

Analysis of Left Hand and Right Hand Movement from Frontal and Temporal Lobes

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ABSTRACT: Brain Computer Interface (BCI) is a relatively new technology in recent era that is showing rapid growth since the time of its first application. BCI provides a way by which machines or devices can be controlled on the basis of brain signals generated from user thought. It acts as an interfacing device between human brain and a hardware system. A subject imagines some tasks and from this brain waves are taken. Then for performing these tasks brain waves are analyzed and turn after efficient pre-processing into commands or signals. EEG device uses non-invasive technique for brain signal recording, this technique is safer than invasive technique because in invasive brain signal is taken by putting electrode inside the scalp. In this paper left and right hand movement is analyzed and compared on the basis of max and min value of channel data from two lobes (frontal and temporal).

KEYWORDS: Brain Computer Interface, EEG, EEGLAB, Frontal Lobe, Temporal Lobe.

I. INTRODUCTION

Brain is not only one of the most intricate part of human being but also the absolute necessitated. It commands each and every activity occurring inside body. Brain is responsible for generating electrical signals either way direct or indirect for controlling the body organs or its activity. Nowadays various interfacing devices for providing interfaces between human and computer have been developed. For a fit person keyboard, joysticks are useful interfaces but for a disabled person who cannot move or use his organs is left with no choice. So for these kinds of persons science have proposed and manufactured new devices and techniques. Among these techniques one of the most recent one is Brain Computer Interface. For the idea of controlling machines by human thought Hans Berger was the first scientist who take a step in this direction and discovered a device in 1929, named EEG. EEG device uses non-invasive technique for brain signal recording, this technique is safe than invasive technique because in invasive brain signal is taken by putting electrode inside the scalp.

A Brain Computer Interface (BCI) system takes input signals from a brain activity and translates them into commands to which a computer can take actions. To control a BCI, the user should produce various brain activity patterns which are captured in form of Electroencephalogram (EEG) and converted to commands by identifying the sequence of the system. In this paper the EEG signal which is used for analysis is downloaded from Physionet. The work done here is for analysing and comparing the left and right hand activity from frontal and temporal lobe.

II. RELATED WORK

A brain produces so many thoughts (events) at a single time and these events are recorded for in the form of signals through EEG Cap (headset). When these signals are recorded it contains many types of artifacts and noises so these have to be removed through filtering, artifact removal or other techniques. We will analyse the data of the motor movement tasks(left and right hand movement) using three channels of frontal lobe (Fp1,Fpz,Fp2) and three channels of temporal lobe (T7,T8,T9). Channel position map show in figure 1.

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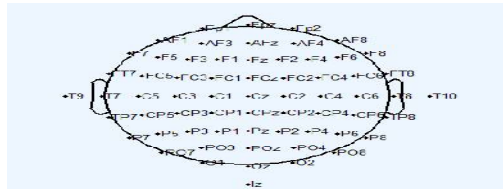


Fig 1 Channel location map according to international 10-20 system

III. WORKING PROCEDURE

In our work we have used EEGLAB for our purpose for analysis of motor movement tasks (left and right hand movement). EEGLAB is a toolbox which runs under the MATLAB environment, and provides various kinds of functions for analysis of data. It has some inbuilt features like artifact removal, activity power spectrum plotting, history scripts, data importing, etc. The steps of the working procedure are shown below:

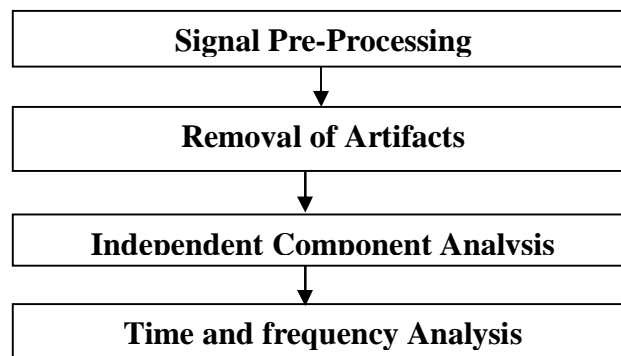


Fig 2 Block diagram

A. Signal Pre-processing

The data taken from Physionet is in EDF format. So the first process is to do filter this and further amplification for acquiring the clear and enhanced signal. In EEGLAB signal is filtered using FIR filter.

B. Removal of Artifacts

Artifacts are signal which are due to noise effects so the user wanted them to remove. They make it difficult to measure the signal of the devices. EEGLAB does provide special feature for artifact removal.

C. Independent Component Analysis(ICA)

ICA is a primary tool of EEGLAB whose function is converting of the high dimensional data into low dimensional ones. Its main purpose is the rejection and subtraction of artifacts generated by eye blink and muscles activity. ICA algorithms have clearly shown to be fit for both artifacts and neural activity.

D. Time and frequency analysis

For estimating event-related spectral amplitude, phase and coherence perturbations for the data which is being recorded using the ICA component or a single electrode EEGLAB incorporate these spectral decomposition techniques. They are: Event-related spectral perturbation (ERSP), Inter-trial coherence (ITC magnitude and phase) at single channels or components and Event Related Cross Coherence (ERCOH) between two data or components.

