

**MYOELECTRIC DECODING OF FINGER POSITIONS
FOR ADVANCED PROSTHESES**

by
Ryan J. Smith

A thesis submitted to The Johns Hopkins University in conformity with the
requirements for the degree of Master of Science in Engineering

Baltimore, Maryland
October, 2009

© 2009 Ryan Smith
All Rights Reserved

Abstract

Myoelectric signals, or electrical signals produced from muscles, have emerged during the last century as a viable control signal for prosthetic devices. Unfortunately, myoelectric technology for upper limb amputees developed slowly and has been characterized by claw-like gripping devices with limited functionality. The recent emergence of advanced anthropomorphic multi-fingered end effectors, however, offers great promise to upper limb amputees. As these devices increase in mechanical sophistication and dexterity, there is a need for the development of intuitive and functional myoelectric-based control schemes that are capable of utilizing the full potential of these devices. This work focuses on the development, testing and validation of an endpoint-based control algorithm capable of continuously decoding finger positions from myoelectric signals from the residual limb of below-elbow amputees.

In an initial study, four below-elbow amputees performed self-directed individual finger movements with their phantom limb while mirroring the motions with their intact hand. Myoelectric signals were simultaneously recorded from an array of eight bipolar electrodes on the residual limb. The collected myoelectric data were later used offline to predict the finger positions of the subjects. The decoding method is shown to have significant decoding performance with correlation values of 0.85 to 0.95 between the predicted and actual finger position for the amputee subjects.

In a second study, subjects utilized control of myoelectric signals in their residual limb in order to control the fingers of a virtual multi-fingered hand in real-time. Two below-elbow amputees participated in the study and were able to successfully manipulate the fingers of the virtual hand to touch and maintain contact with targets appearing in the virtual environment. The subjects were able to utilize myoelectric control using signals from their residual limb to complete the tasks for multiple fingers with completion accuracies ranging from 74% to 92% across multiple target locations and difficulties.

The collective work serves as a significant step toward dexterous control of multi-fingered prosthetic devices. Further investigation is warranted into the incorporation of this decoding algorithm in prosthetic devices for long term use. Extended usage of a virtual environment for real-time decoding of myoelectric signals is also of interest, particularly with regards to improving the usability of prosthetic devices as well as the potential impact on phantom limb pain.