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Real-Time Control of a Virtual Hand Using Surface Electromyography

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Abstract

Most multi-articulate prostheses allow the user to control the prosthesis through a range of pre-determined grip patterns with fixed force outputs. Although these pre-determined movements can make the prosthesis more reliable, user commands are limited to these grips and cannot be controlled naturally in real-time. Using surface electromyography (sEMG) and a modified Kalman Filter, upper limb amputees can intuitively control arm prostheses with independent, proportional control. We created an inexpensive sleeve of 32, dry sEMG electrodes (plus reference and ground) and built a graphical user interface in Matlab to train and control an 8 degree-of-freedom virtual arm (MuJoCo, Roboti). First, the user trains the Kalman filter by mimicking a predetermined set of movements while recording muscle signals. The mean-absolute-value of all possible differential pairs (528 features) was calculated over a 300-ms window and aligned with the movement data. Gram Schmidt forward selection identified the 48 most unique and useful features which were used to train a steady-state Kalman filter and control the virtual arm in real-time. We incorporated thresholds and a latching filter to reduce noise in the system. This system will enable our lab to study proportional control algorithms and low-cost, non-invasive sensory feedback in a virtual environment.