Defense Announcement

Brain-machine interface with closed-loop neuromuscular stimulation for grasping in stroke and SCI survivors

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(Abstract/Summary) Sixty percent of elderly hand movements involve grasping, which is unarguably why grasp restoration is a major component of upper-limb rehabilitation therapy. Functional electrical stimulation (FES) can help retrain grasping, by using short bursts of electrical pulses to artificially contract paralyzed muscles. However, current FES devices are either operated by a therapist or by pre-programmed software routines, which fails to sufficiently engage the patient during therapy. Besides, commercially available FES devices are open-loop systems that require frequent parameter adjustments, which disrupts their continuous use.

The purpose of this study is to demonstrate that chronic stroke and spinal cord injury (SCI) subjects can learn to operate an FES device for grasping, using their brain activity recorded via electroencephalography (EEG). In addition, a closed-loop FES prototype with feedback was developed, to automatically adjust the stimulation intensities during grasping and its performance was compared with conventional open-loop systems, in an isometric force tracking task. Results from two pilot studies using a novel EEG-based brain-machine interface (BMI), demonstrated consistent performance in detecting motor intent from a cohort of stroke, spinal injury and able-bodied subjects. Moreover, after testing for three sessions, we concluded that the normalized tracking errors were significantly smaller during closed-loop (25 ± 15%) over open-loop (31 ± 24%), ($F(748.03, 1) = 23.22$, $p < 0.001$). In summary, our results provide compelling evidence in favor of EEG-based BMI with closed-loop stimulation, in order to restore grasping in stroke and SCI survivors.