Bilateral Relation of Bio-potential of Cerebral- cortex using EEG Signal

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Abstract : Electroencephalography (EEG) has been recently used as a new type of biometrics in user authentication with the advantages of being difficult to fake, impossible to observe or intercept, and requiring alive person to record. This paper attempts to introduce the identification and localization of the bio-potential produced from the neurons of human brain: left vs right region of brain. The bio-signal has been captured from 10 volunteers at their conscious state of mind. In biomedical sense, consciousness is the abnormal generation and propagation of action potential of the neuron networks. The estimation of consciousness is based on the electroencephalography (EEG). The bio-potential generated by the neuron network has been picked up by non-invasive (Ag-AgCl) electrodes.[7] With the help of suitable programs in labVIEW environment and Matlab the acquire signals has been processed to confined the position of human brain enrooting the EEG signal and its subbands. Here, graphical indicators have been used to display the waveforms. The system is fully non-invasive and has many real life applications.

Index Terms : Electroencephalography (EEG), Fast Fourier Transform FFT, Non-invasive, Neuron Bio-potential, Cerebral Cortex.

I. INTRODUCTION

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically non-invasive, with the electrodes placed on the scalp. Although, invasive electrodes are sometimes used in specific applications . In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a period of time, as recorded from multiple electrodes[5]. Three types of brainwaves are associated with

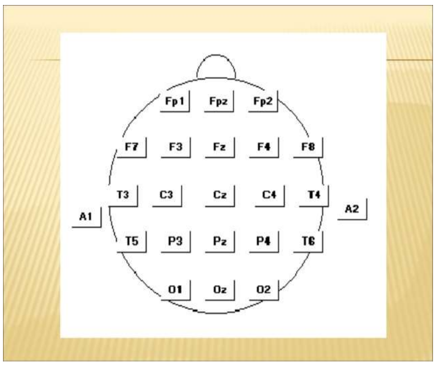

Fig. 1. Standard 10-20 electrode position

the conventional uses of clinical diagnosis and conventional cognitive neuroscience. An early use was during World War II by the U.S. Army Air Corps to screen out pilots in danger of having seizures long-term EEG recordings in epilepsy patients are still used today for seizure according to 10-20 position system. Some of them are (FP1,FP2), (C3,C4), (F3,F4), (P3,P3), (O1,O2).

These positions are shown in the following figure(1).The electrodes which are used are placed on the scalp on 10 fixed positions predictions[4].

II. METHODS

This paper has been approached in two models:

A. Software based model

The Block diagram is exhibited as shown in **Fig. 2.**of approaching paper on software based system. Initially sample EEG data of almost sleeping patients is collected from net(physionet.org) and using MATLAB enforced this raw data and observed the output in time scale. The amplitude analysis is done on each position of the brain. Later the same data has been processed in MatLAB for obtaining the FFT and observing the output at each position of brain on frequency scale.

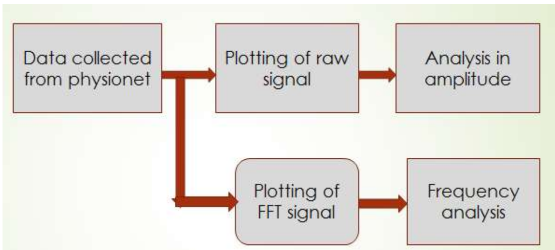

Fig. 2. Software based: Block diagram of EEG signal analysis using Matlab.

B. Hardware Based Model:

The Block diagram is exhibited as shown in **Fig.3.**of approaching project using hardware based system.Initially two electrodes (Ag-AgCl) picked then select the position on the scalp of left part and right part of brain. The positions are F3,F4,C3,C4,P3,P4. One electrode is fixed on left ear because this electrode is considered as a reference electrode. One more electrode is fixed on the respective positions on scalp using conducting gel. A labVIEW program is written and entire setup is connected to the audio jack of pc or laptop. Now the entire setup is ready, On clicking the run button and by obtaining the output on both time domain and frequency domain.

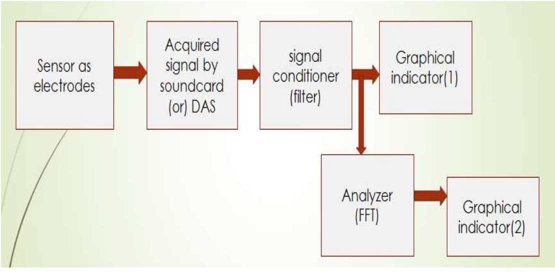

Fig. 3. Hardware based: Block diagram of EEG signal analysis using labVIEW

C. Data Base:

In the Table.1. bio-signal data of 8 persons has been shown. The data has been taken at different electrode positions ,in addition to these blood pressure and pulse rate has also been taken. From the table it can be seen that the amplitude at P3 and F3 positions that are left side of cerebral cortex are comparatively higher than the amplitude produced at the P4 and F4 positions that are at the right side of cerebral cortex . This signifies that the left region of the human brain is more active for generating the bio-potential responsible for conscious state than the right region of human brain.

