Detection of Sleep Stages with the Help of EEG Features

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Abstract— Measurement of the electrical activity in the neurons system of human brain is called EEG signal. This document is describe the analysis of EEG signal or brain signal using computational tool lab view to detect the human sleep stages such as relaxed, unconscious, dream and dream less seep according to the brain waves and its frequency bands. The EEG signal is captured by using the 10-20 electrode placement system when the subject in sleep condition. Read bio-signal and FFT tool box of lab view is used to process the raw data and produced the EEG power spectrum. There will different features like variance, mean, standard deviation and skewness etc. The extracted features are used further in other purposes. In this study the extracted mean is give the help in detection of human sleep stage with the help of lab view software.

Key words: EEG (Electroencephalogram), FIR (Finite Impulse Response), FFT (Fast Fourier Transform), LAB VIEW (Laboratory Virtual Instrumentation Work Bench), Power Spectrum

I. INTRODUCTION

EEG signal or brain signals are the electrical activities of the brain .The frequency range of brain (EEG) signal is 0.5 to 256 and have the very low amplitude [1]. The brain (EEG) signal is produced by the vibration in the human brain neurons network this signal is recording of electrical activity from the human scalp. There will be the different types of brain signals are produced by different thoughts of human behaviour. There are 6 different frequency bands are generated from the brain signals are also called the brain waves which's are Alpha band wave, Delta band wave, Beta band wave, Theta band wave, Gamma band wave and Mu wave[2].

These frequency bands are used to study of human behavioural mental stages that is delta wave having the frequency range 0.5 to 3Hz these rhythms are occurs during deep and dream less sleep, Theta waves having the frequency range from 4 to 7 Hz it is slowest waves are occurs when person sleep but in dream. Alpha is normal rhythm having the frequency range 8 to 12 Hz these are occurred from occipital region and when person is in relaxed condition the Mu rhythms are similar to the alpha waves. The Beta waves consists of frequency range from 13 to 45 Hz are produced central region of brain above the 45 Hz frequency is called the Gamma waves. Different types of EEG brain waves are shown in fig.1. The brain signal is acquired from the EEG devices. The brain (EEG) signal will undergo signal conditioning and signal processing to provide feature extraction for classify the human behavioural stages.

Brain signals contain a lot of features to describe human behaviours or traits and can be applied in many applications. For example, the change of EEG Alpha and Beta power is used to determine the type of human emotions when watching movies. In addition, EEG signals were used to identify a person characteristic.

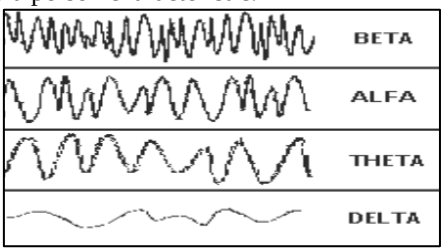

Fig. 1: Types of Brain Waves

The mental workload and drowsiness level of aircraft pilots and car drivers can be assessed and determined from the analysis of the brain signals.

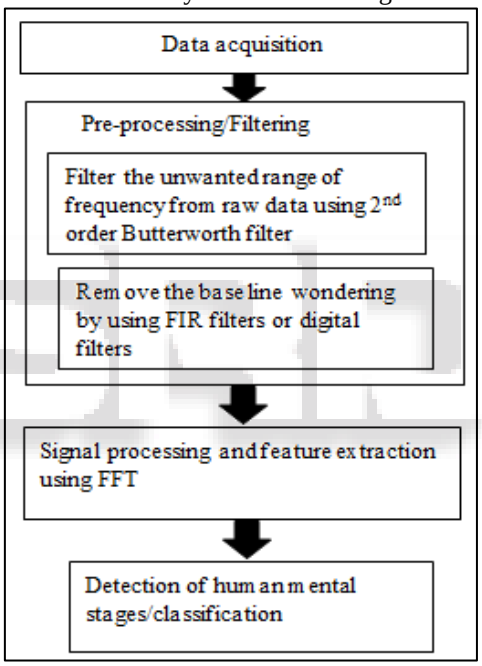

Fig. 2: Structure of complete process of EEG signal

The researchers are introduced various methods for analyse the EEG signal the famous methods are non-parametric or spectral analysis of EEG signal for search the hidden features inside the signal. The power spectrum of EEG signal and measure the performance of arithmetic mental task. There are the different artifacts and noises with the EEG signal like moments of eyes, blinking of eyes, breathing, muscles activities, base line wondering and power line frequencies. The DSP tool FFT is used to extract the features and lab view is most powerful software tool for research on EEG signal.