Now, if there are n trials and $f_k(f, t)$ is approximation of spectral for trial k and frequency f with respect to time t then, Inter-trial phase coherence is defined by:

$$ITPC(f, t) = \frac{1}{n} \sum_{k=1}^n \frac{f_k(f, t)}{|f_k(f, t)|} \quad (1)$$

ITLC shown as

$$ITLC(f, t) = \frac{\sum_{t=1}^n f_k(f, t)}{n \sum_{k=1}^n |f_k(f, t)|^2} \quad (2)$$

ERSP shown as

$$ERSP(f, t) = \frac{1}{n} \sum_{k=1}^n |f_k(f, t)|^2 \quad (3)$$

IV. EXPERIMENTAL RESULTS

EEG dataset is taken from Physionet. It contains EEG recordings of two to three minutes. The data is in EDF+ format (European Data Format). This includes 64 EEG channels as according to the international 10-20 system. Sampling is done at 160 Hz. Channels selected from frontal lobe are Fp1, Fpz, Fp2 and from temporal lobe are T7, T8, T9. Following results are obtained:

For Frontal Lobe:

The max and min value is shown for the frontal lobe channels in below table:

Channel Names	Left Hand		Right Hand	
	Maximum	Minimum	Maximum	Minimum
Fp1	284	-258	284	-248
Fpz	277	-253	279	-250
Fp2	286	-254	298	-258

Table 1. Comparison of maximum and minimum value for Frontal Lobe selected channels (values are in root mean square microvolt)

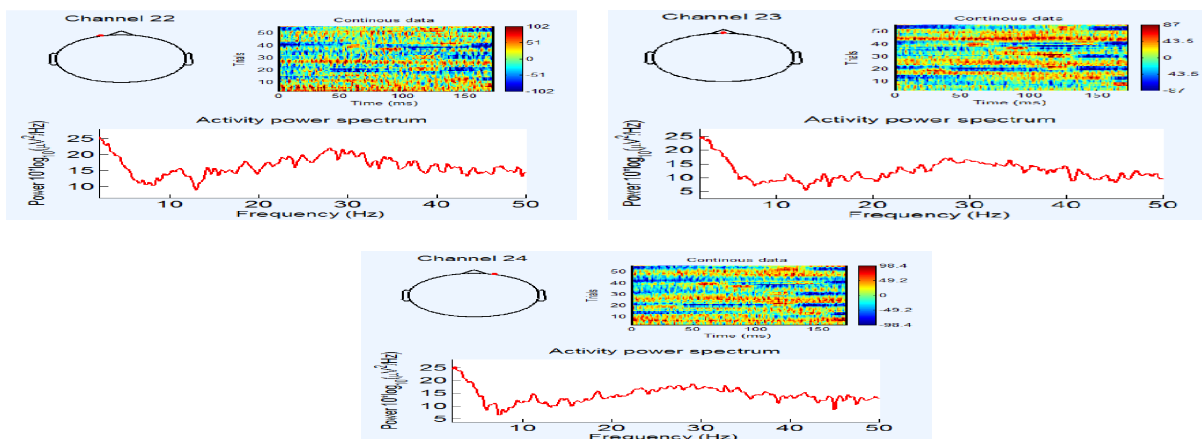


Fig 3 Activity power spectrum of Frontal Lobe channels for Left hand movement

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Fig.3 shows the activity power spectrum of the frontal lobe channels for left hand movement and it is taken for the channel number: 22, 23, 24 and taken same channels for the activity power spectrum of the frontal lobe channels for right hand movement in Fig.4, this shows that these motor movement tasks lies in the beta frequency range for the frontal lobe.

