Preprocessing the P300 word speller with ICA for Brain-Computer Interfacing

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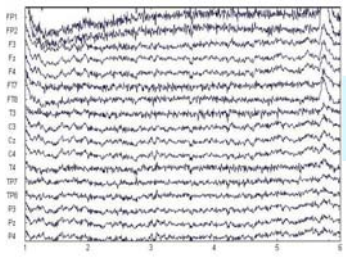
EEG

The electroencephalogram (EEG) is a recording of the electrical activity of the brain measured at the scalp. The waveforms recorded are thought to reflect the activity of the surface of the brain, the cortex.

Electrodes are placed on the scalp in predeterminedl positions. These positions are identified by the EEGer who measures the head using the International 10/20 System.

EEG Data

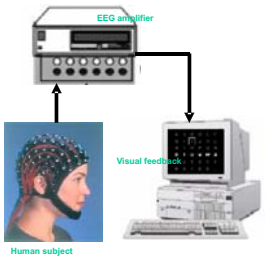


Time (s)

Brain-Computer Interfacing

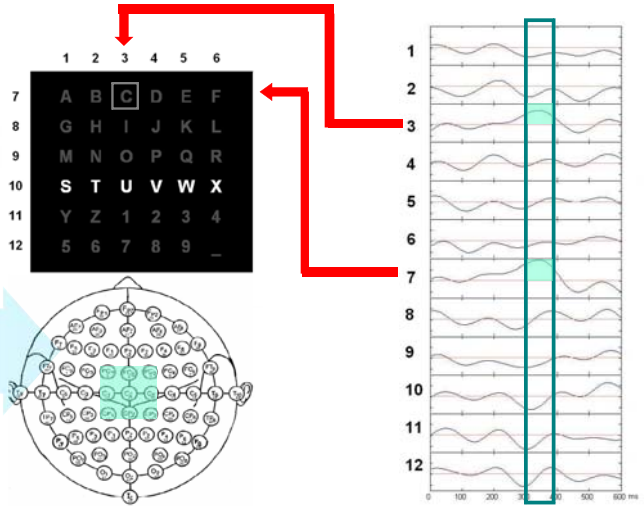
An EEG based brain-computer interface (BCI) is a communication system in which messages or commands that an individual sends to the external world do not pass through the brain's normal output pathways of peripheral nerves and muscles but is detected through EEG activity. One of the overall goals is to provide those users with severe mobility disability or aphasia, basic communication capabilities to interact with their environment.

BCI Set-up



P300 Word Speller

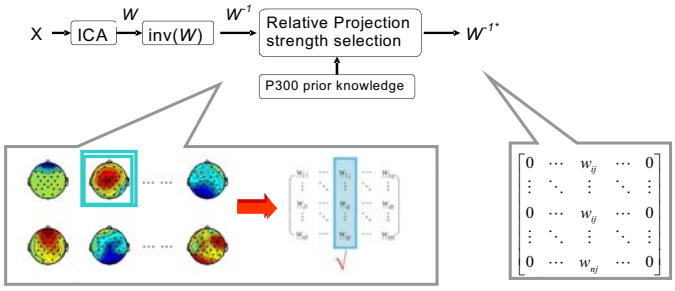
This speller, an Important BCI application has been introduced by Farwell and Donchin who developed a protocol whereby a subject is presented a 6 by 6 characters matrix in which a row or column is randomly intensified. Then large P300 evoked potentials appeared at the vertex region can be recorded in response to the intensification of a desired character. Hence the objective of the problem is to classify these potentials whether or not they correspond to the desired character.



P300 Preprocessing with ICA

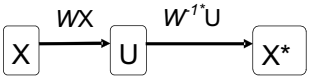
In this work we use Infomax ICA to get a clear P300 by extracting independent component (ICs) of P300 evoked potentials according to the a priori knowledge of P300s. The data from the Wadsworth centre consists of three parts: A and B for training, C for testing. They are sampled at 240Hz with 64 EEG channels for the same subject. For each character in a word, there are 15 repeated sets of data with 12 trials in each set. Here we choose 24 channels (10-20 system) and the data is bandpass filtered (0-20Hz) first.

Training session



Testing session

Since this dataset was collected from the same subject, it it reasonable to treat the demixing matrix as a relatively stable one.



X* is the P300 enhanced EEG for Classification

Results

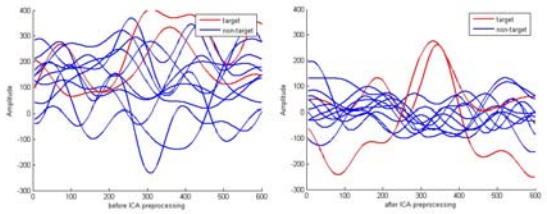


Fig.1. 12 response curves corresponding to the 12 StimulusCodes. The two red lines are target responses, while the other ten lines are nontarget responses.

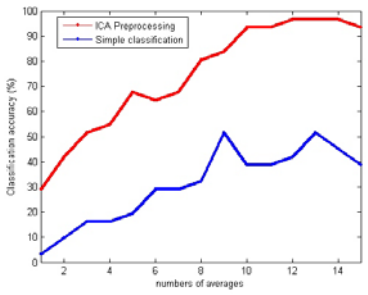


Fig.2. The comparision of the proposed method to a simple classifier with the detection criteria of comparing the amplitude values at 310 ms which is provided within the dataset by the Wadsworth centre.It presents the word classification accuracy by using different numbers of trial averages.An accuracy of 96.77% was achieved with first 12 trials averaging on testing data which means only one error out of 31 characters