Hence the study of this paper is conducts the two main objectives:

- Analysis the EEG signals for extracting the EEG features and other information.
- Identify the sleep stages of human behaviour on the basis of extracted EEG features or information.

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The lab view is used to analysis the EEG signal and extraction of features for classification of human stages as a software.

A. Material and Experiment Design

The experimental operation is consists of the following criterion is discuss below.

1) EEG Data Acquisition/Raw Data

The data is play an active role in experimental work on the biomedical signals (EEG).A good data is mostly necessary for producing or developing batter mental stages recognition system. The raw signal or data is takes with the help of two methods

- In an invasive method, the electrodes are physically implanted inside the human brain. They require surgical procedures and are not generally recommended.
- In the non- invasive method, electrodes are placed on the surface of the skin to measure the electrical potential generated by the muscle neurons. They are safe and painless.

Both the methods give different views and allow us to visualize the brain.

EEG data is recorded with the help of 10 to 20 standard system. A no. electrodes or channels are placed on the scalp of human. The impedance of the electrodes are used below 5 kΩ and a conductive gel or paste, usually after preparing the scalp area by light abrasion to reduce impedance due to dead skin cells[4]. In 10 to 20 system the placement of the electrodes is based on directly relationship between the area of cerebral cortex (the 10 and 20 refers to the 10% and 20% inter-electrode distance) and location of electrodes on scalp[4]. Electrodes are placed according to parts of human brain F (frontal), C (central), T (temporal), and P (posterior), O (Occipital). Odd numbers at the left side of the head and even numbers right side as shown in fig.2. Now a day modern method for EEG acquisition collect these underlying electrical pattern from the scalp and digitalize for computer storage.

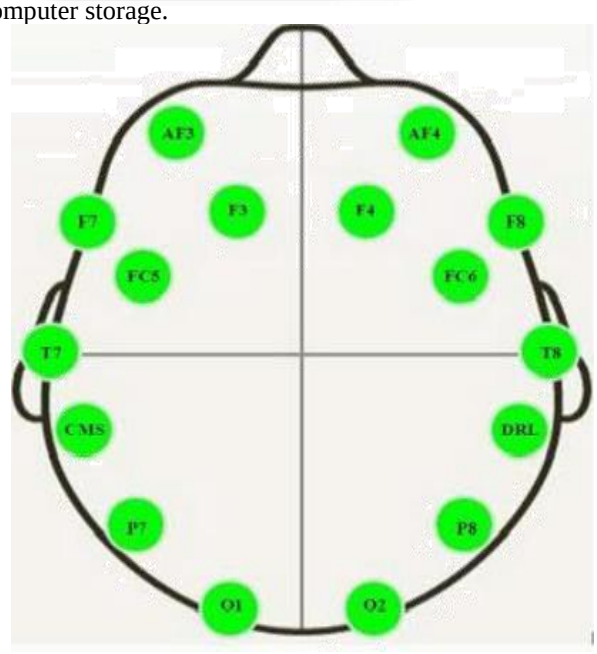

Fig. 3: EEG signal measurement

The lab view is most versatile tool of the analysing of the biomedical signal and extract the feature or information about the signal.

