UNDERSTANDING ERRORS IN PATTERN RECOGNITION-BASED MYOELECTRIC CONTROL

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ABSTRACT

Recent advances in pattern recognition-based myoelectric control have allowed the technology to be commercialized after decades of controlled laboratory and clinical usage. Despite this success, challenges remain; one of the most critical of these is susceptibility to unintended movements. These errors often require correction to accomplish the desired task, a frustrating process that can hinder device adoption. Although many studies have examined systemic causes of error, such as limb position, electrode shift, and changes in patterns over time, no study to date has investigated how errors actually occur in real time. A handful of studies have analyzed the training data to establish what, if any, characteristics are predictive of successful control, but with little success. In this work, we examined and characterized the nature of errors as they occurred during a real-time myoelectric control task.

To better understand how errors occur, 24 subjects (50% female, 92% right-handed, age 25.8±3.2 y) were recruited to participate in a myoelectric control task. Subjects elicited eight sample contractions of four movement classes (wrist pronation, wrist supination, chuck grip, and hand open) and a no-movement class, which were used to train a classifier. This classifier was then used to control a cursor through a virtual targeting task, during which the myoelectric signals and the resultant cursor position were recorded. Indices of separability, repeatability, and variability were calculated from the training data, while outcome measures based on Fitts' Law were computed for the usability trials.

A thematic analysis of the real-time errors resulted in identification of three major types of error. The first, overshoot, described when users moved past or through a target without stopping. The second, bounceback, referred to an unintentional activation while the user attempted to stop. The third category encompassed all other active errors that resulted in movement away from the target. Within these error categories, several descriptive metrics were computed, including proportional control values, classifier confidences, and feature space distance metrics.

Although traditional Fitts' law metrics could not be predicted from the training data alone, several of the proposed real-time error characterization metrics could be. Although these measures were calculated during Fitts' Law tests, their results were not found to be correlated with the more traditional Fitts' Law measures. This work suggests that prediction of future performance of pattern recognition-based myoelectric control may be achieved through a better understanding of the nature of errors.