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An Audiovisual BCI to Control a Wheelchair by Using Mixed-Reality

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***Abstract*— To enable to move or turn a wheelchair to any place at once without the need for physical manipulation, we constructed an audiovisual BCI system. Virtual markers and sound sources were placed in front of and around the user in a mixed reality space. The subjects counted the number of the stimuli from the target marker or the sound. The accuracy of choosing the target marker or sound were obtained from EEG analysis, and they were 60 % and 20 % at maximum.**

***Clinical Relevance*— Although, the methods to present stimuli need to be improved, our system will help paralytic patients to move freely by wheelchair.**

I. INTRODUCTION

Brain-computer interface (BCI) measures the signal of the brain activity and converts it to the signal to control a device. It helps paralytic patients control devices or communicate. There are 2 types of BCI to control a wheelchair. One is a system that the user chooses the place which is registered [1]. The other is a system that the user chooses a direction by motor imagery and move freely [2]. However, the user cannot move or turn a wheelchair freely at once by these BCIs.

II. METHODS

Five healthy participants took part in this study (4 male, 1 female, mean age 23.8 years, range 22–25). All of them signed an informed consent to participate in the study.

Electroencephalograph (EEG) and electrooculogram (EOG) data were collected by Polymate Mini AP108 (Miyuki Giken, Japan). EEG electrodes were placed on Fz, Cz, and Pz accordingly to the 10-20 System. An EOG electrode were placed under the left eye. The left earlobe was selected for reference and ground. The sampling frequency was 500 Hz.

Virtual markers and sound sources were placed in front of and around the subjects by a HoloLens (a Mixed-Reality head mounted display) (Figure1). The subjects could see the virtual markers and hear the sound. The markers were displayed in blue and changed to red at the timing of the visual stimulus. The sounds were C4 (261.626 Hz), E4 (329. 628 Hz) and G4 (391.995 Hz). In a similar way of P300 speller, the audiovisual stimuli were presented from each row or column 12 times in a measurement. The subjects counted the number of the target marker or sound in their mind. The stimulation lasted 200 ms and the interval between stimuli was 800 ms.

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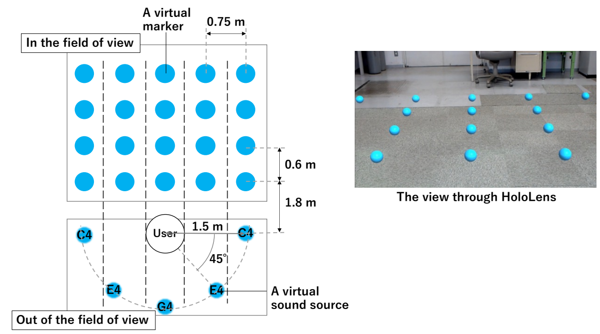

Figure 1. Virtual markers and sound sources were placed in the mixed

The data of 20 measurements (10 marker-target and 10 sound-target) were used to obtain the classification model. The test data were 10 measurements (5 marker-target and 5 sound-target). The data were bandpass filtered 1-20 Hz, averaged and down sampled to 20 Hz. The trials in which EOG was larger than 50 µV were eliminated.

III. RESULTS

Four out of five subjects were able to choose the target marker. The accuracy was 60 % at maximum. The average accuracy of the four subjects was 40 %. One subject could not choose the target marker, but he could choose the target column.

Two out of five subjects were able to choose the target sound. The accuracy of the two subjects was 20 %. Three subjects could not choose the target sound, but they could choose the target row or column.

IV. DISCUSSION & CONCLUSION

The results indicate that the user can choose the target marker. This means that the user can move to any place in the field of view. It is possible that presenting the audiovisual stimuli at the same time makes it difficult to choose the sound. To enable to turn the wheelchair, it might be better to prepare several interfaces for choosing the location in the visual field and the direction out of the field of view.

REFERENCES

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