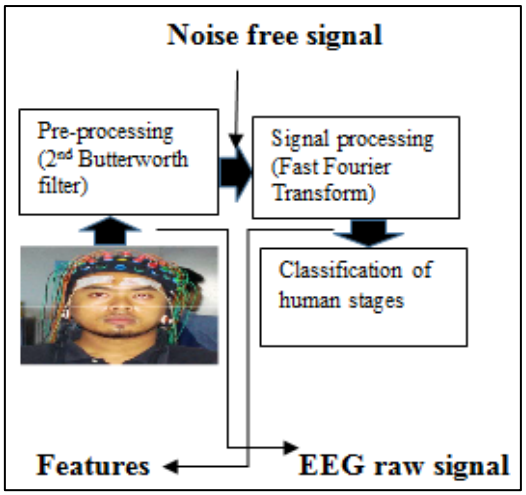

Fig. 4: Detection of human sleep stages over all structure

II. PRE-PROCESSINING

There are dfferent noises and artifacts in the EEG signal

- EEG equipment
- External electrical interference to the subject and recording system.
- The leads and electrodes
- The subject's normal electrical activity from eye blinking, eyes movement, muscles, breathing and heart activity etc.

We are used the digital 2nd order butterworth FIR filter to remove the unwanted frequencies and noises from the EEG signal. A Butterworth filter having good response to the signal. Butterworth filters have a smooth, monotonically decreasing frequency response. An FIR filter, which is a digital filter with finite impulse response. FIR filters operate only on current and past input values. Because an FIR filter does not depend on past outputs, the impulse response decays to zero in a finite amount of time. Use FIR filters for applications that require linear phase responses. There are four FIR band pass filters are used according of type of brain waves and the frequency range of each filer is different are called Alpha, Beta, Theta and Delta filters[3].

The diagram of the Filtering of EEG signal on the lab view as shown in fig. 5.

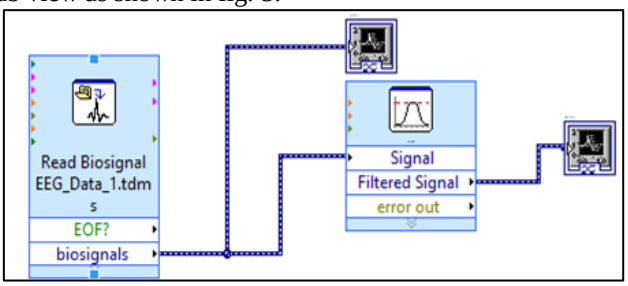

Fig. 5: Filtering of EEG signal with FIR digital filter

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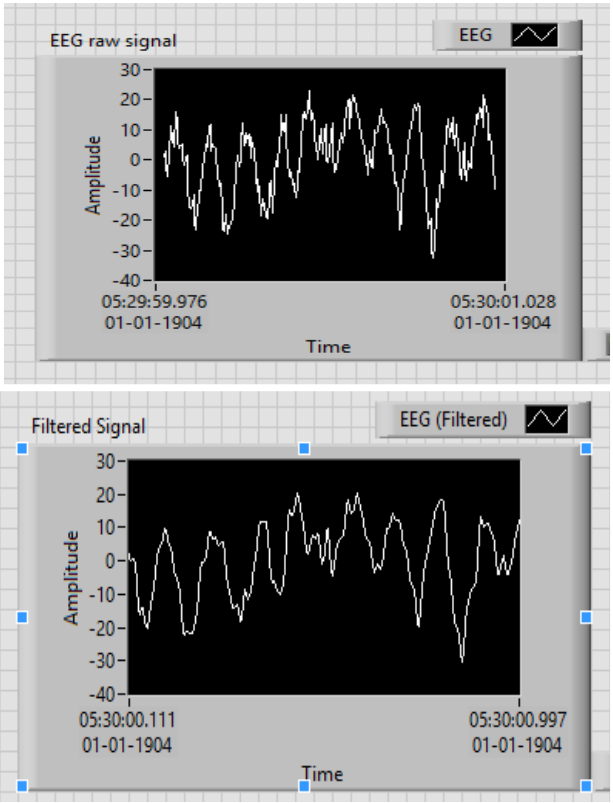

Fig. 6: (1) EEG Raw Signal (2) Filtered Signal

III. SIGNAL PROCESSING

The second step in this experiment is the smartest DSP tools are used in signal processing. EEG signal is very complex signal but the analysing of EEG signal is necessary to extract the information and research is done on the signal.

