CONTROLLER SELECTION FOR MYOELECTRIC PROSTHETIC HANDS

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ABSTRACT

Powered prosthetic hands are traditionally controlled using proportional control, where the motor voltage varies in proportion to the differential EMG signal form antagonistic muscles. This method of control performs adequately in position control as well as grasping durable objects perform poorly where force control is needed, such as grasping brittle objects. We are seeking to improve the ability to control grip force of a hand prosthesis through modifications to the control scheme for both a basic and a responsive prosthetic hand. For the basic hand in this study we used an Ottobock MyoHand with direct motor drive. For the responsive hand internal feedback control was implemented on the MyoHand to compensate for the high effective inertia and friction of the system. The two modifications under consideration are EMG gain scheduling and adaptive time constant low pass EMG filtering. EMG gain scheduling is a simple scheme which consists of changing the EMG signal gain to one of two user selected values based on the activity. One value is for control of an open hand and the other for control while an object is grasped. The adaptive EMG filter varies the time constant of a low pass filter based on the control signal to allow the filtered signal to track fast control signals while filtering out noise when the EMG signal is relatively constant.

Two experiments were performed to compare the variations of myoelectric prosthetic hand controllers. Control of force, control of position and manipulation of a brittle object were evaluated. The manipulation task was performed using a manipulandum that slips at low grasping force and breaks with excessive grasping force. Force and position tracking were evaluated by the ability to track desired values displayed to the subject. Users self-select separate EMG gains for force and position control. Evaluations were performed with both fixed and scheduled gains. The adaptive EMG filter was compared against a fixed time constant low pass filter for each of these conditions. For the basic (Ottobock MyoHand) it was found that the adaptive filter showed no significant improvement but EMG gain scheduling showed a significant increase ($p<0.05$) in performance and user rating of the brittle object manipulation. For the responsive hand (Ottobock MyoHand with internal control) it was found that EMG gain scheduling showed no significant improvement but the adaptive filter showed a significant increase ($p<0.05$) in performance and user rating in force control and brittle object manipulation.