Seminar

CENTER FOR
ADAPTIVE NEURAL SYSTEMS

IRA A. FULTON SCHOOL OF ENGINEERING

Neural Interfaces for Somatosensory Feedback

Douglas J. Weber, PhD
University of Pittsburgh, PA

Abstract: Several groups are working to interface the nervous system with prosthetic devices for the restoration of sensory and motor functions. The ultimate goal is to create neuroprosthetic limbs that literally look, feel, and function naturally, with user intention and state feedback communicated by a neural interface. It is now clear that cortical signals can be recorded and decoded to express user intention, but adequate provisions for somatosensory feedback have not yet been made. Somatosensory feedback is needed to convey information about the physical state of the limb, including position, velocity, and force in the controlled limb. In the intact system, this information is measured and conveyed by primary afferent neurons, particularly muscle spindles, golgi tendon organs, and cutaneous afferents.

We are developing methods to record and stimulate primary afferent neurons using microelectrode arrays implanted in the dorsal root ganglia of cats. Multichannel neuronal recordings allow the extraction of limb-state information from somatosensory neurons, while multichannel microstimulation can be used to transmit state information into the nervous system to provide natural haptic and proprioceptive sensations for an artificial limb. Both applications require knowledge of how state-information is encoded in the neuronal population, and of course, physical connections (e.g. microelectrodes) with a sufficient number of neurons to convey meaningful information about limb-state. We have shown that accurate and reliable estimates of limb-state can be made by decoding the firing rates of as few as 10 primary afferent neurons. We are now implementing this approach to provide state-feedback for controlling functional electrical stimulation (FES) in a paralyzed limb.

We are using a similar animal model to develop a multichannel microstimulation method of transmitting limb-state information into the nervous system, a somatosensory analog to the cochlear implant used to restore hearing to persons deafened by the loss of hair cells in the inner ear. Our approach uses arrays of microelectrodes implanted in dorsal root ganglia (DRG) to stimulate multiple groups of primary afferent neurons in parallel. The spatial and temporal patterning of microstimulation pulses across the array encodes limb-state information in a way that mimics the natural somatosensory inputs for proprioception and touch. Efficacy is assessed by measuring the neuronal response in somatosensory cortex with an array of microelectrodes. Results from this so-called "replay" stimulation show that cortical neurons respond similarly to the movement and "replay" conditions, indicating that microstimulation is effective at mimicking the natural sensory response to movement. We also measured the cortical responses to arbitrary patterns of input, where the location, intensity, and frequency of microstimulation are varied systematically to determine parameters most effective for transferring information to the brain. Results show that the intensity and location of stimulation provide the most discriminable responses in cortex, thus representing two distinct dimensions for encoding information for transmission to the brain. Results from these studies will be used to determine the optimal size, location, and encoding functions of a sensory neural interface for neuroprosthetic limbs

Biography: Dr. Weber is an Assistant Professor in the Department of Physical Medicine and Rehabilitation at the University of Pittsburgh. He is also a faculty member in the Department of Bioengineering and the Center for the Neural Basis of Cognition. His research is aimed at understanding the role and nature of somatosensory feedback in the motor control, improving activity-based rehabilitation strategies, and developing neuroprosthetic devices for restoring function after neurologic injury and limb-loss

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Location and Time:
Location: ISTB1 227
Date: Mar. 28, 2008
Time: 9:30 am - 10:30 am

Contact for further information:
Jeanine Elliott
Phone: 480-965-9489
Fax: 480-727-7624

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