In this here we are used the FFT for signal processing and feature extraction of the signa[7]. It is most effective and convenient tool and consist of the batter co-ordination with the lab view software. FFT algorithm is involved a wide range of mathematical operation from simple real and complex numbers arithmetic to group theory and no.[3 and5] theory. The FFT is can compute the result O (N log N) operation.

Where N is the length of the vector

After the filtering process, the Hanning window with FFT (Fast Fourier Transform) length of 1024 and 50% of window overlapping are selected. The power spectrum of the EEG signal as shown in fig. 7

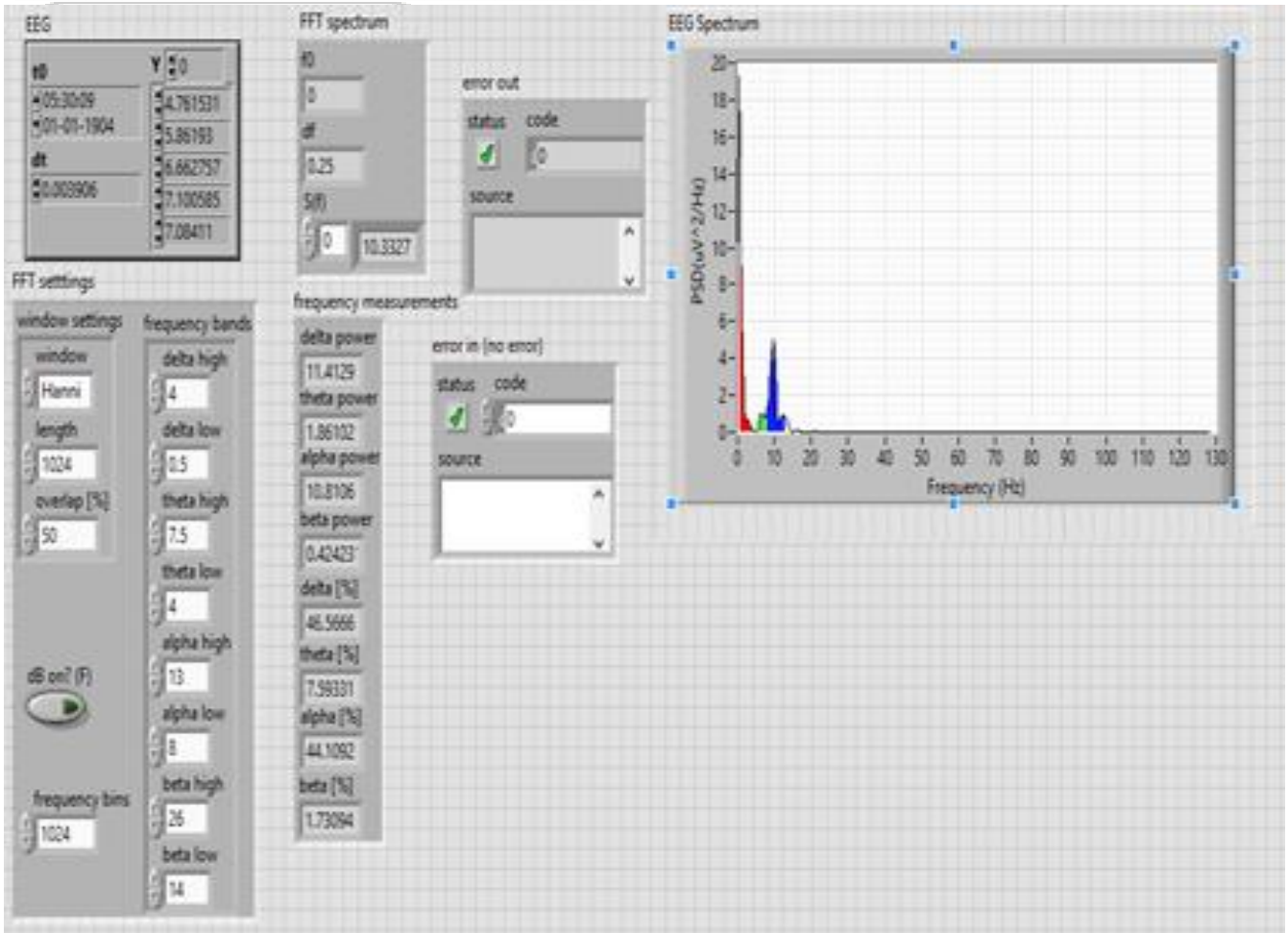

Fig. 7: Front panel of FFT frequency spectrum

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IV. FEATURE EXTRACTION

To take the information about the biomedical signal different methods of the extract the waveforms of the EEG signal. The activity of the brain is divided into frequency bands, named: Delta (0.5–4 Hz), Theta (4–8 Hz), Alpha (8–12 Hz), Beta (12–30 Hz) and Gamma (over 30 Hz). In this paper, there have been calculated the mean, skewness, standard deviation and variance from time analysis and calculate the power from spectral analysis by using FFT [3, 4, and 7]. The block diagram of the feature extraction as shown in fig.8 and fig 9 is shows the front panel of feature extraction.

	Name of extracted features			
Brain waves	Mean	Standard deviation	Variance	Skew-Ness
Alpha waves	7.039	10.267	103.37	-0.1079
Beta waves	1.132	5.28	27.92	-0.3165
Delta waves	7.25	7.00	49.07	-0.0955
Theta waves	8.065	8.659	74.979	-0.0796

Table 1: Extracted feature of EEG signal Mean, standard deviation, variance, skewness

	Name of Extracted Features			
Brain waves	Amplitude	Frequency	Power	Power %age
Alpha waves	8.163	9.603	11uV^2	44%
Beta waves	4.0425	9.64403	0.42uV^2	1.7%
Delta waves	4.667	9.5803	11uV^2	47%
Theta waves	6.218	9.5669	1.9uV^2	7.6%

Table 2: Extracted features of EEG signal Amplitude, Frequency, Power, Power %age

