뇌신경재활

게시일시 및 장소 : 10 월 18 일(금) 13:15-18:00 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 15:49-15:53 Room G(3F)

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The Development of Brain-Machine Interface controlled Soft-Robotic Glove for Stroke Patients

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Purpose

A brain-machine interface (BMI) being integrated with a motion assistive robot is a new solution for post-stroke patients suffering from severe hand paresis, for whom the effective rehabilitation therapies such as active movement therapies which require a certain degree of remaining hand motor function would be less beneficial. The BMI-robot system can offer a neurofeedback training which could lead to affirmative neuroplasticity. Thus, we developed a BMI-controlled soft-robotic wearable device for the post-stroke patient with severe motor impairment of hand and performed a technical feasibility study.

Methods

The BMI system including wearable robotic glove assists finger extension movement when a BMI algorithm detects certain perilesional activation in functional near-infrared spectroscopy (fNIRS, NIRx Medical Technologies, LLC, US). NIRS. motor intention from the brain. The fNIRS system measures variations in local hemoglobin concentrations through 38 measurement channels placed on a patient's scalp. The BMI algorithm, based on linear discriminant analysis, detects a motor intention of hand extension from the fNIRS signal. And, the soft-robotic glove with pneumatic muscles assists hand extension of the paretic hand. (Figure. 1)

Experiment

An evaluation of the system was conducted with the patient (female, 53 years, right striatocapsular infarction, post-onset 60 days) who was incapable of voluntary finger extension. The main purpose of this experiment was on whether the BMI-robotic glove system could detect a motor intention from the affected brain with acceptable accuracy real-timely. The experiment was designed on motor-imagery (MI) protocol. Three periods of hand extension, 5, 7 and 10 s were used, and each period was repeated five times. During the experiment, the patient sat on a comfortable chair in a relaxed manner and performed the MI tasks by following the instructions given from the system. (Figure. 2)

Results

The BMI-robotic glove system detected a motor intention with a classification accuracy of 91.63±6.34% (balanced accuracy) and a detection latency, 2.47±0.10s. The classification accuracy and detection latency varied depending on the task period (Table. 1). The computation time from data acquisition to motor intention detection was 22.9 ms.

Conclusion

The results indicates that the BMI-robotic glove system presented in this paper could detect motor intention with acceptable classification performance and assist a hand extension in a real-time manner. In addition, the results implicit a post-stroke brain could produce a detectable hemodynamic response within a MI protocol.

Acknowledgment :This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF, 2016R1A2B4013730) and National Research Foundation of Korea (NRF) Grant funded by the Korean Government (MSIT) (NRF-2016R1A5A1938472)