Person	Position of Electrode	Left Side of cerebral cortex			Right side of cerebral cortex		
		F3	C3	P3	F4	C4	P4
1 BP:118/71 PR:64	Frequency Peak	28	28.2	28.3	28	28	28.3
	Amplitude	2×10^{-3}	2.2×10^{-3}	2.3×10^{-3}	1.8×10^{-3}	1.1×10^{-3}	1.82×10^{-3}
2 BP:103/59 PR:64	Frequency Peak	28.2	28.2	28	28.2	28.2	28
	Amplitude	3.5×10^{-3}	1.75×10^{-3}	2.75×10^{-3}	1.6×10^{-3}	2.2×10^{-3}	2.7×10^{-3}
3 BP:105/68 PR:	Frequency Peak	29	29.3	29	29	29	29.1
	Amplitude	2.2×10^{-4}	2.9×10^{-3}	3.1×10^{-3}	2.2×10^{-5}	1.8×10^{-3}	3.3×10^{-3}
4 BP:110/77 PR:71	Frequency Peak	62	31.5	61	31	35	30
	Amplitude	2.1×10^{-5}	6.2×10^{-5}	1.5×10^{-5}	2.8×10^{-5}	2.61×10^{-5}	2.4×10^{-4}
5 BP:127/84 PR:93	Frequency Peak	61	31	60	62	62	31
	Amplitude	1.8×10^{-4}	9×10^{-4}	9×10^{-4}	1.1×10^{-4}	6.5×10^{-4}	9×10^{-4}
6 BP:106/74 PR:	Frequency Peak	29	29.5	32	29	29.4	29.1
	Amplitude	3.15×10^{-3}	1.75×10^{-3}	2.78×10^{-3}	1.7×10^{-3}	2.5×10^{-3}	2.0×10^{-3}
7 BP:102/76 PR:70	Frequency Peak	29.6	29.5	31	29	29.9	29.5
	Amplitude	2.1×10^{-5}	4.2×10^{-5}	1.5×10^{-5}	2.8×10^{-5}	2.61×10^{-5}	2.4×10^{-4}
8 BP:124/82 PR:89	Frequency Peak	61	30	64	59	62	29
	Amplitude	3.8×10^{-4}	9×10^{-4}	7.2×10^{-4}	1.1×10^{-4}	5.5×10^{-4}	2.6×10^{-4}

Table.1. Data collected from 8 volunteers.

III. RESULT

A. Result from Software based model

The data of different persons which was taken from physionet is enforced through Matlab. The output waveforms of no of samples vs amplitude in micro volts are shown below in **Fig.4.&Fig.5.**The raw EEG signal for F3 and F4 positions are different from each other.

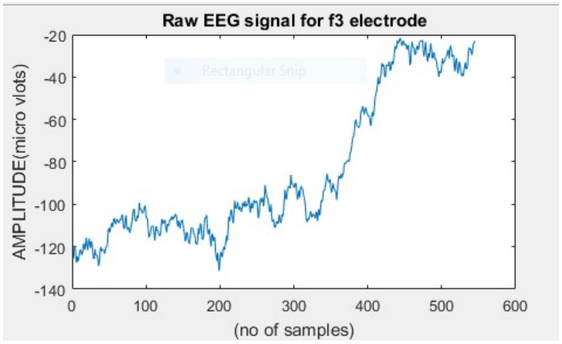

Fig. 4. Raw EEG signal for F3 (Left side) electrode.

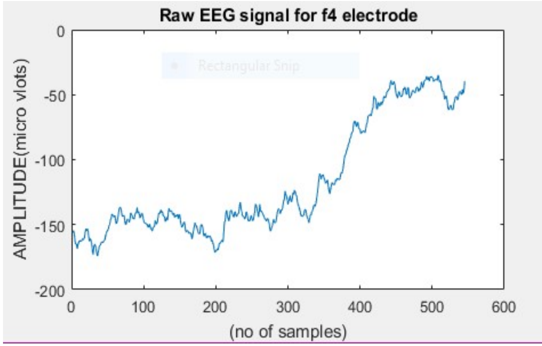

Fig. 5. Raw EEG signal for F4 (Right side) electrode.

