A HOME TRIAL COMPARISON OF DIRECT CONTROL VS PATTERN RECOGNITION CONTROL USING AN ADVANCED TRANSRADIAL PROSTHESIS

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INTRODUCTION

Pattern recognition (PR) has been described as a method of controlling a larger number of prosthetic arm movements than those that are possible with currently available commercial myoelectric control devices (Englehart, 2003). PR has also been used by individuals with higher levels of amputation who have had targeted reinnervation to control advanced prosthetic components (Kuiken, 2009). This work shows that targeted reinnervation is not necessary to improve control using pattern recognition.

Previous testing was performed on five individuals with transradial amputations using a virtual reality system with 10 wrist/hand movements. The performance using the residual limb was compared to the intact arm (Li, 2010). Performance metrics with the residual limb were not as high as with the intact arm. However, this does not indicate how well an individual might perform with a prosthetic device.

Laboratory experiments showed that PR can also be used for transradial amputees (without targeted reinnervation) to control a physical device: a multifunction hand-wrist system with seven degrees of freedom (DOFs), including wrist pronation and supination, wrist flexion and extension, hand open, lateral/key grip, and opposition/pinch grip (Miller, 2011). This work has been expanded to a home trial comparison of direct control and pattern recognition control using this multifunction device.

METHOD

Subjects: This abstract provides results from 3 transradial subjects. We will present data at AAOP on at least 4 subjects.

Apparatus: Subjects were fit with a socket and liner with six electrodes. An embedded controller was developed that could be programmed with either pattern recognition or two-site direct control. For PR control, EMG from all six electrodes was input into an LDA classifier running in real-time. For direct control (DC), two sites (over the flexors and extensors) were used as input. The subject switched between the degrees of freedom (using single-site impulses) and used only the two signals for control. All hardware and the socket remained the same for both trials

Procedures: Subjects used a multifunction hand-wrist system with wrist pronation/supination, wrist flexion/extension, and two grasps (three-jaw chuck and key). Subjects were trained and took the device home for a one month trial using each control. The order (DC vs PR) was randomized for all but the first subject who was chosen to use PR first to ensure that this type of control would be possible in a home environment.

Data Analysis: Data (ACMC, SHAP, Jebsen-Taylor, Box-and-Blocks, Clothespin test and a custom survey) were collected pre- and post-home trial for both DC and PR control. Usage statistics were recorded as well as subjective feedback. Each subject's data were processed independently.

RESULTS

In general, the subject preferred the control that had the highest scores on the outcome measures. Following the home trials, subjects 1 and 2 performed better with pattern recognition versus direct control and preferred pattern recognition. Both wore the pattern recognition system on average over 1.5 hours per day. Subject 3 preferred direct control and scored better on most measures. Because the research set up was bulky and would not fit under his tightfitting dress shirts, on average he wore the direct control set up 12 minutes per day and the pattern recognition system less than 5 minutes per day.

DISCUSSION

Subjective results included feedback that it took time to figure out how to distinguish movements with PR. Therefore, the third subject may not have worn the device in either configuration long enough to provide useful information. All subject agreed that it was nice to not have to switch with PR, but DC could result in less inadvertent movement; DC could also have unintentional switching.

CONCLUSION

All subjects successfully completed testing using device with 2 wrist movements and 2 hand grasps. Additional subjects are needed to see if more trends develop. Longer trials with commercial arm systems are also needed.

CLINICAL APPLICATIONS

Pattern recognition has shown to be a clinically viable system for individuals with a transradial amputation. Compared to existing commercial systems, subjects were able to control additional wrist movements and hand grasps.

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