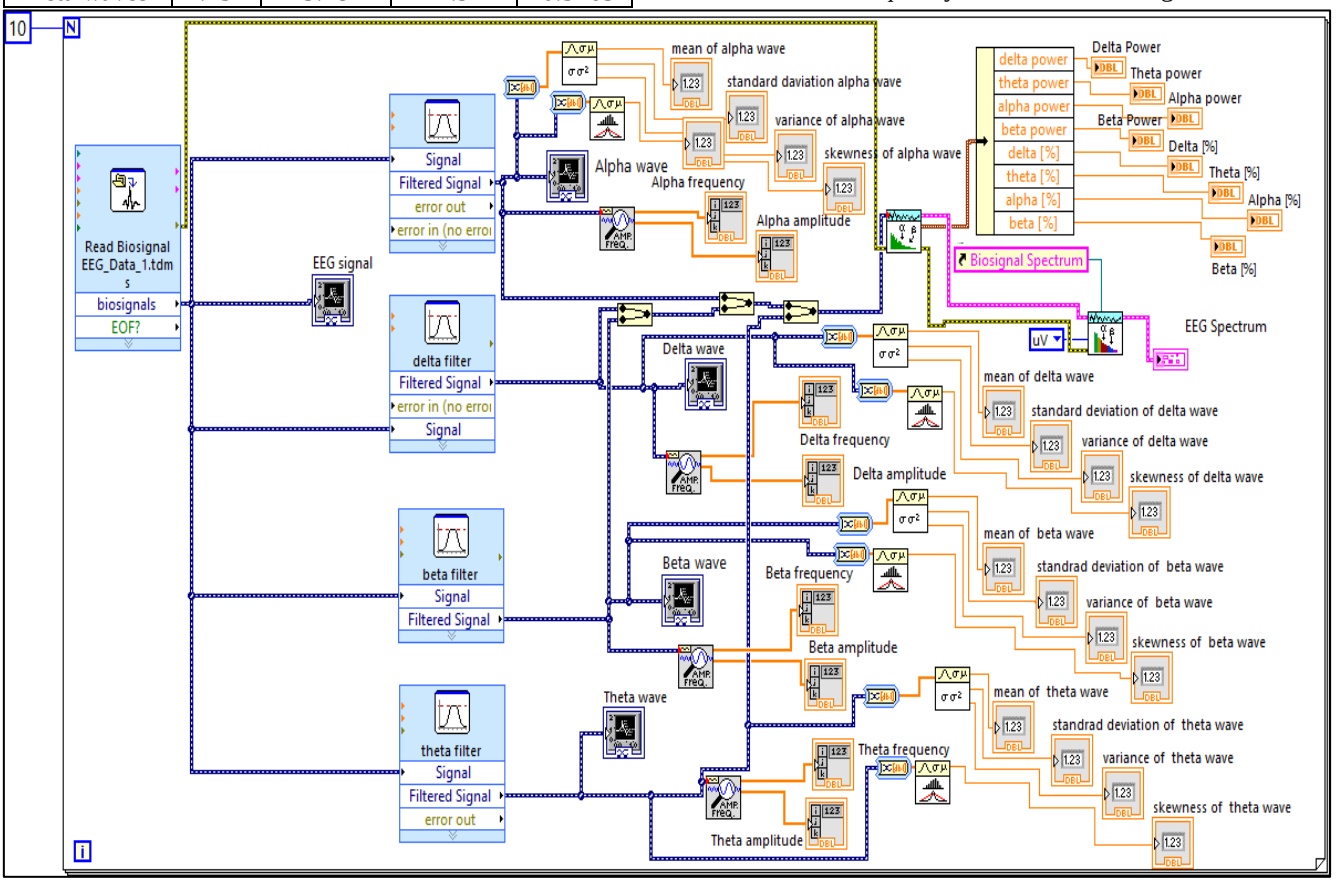

Fig. 8: Block diagram of the feature extraction in lab view

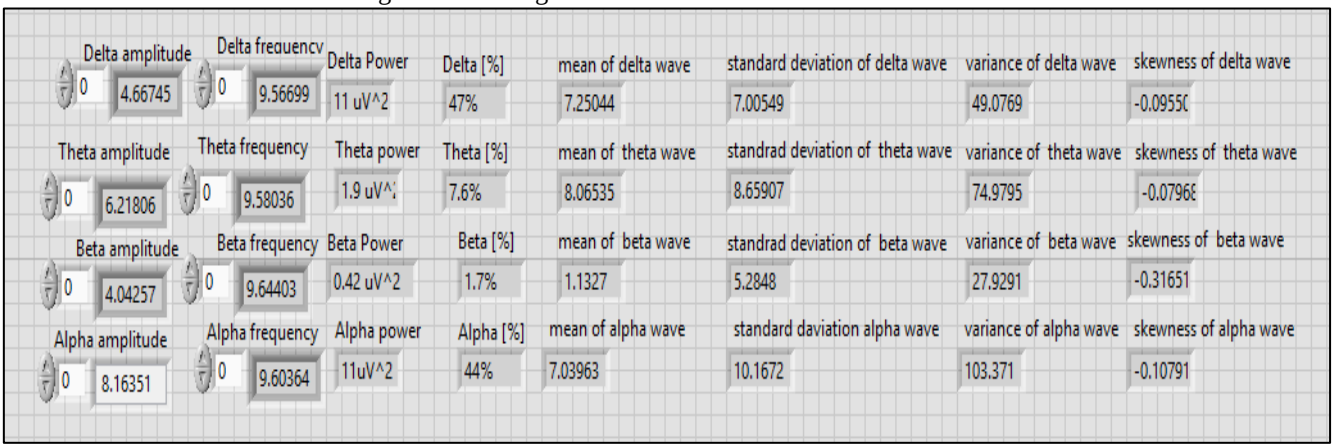

Fig. 9: Front panel of extracted features values of EEG signal

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V. DETECTION OF SLEEP STAGES

There will be the human sleep stages are depends upon the Alpha, Beta, Theta and Delta frequency bands of the human brain signal [9]. The block diagram and front panel of detection of the human sleep stages as shown in fig.9 and fig.10