The same data has been analyzed in matlab platform signal on frequency scale by FFT. The FFT of the signals at F3 and F4 positions are shown in **Fig.6. & Fig.7.** where theX axis represents frequency and Y axis represents amplitude in microvolt. The peak frequency is obtained near zero at both the positions.**Fig. 8.** And **Fig. 9.** are showing the bio-potentials of the same person , collected from the electrode position at O2 and O1 respectively. While **Fig. 10. & Fig. 11.** Signifies the frequency response of the same raw signals.

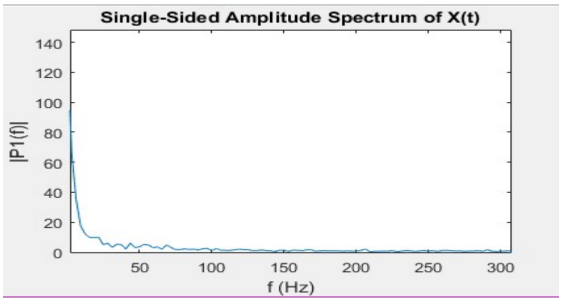

Fig. 6.FFT of F3(Left side) electrode signal

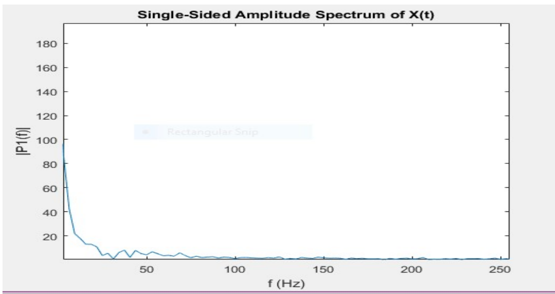

Fig. 7.FFT of F4 (Right side) electrode signal

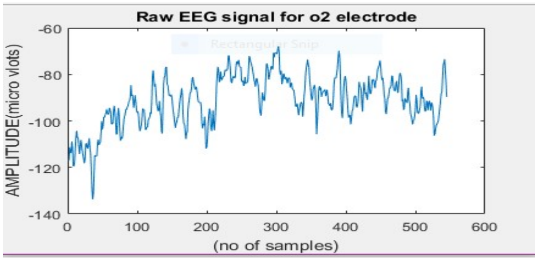

Fig. 8. Raw EEG signal for O2 (Left side) electrode.

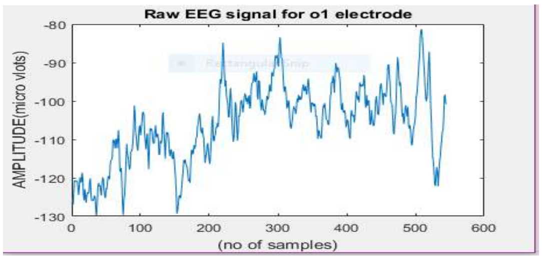

Fig. 9. Raw EEG signal for O1 (Right side) electrode.

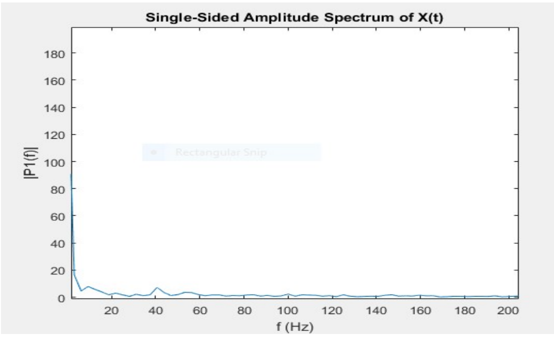

Fig. 10.FFT of O2 (Left side) electrode signal

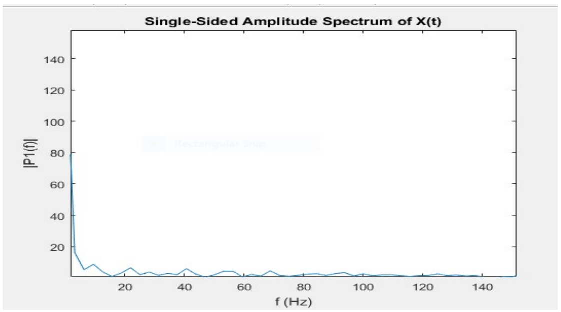

Fig. 11.FFT of O1 (Left side) electrode signal

B. Hardware based model:

Analyzing of Bio signals of different persons using labview platform is shown in **Fig.12. and Fig.13.** X axis represents frequency and Y axis represents amplitude.In both the **Fig.12**. and **Fig.13.** the frquency is 28Hz that lies under the sub frequency band of EEG, Beta(13-30). In Beta sub-band persons busily engaged in deep conversation. And the person was in his full conscious mind when the data has been collected.

