spinal cord injury can result in paralysis of the core trunk and hip musculature that compromises the ability to stabilize the torso while reaching, resist disturbances to sitting balance, and efficiently propel a manual wheelchair, thereby limiting the ability to work and engage in social or leisure activities. We have shown that constant stimulation of the otherwise paralyzed trunk and hip extensor muscles can positively alter seated posture, extend bimanual reach, restore erect sitting, and improve wheelchair propulsion mechanics at slow speeds and on level surfaces. However, the benefits of low levels of continuous stimulation disappear during dynamic movements that either require more stiffness of the core, or modulation of stimulus timing and intensity.

Current development goals for this project include designing new ways to let users set their seated posture to automatically maintain balance, and synchronize stimulation to the trunk and hip muscles with the manual wheelchair propulsion cycle via the voluntary activity of the intact shoulder muscles.



Erect anterior (left), posterior (center) and lateral (right) views of the musculoskeletal model of the torso showing anatomically derived representations of major muscles (red) controlling the trunk and pelvis and physiologically appropriate wrapping surfaces (blue).



Left is reaching without trunk and hip stimulation; right is reaching with stimulation.

APT Center Contributions:

- Wireless sensor system hardware and software
- Control system modeling, design and biomechanical analysis
- Design controls and documentation within a quality system to facilitate future commercialization
- Regulatory affairs expertise for interactions with US FDA

Project Funding History:

US Department of Veterans Affairs, Merit Review 1I01RX001204, July 2013 – June 2016

US Department of Defense Spinal Cord Injury Research Program, SC090230, October 2010 – September 2013

US Department of Veterans Affairs, Merit Review B6406R, January 1, 2010 – December 2012

US Department of Veterans Affairs, Merit Review B3043-C, July 2002 – June 2004

Selected Publications:

"Effects of stimulating hip and trunk muscles on seated stability, posture and reach after spinal cord injury," R. Triolo, L. Lombardo, M. Miller, S. Nogan-Bailey, M. Audu, *Archives of Physical Medicine & Rehabilitation* 94(10):19987-2005, 2013.

"The effects of combined trunk and gluteal neuromuscular electrical stimulation on posture and tissue health in spinal cord injury," G.A. Wu, L. Lombardo, R. Triolo, KM Bogie, *Physical Medicine & Rehabilitation Journal* 5(8): 688-696, 2013.

"Implanted electrical stimulation of the trunk for seated postural stability and functional mobility after cervical SCI: A single case study," R.J. Triolo, L. Boggs, M. Miller, J. Nagy, G. Nemuanitis, S. Nogan-Bailey, *Archives of Physical Medicine & Rehabilitation* 90(2): 340-347, 2009.

"Biomechanical analysis of surface electrical stimulation on the trunk musculature during wheelchair propulsion," Y. Yang, A. Koontz, R. Triolo, J. Mercer, S. Fitzgerald, R. Cooper, M. Boninger, *Neurorehabilitation and Neural Repair* 23(7):717-25, 2009. (Epub 2009 Mar 4).

The **APT CENTER** is a Department of Veterans Affairs Rehabilitation R&D Center of Excellence that creates novel, cross-cutting technologies for the diagnosis, treatment or study of high priority clinical conditions within a structured framework that facilitates regulatory compliance, dissemination within the rehabilitation community and commercialization by outside manufacturers. Center projects focus on the following: prosthetics and orthotics, health maintenance, neural interface and enabling technologies. The Center has over 30 investigators, engineering and clinical staff, and support services including regulatory affairs, quality systems, project management and grants administration.

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