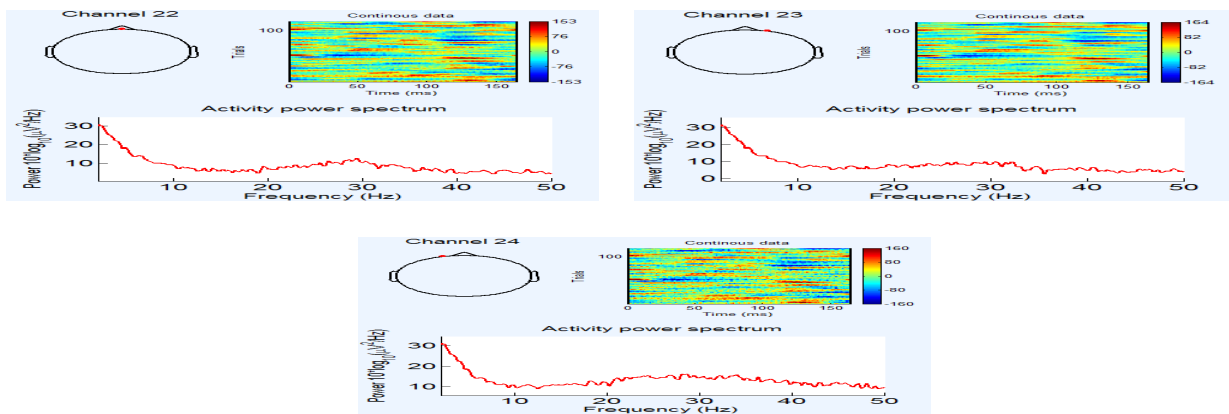


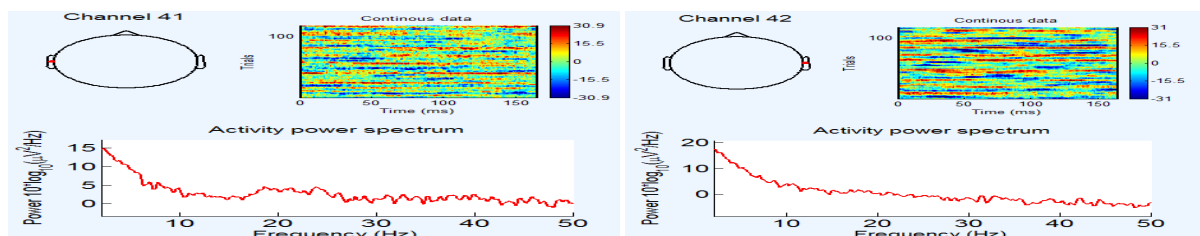
Fig 4 Activity power spectrum of Frontal Lobe channels for Right hand movement

For Temporal Lobe:

The max and min value is shown for the temporal lobe channels in below table:

Channel Names	Left Hand		Right Hand	
	Maximum	Minimum	Maximum	Minimum
T7	99	-125	105	-76
T8	78	-90	116	-55
T9	81	-122	90	-93

Table 2.Comparison of maximum and minimum value for Temporal Lobes selected channels (values are in root mean square microvolt)



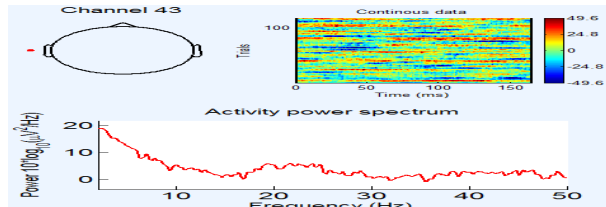


Fig 5 Activity power spectrum of Temporal Lobe channels for Left hand movement

In Fig 5 and Fig 6, the activity power spectrum is shown for temporal lobe channels:41,42,43 for left hand movement and right hand movement and from table 2, it is clear that the motor movement tasks in these lobes have low max and min value than frontal lobe channels.

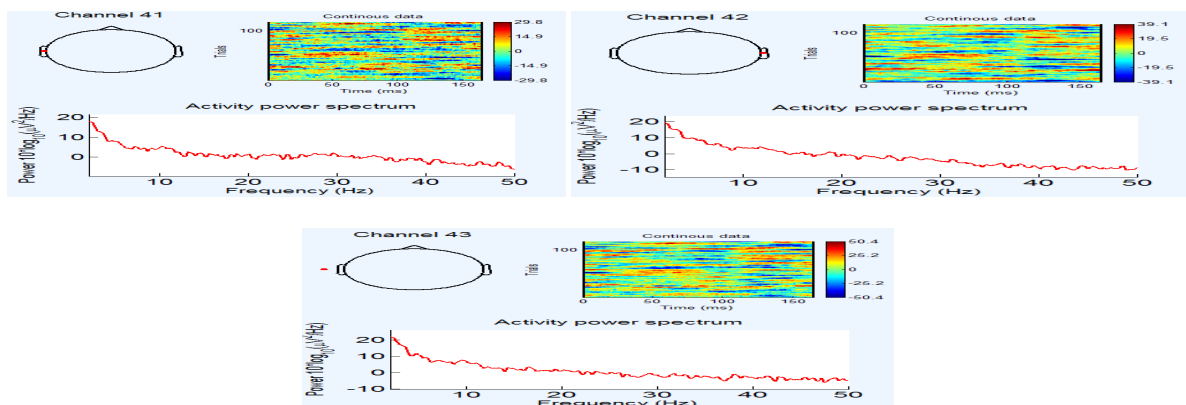


Fig 6 Activity power spectrum of Temporal Lobe channels for Right hand movement

V. CONCLUSION

EEG is one of the technologies that is all safe, cheap and faster to process. It can easily capture signals from brain without causing damage. For analysis purpose we have used EEGLAB which is one of the most useful toolkit that is freely available and easy to implement. From Table 1 and Table 2, it is analyzed that Frontal lobe is more active towards motor movement tasks and Temporal lobe is less active for these tasks. Therefore it is clear that Frontal lobe remains more active than other lobes for motor movement tasks. Right hand movement activity for frontal lobe is more active than left hand activity as on the basis of maxima value of channel data. Also it is clear from activity power spectrum graphs motor movement tasks (left hand movement and right hand movement) both comes under beta frequency range. These results provide useful information for the development of various robotic, remote control applications.

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