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A New Stimulation Method of Virtual Speller for Simultaneous P300 and SSVEP Responses

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Abstract. In this paper, we introduce a new hybrid stimulation method for virtual speller. The virtual speller is desinged to elicit P300 and SSVEP reponses simulanously. It is 6-by-6 matrix and the column is filckering specific frequency and the row is turned off in a random order. The result of experiment with a healthy male subject shows the possiblity of the development of hybrid based BCI system.

Keywords: P300, SSVEP, hybrid paradigm, virtual speller, EEG

1. Introduction

There has been emerging interest in hybrid paradigm for brain-computer interface (BCI) recently. [Pfurtscheller et al., 2010; Allison, 2010; Leeb, 2010] A hybrid car has two engines: internal combustion engine and electric motors. They cover their weakness to each other, so the hybrid car has enhanced energy efficiency and reduced CO_2 output as a result. On the other hand, for BCI system, there are many paradigms such as P300, SSVEP, ERD, motor imagery and etc. They also have their own weakness respectively. For example, it takes longer time for averaging in P300 paradigm and the number of flickering frequency is needed as many as targets in SSVEP paradigm. They also can be combined to each other to cover the weakness and to enhance the performance of BCI system.

In this study, we designed a hybrid virtual speller which is combined P300 and SSVEP paradigm. With proposed speller, for 36 targets selection, only 6 different frequencies is used for SSVEP and only row is used for P300 response, which means no more time needed to column averaging. The proposed virtual speller covers their own weakness, so it could make BCI system enhanced ITR or accuracy as a hybrid car.

2. Material and Methods

2.1. Virtual Speller

Virtual speller is composed with 6 x 6 matrixes. Each target has a LED bar covered with translucent paper which is respective English alphabets or numbers printed on it. (see Fig. 1). Each column of the matrix is flickering specific frequency (25, 45.45, 19.61, 16.16, 29.41 and 35.71 Hz) and each row is turned off in a random order. Random row is turned off for 200ms and inter stimulus interval(ISI) is 400 ms. The size of individual target is 7x4.5 cm and matrix is 54x38.8 cm.

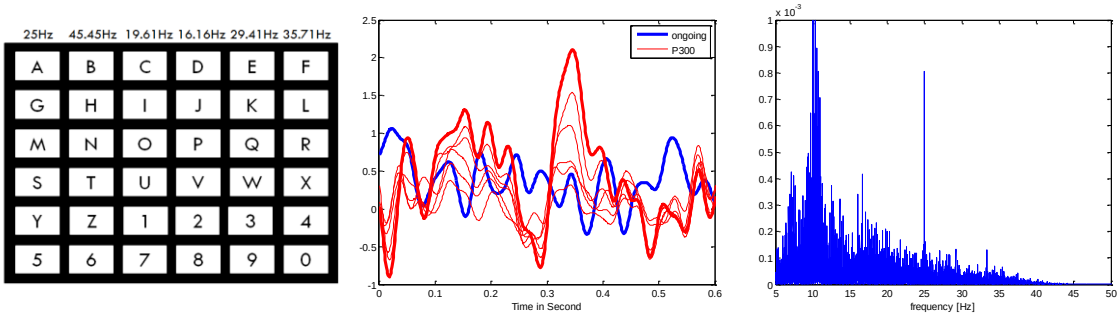

Figure 1. *Virual Speller(in the left), averaged 60 times of P300 response in Pz(bold red) and ongoing EEG (blue) in the middle, SSVEP respones of 25 Hz in the occipital region (in the right). The P300 and SSVEP responses are acquired at the same time with the hybrid speller.*

2.2. Signal Acquisition

EEG signal was acquired at Fz, Cz, Pz, Oz, P3, P4, O1 and O2 with a multi-channel EEG acquisition system (LXE3208, Laxtha Inc., Daejeon, Korea). EEG signal and trigger signal from virtual speller which is controlled by a MCU are digitalized by NI-DAQ system. Data were stored and processed by MATLAB R2012b.

2.3. Experiment

One healthy subject (31 year old, male) is participated in this experiment. He is asked to gaze individual target (A, B, C, D, E) in the matrix for 3 minute respectively and to rest for 30 seconds.

3. Results

P300 response at Pz and SSVEP at O1 are shown in Fig. 1 when the subject was gazing letter 'A'. Positive peak of 60 times averaged P300 is shown in bold red line in the middle of figure. Also, SSVEP response of 25 Hz is shown in the right of it.

4. Discussion

We introduced a hybrid simulation method for virtual speller for BCI. It is designed to elicit P300 and SSVEP simultaneously. We found out that P300 and SSVEP responses can be acquired in the same time. With proposed speller, the number of frequency for SSVEP responses can be reduced to 6 and averaging time also reduced by half for 36 targets. However, it is necessary more experiment with more subjects to generalize the result and online and evaluation of performance of proposed system with such as ITR or accuracy.

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