

Single Channel Hybrid BCI System using Motor Imagery and SSVEP

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Introduction: A user friendly device with few channels/electrodes is important for practical EEG based Brain Computer Interface (BCI) applications of everyday life. However, with few channels (especially a single channel) system, the acquired EEG information limits the classification accuracy or the performance of BCI system. In this paper, we propose a single channel hybrid BCI system using both Motor Imagery (MI) and Steady state visually evoked potential (SSVEP) to show the possibility of a single channel BCI system having higher performance. Since, the SSVEP feature can also be acquired from C3 and C4 channel according to [1], for developing a single channel system either C3 or C4 channel can be used for extracting SSVEP features. Recently, a study has shown that MI features can also be extracted through a single channel using Short-time Fourier transform (STFT) and Common Spatial Pattern (CSP) [2]. As both MI and SSVEP features can be extracted from C3 or C4 channel, it provides the possibility of developing a single channel Hybrid BCI system using MI and SSVEP.

Material, Methods and Results: A 32 channel Neuroscan EEG equipment was used to acquire offline data for a two class hybrid BCI system. These classes include Right hand MI with 15Hz SSVEP and Left hand MI with 20Hz SSVEP stimulus. After artifact removal and epoch extraction of this offline data, STFT was applied on each trial (of 4 seconds duration) of EEG data acquired from C3 and C4 channels. The time-frequency data will be the input for a feature extraction method called Common Frequency Pattern (CFP) as shown in fig. 1A. The features obtained from CFP then were classified using Support Vector Machine (SVM).

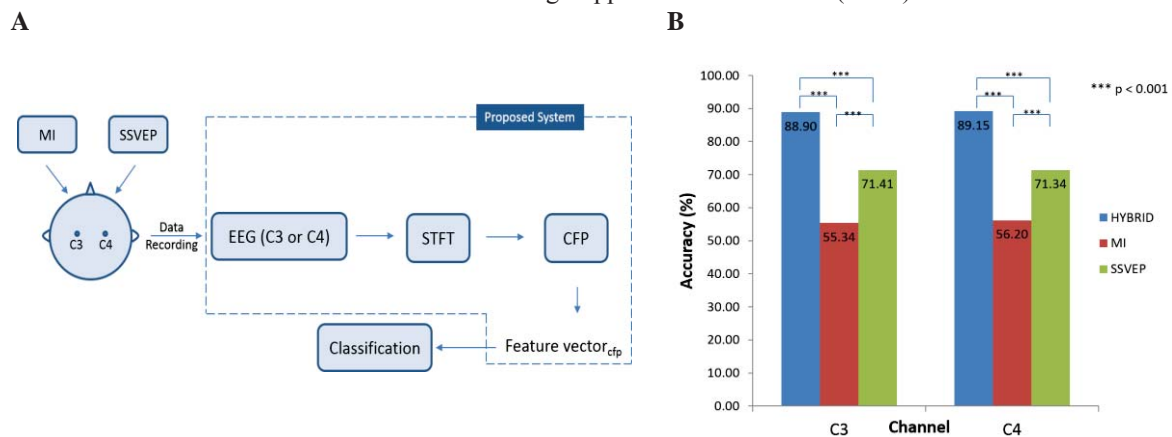


Figure 1. A) Framework of proposed single channel Hybrid BCI system B) Classification accuracy at C3/C4 channel for time window of 4 seconds

Considering a trial length of 4 seconds, the highest classification accuracy of 89.15% is achieved through hybrid BCI system, whereas the accuracy is less for MI or SSVEP based system (see Fig.1B). A significance test has shown that there is significant difference in the performance of Hybrid BCI system to that of MI or SSVEP based BCI system.

Discussion and Conclusion: It is observed that both the channels C3 and C4 channels has similar performance. Therefore, use of any of these channels in practical applications will not have significant difference in its performance. Also, it is very common for the performance to drop as the trial length gets shorter. This variation of performance with trial length has to be studied.

Significance: The possibility of a single channel Hybrid BCI with good classification accuracy is shown through this work.

References:

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 [2] Ge, Sheng, Ruimin Wang, and Dongchuan Yu. "Classification of four-class motor imagery employing single-channel electroencephalography." (2014): e98019.