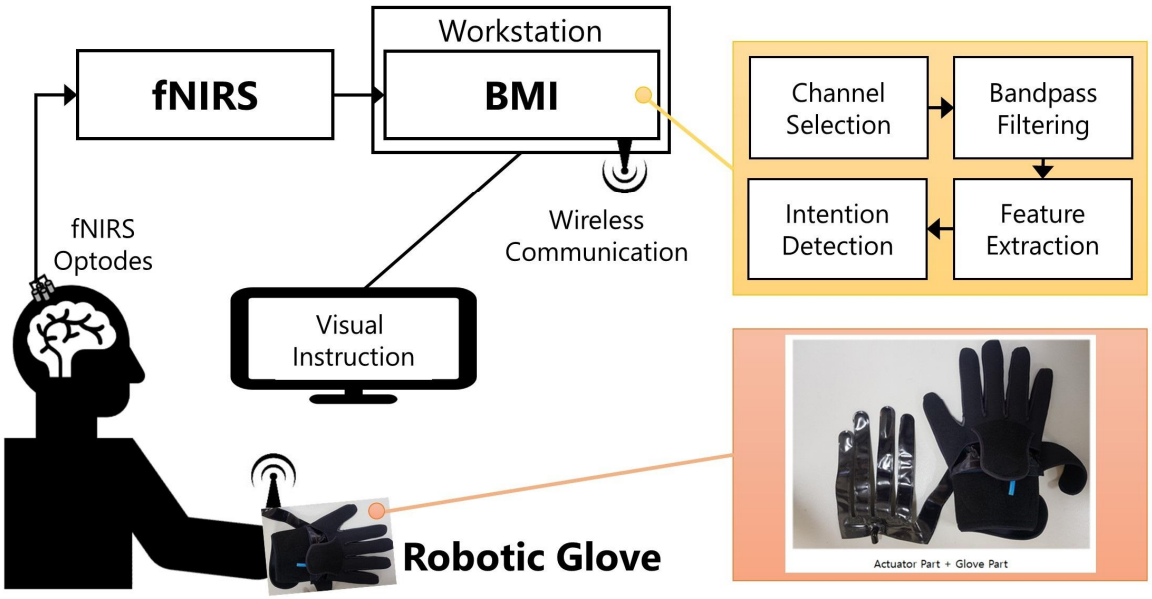

Figure 1. System Configuration and Components. The system consists of three main components: an fNIRS system, a BMI algorithm, and a robotic glove. The fNIRS monitors cortical activations in term of hemoglobin concentrations. The BMI algorithm processes fNIRS signals and detect a motor intention from the signal. The soft-robotic glove assists finger extension.

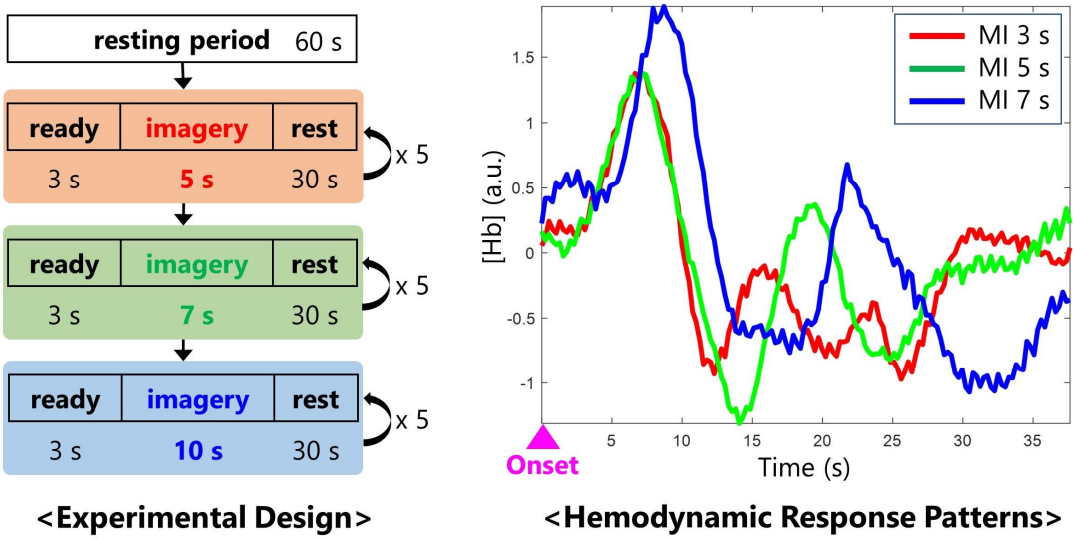

Figure 2. Experiment and Hemodynamic responses. Experimental design (left) consists of a resting period (60 s) and the following 15 motor imagery task trials. Each imagery task trial is a combination of 'ready', 'imagery', and 'rest' periods. Three kinds of imagery periods, 5 s, 7 s, and 10 s, were used. Hemodynamic responses patterns (right) were obtained through the experiments. The response patterns were the average of all HbO signals from ipsilateral channels.

Table 1. Classification Performance. The test results of the BMI algorithm were presented in term of classification accuracy (%) and detection latency (s).

	Classification Accuracy (%)	Detection Latency (s)
MI 5 s	84.33	2.5
MI 7 s	95.80	2.3
MI 10 s	94.76	2.4
Total	91.63	2.4