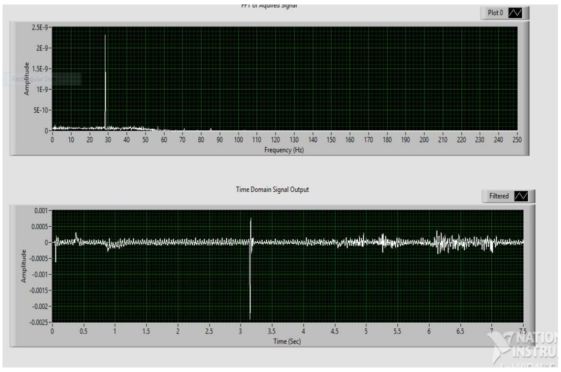

Fig. 12. FFT (above) and raw bio –signal (below) of person1 at O1 position.

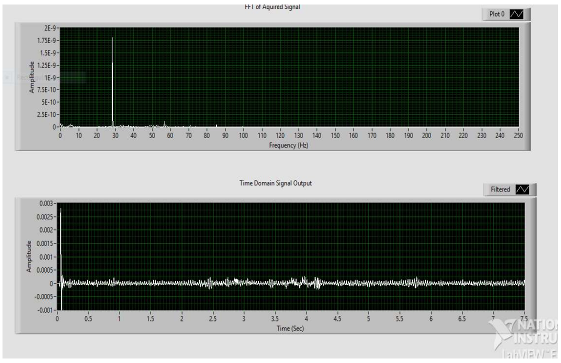

Fig. 13.FFT (above) and raw bio –signal (below) of person1 at O2 position.

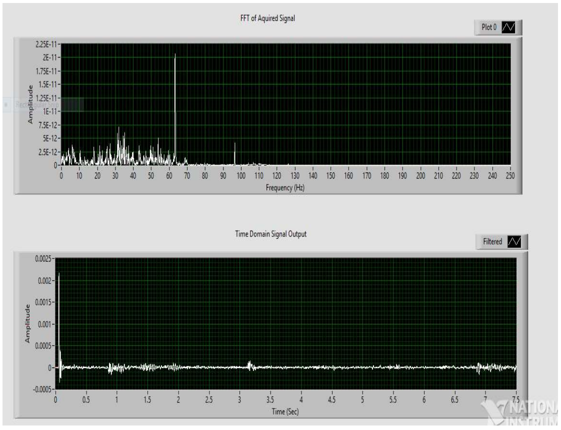

Fig. 14.FFT (above) and raw bio –signal (below) of person1 at F3 position (Left side).

Fig.14. and **Fig.15.** are for the FFT and raw EEG signal plotted in Labview platform for sensor position F3 and F4 respectively. In the **Fig.14.**the frquency is 63Hz that means the person is a Hyper excited which is great for learning. Whereas in **Fig.15.** frequency peak is located at 28 Hz, replies that the person is in excited and conscious state.

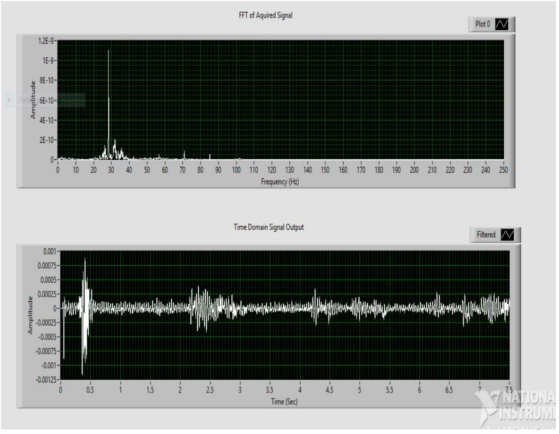

Fig. 15.FFT (above) and raw bio –signal (below) of person1 at F4 position (Right side).

IV. CONCLUSION

First the data has been taken from psysionet and it is analysed based on the proposed system on matlab by using **FFT** and also in labview platform. The result shows that all the frequency peak basically lies near about zero Hz. This is because all the data taken are for sleeping state of different persons. In the next hardware part the real time EEG data has been taken from different volunteers in their conscious state of mind. All the data is showing the frequency peaks above **25 Hz**. The left region brain is producing more active and prominent frequency than the right side of brain. Here **F3** and **P3** are showing the activeness of the persons. Here the Blood pressure and pulse rate are also been taken for those persons. From the data sheet it is clear that there is relation of bio-potentialproduced in ones brain with the blood pressure (BP).

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