For Submission

- Theme: BioRobotics and Medical Devices
- Topic: Rehabilitation engineering & assistive technology
- Title: Assistive Soft Robotic Glove Stroke Rehabilitation using EEG-based Motor Imagery Brain-Computer Interface for Elderly Stroke Patients
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- Abstract

Objectives

Stroke is one of the leading causes of disability with 17 million new cases worldwide each year, and it greatly affects the quality of life of the survivors. Recovery of the motor functions after the onset of stroke is important in order to perform activities of daily living. The main mechanism underlying motor recovery involves enhancement of the primary motor cortex through neuroplasticity, leading to the formation of new neural pathways in the brain. Conventionally, neuroplasticity is brought about by active motor training and pharmacological interventions. However, the use of motor training is highly dependent on the residual motor performance of the stroke survivor and may exclude survivors with poor motor performance. Given that physical movements by stroke survivors are often not possible, alternate strategies are needed. Motor imagery, the mental rehearsal of physical movement tasks, represents such an alternative. Unlike active motor training, motor imagery is not dependent on residual motor performance and can be applied to a wider range of stroke survivors. Further studies have shown that in tandem with the practice of motor imagery, the provision of feedback such as visual and kinesthetic feedbacks can enhance the effect of neuroplasticity by engaging the different senses of the patient. In this work, we have integrated visual and kinesthetic feedbacks into the practice of motor imagery using a brain-computer interface to result in a novel stroke rehabilitation system.

Methods

The setup consists of an EEG acquisition system, a monitor screen projecting a rehabilitation game, and a soft robotic glove capable of assisting in the flexion and extension of the hand’s fingers. The use of our system involves the stroke patient performing motor imagery through playing a computer game projected on the monitor screen while donning on the soft robotic glove. The game depicts a virtual avatar in the midst of performing several activities of daily living involving the use of his/her affected hands. Triggering of the virtual avatar within the game in carrying out the task is achieved through performing motor imagery of the intended action. This simultaneously causes a visual event, in which the virtual avatar moves, and another mechanical event, in which the soft robotic glove actuates to move the fingers of the patient. These form the feedbacks to the patient, which enhances the effect of rehabilitation.
Results

Our system has been implemented in a preliminary randomized-controlled clinical trial involving chronic stroke survivors, and sustained improvements have been observed in the Fugl-Meyers Assessment (FMA) and Action Research Arm Test (ARAT) scores of the users of the system.

Conclusions

Our system of stroke rehabilitation had been shown to be effective and can be potentially introduced clinically as a rehabilitation scheme for stroke survivors.