Analysis of EEG Signals for Brain Computer Interface

Jessy Parokaran[1], Ali Ozgur[2], Baran Curuklu[1], Mujdat Cetin[2]

[1] *School of Innovation, Design and Engineering,Malardalen University,Vasteras, Sweden*
[2] *Faculty of Engineering and Natural sciences, Sabanci University,Istanbul,Turkey*

Advancements in biomedical signal processing techniques have led Electroencephalography (EEG) signals to be more widely used in the diagnosis of brain diseases and in the field of Brain Computer Interface (BCI). BCI is an interfacing system that uses electrical signals from the brain (EEG) as an input to control other devices such as a computer, wheel chair, robotic arm etc[1]. The aim of this work is to analyse the EEG data to see how humans can control machines using their thoughts.

In this paper we studied the reactivity of EEG rhythms in association with normal, voluntary and imagery of hand movements using EEGLAB, a signal processing toolbox running under MATLAB. In awake people, primary sensory or motor cortical areas often display 8-12 Hz EEG activity called mu rythm when they are not engaged in processing sensory input or produce motor output. Movement or preparation of movement is typically accompanied by a decrease in this mu rhythm called 'event-related desynchronization'[2].

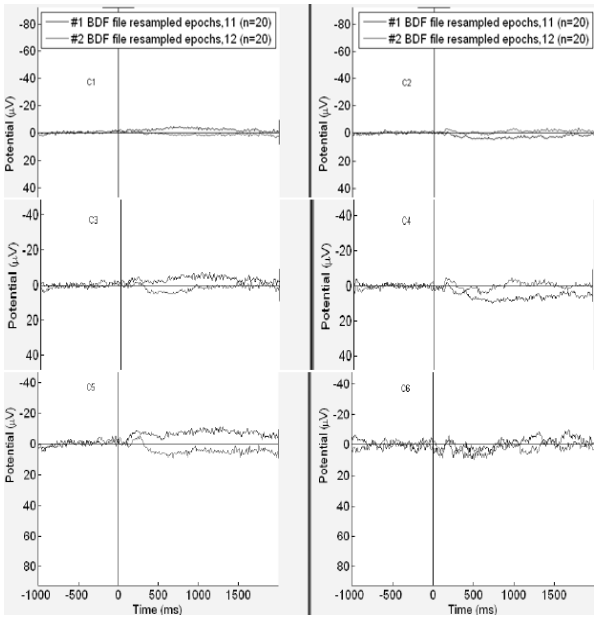

Figure 1 Comparison of ERP averages of right and left imagery at sensory motor area (electrodes C1,C2,C3,C4,C5,C6)

Four males, three right handed and one left handed participated in this study. There were two sessions for each subject and three possible types : Imagery (Im), Voluntary (V) and Normal (N). Experiment order is S1N – S1V - S1Im - S2N - S2V - S2Im. Experiment procedure is Blank Screen – Beep – Blank Screen – Cross –Blank Screen - Arrow with timings: 2000ms – 500ms – 500ms – 1000ms – 500ms - 1000 ms, total time for one epoch of the experiment is 5.5 seconds for N and Im, 4.5 seconds for V.

EEG signals were recorded in the Biosemi format from a grid of 64 Ag/AgCl scalp electrodes. The EEG data was at first referenced to Cz electrode while importing in to the EEGLAB. Then it was downsampled from 2048 Hz to 256 Hz followed by band pass filtering between 0.1 Hz and 50 Hz. From the filtered data, epochs of four events : Left button press (labelled as event 1), Right button press (event 2), Rright arrow (event 11), Left arrow (event 12), were extracted followed by baseline removal.

After this preprocessing of EEG data we studied each epoch file by plotting channel spectra, maps, various Event Related Potential (ERP) plots like channel ERP with scalp maps, two and three dimensional ERP map series, compare ERP averages and channel ERP images which is the two-dimensional representation of the single channel data sorted in the order of appearance in the experiment.

All the above mentioned ERP plots have shown that an imagination or a movement of right hand cause a decrease in activity in the left side of brain in the sensory motor area which shows the desynchronization of mu rythm and vice versa. This result implies that EEG phenomena may be utilised in a Brain Computer Interface operated simply by motor imagery and then feature extraction using Independent Component Analysis and classification using Neural Networks[3].

REFERENCES

[1] M. Ashtiyani, S.Asadi, P.M. Birgani, " EEG Classification using Neural networks and Independent component analysis", Biomed 2008,Proceedings 21,pp. 179-182, 2008.

[2] J. R . Wolpaw, D. J. McFarland , G. Pfurtscheller , "Brain-Computer interfaces for communication and control", Jounal of Clinical Neurophysiology,vol.113,pp.767-791.2002.

[3] G. Pfurtscheller, C. Brunner, "Mu rhythm desynchronization and EEG single-trail classification of different motor imagery tasks", *Journal of NeuroImage*, vol. 31, pp. 153-159, 2006.

[4] A. Delorme, S.Makeig, " EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis", Journal of Neuroscience methods, vol.134, pp.9-21, 2004