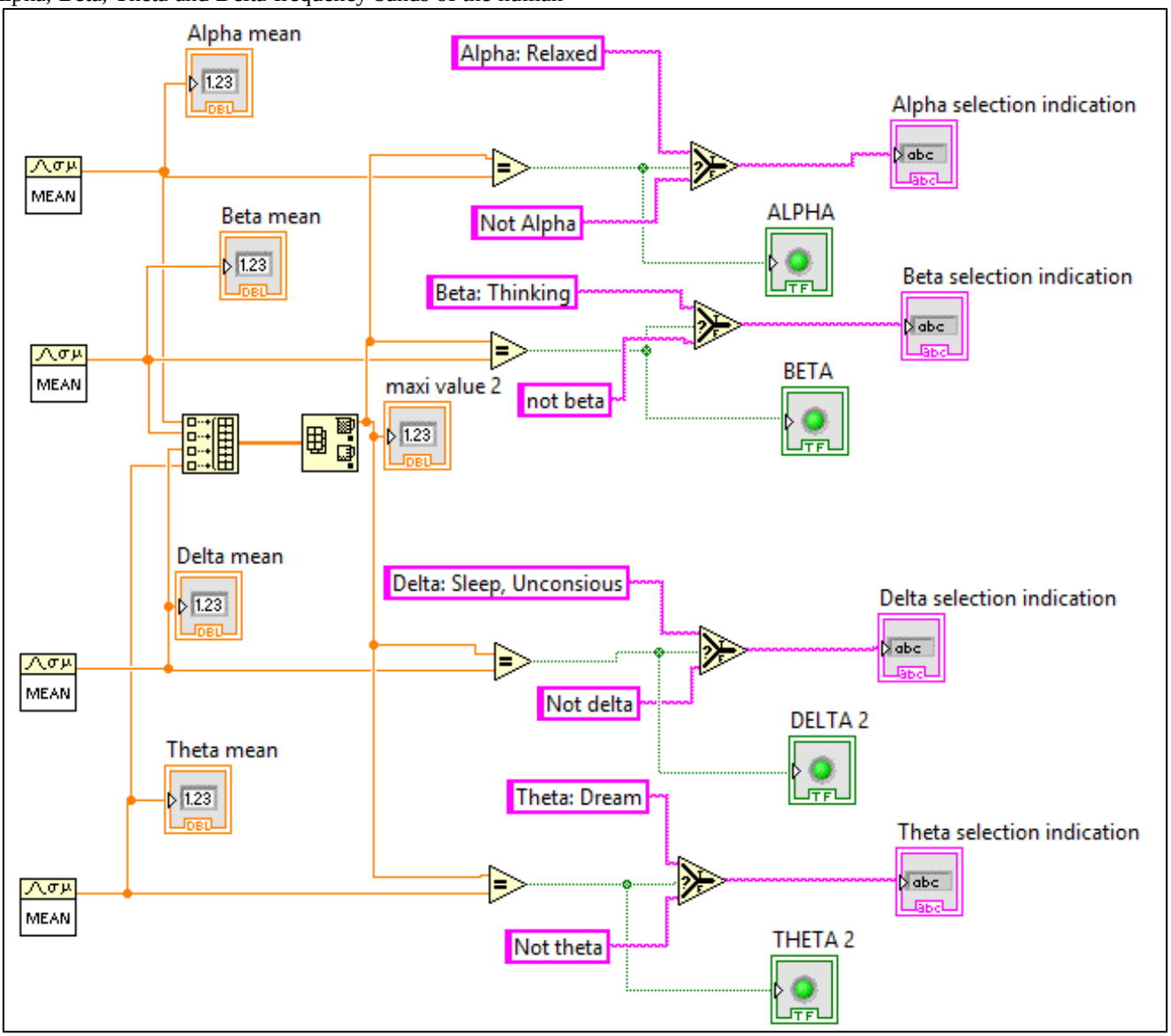

Fig. 10: Labview block diagram of detection of human sleep stages

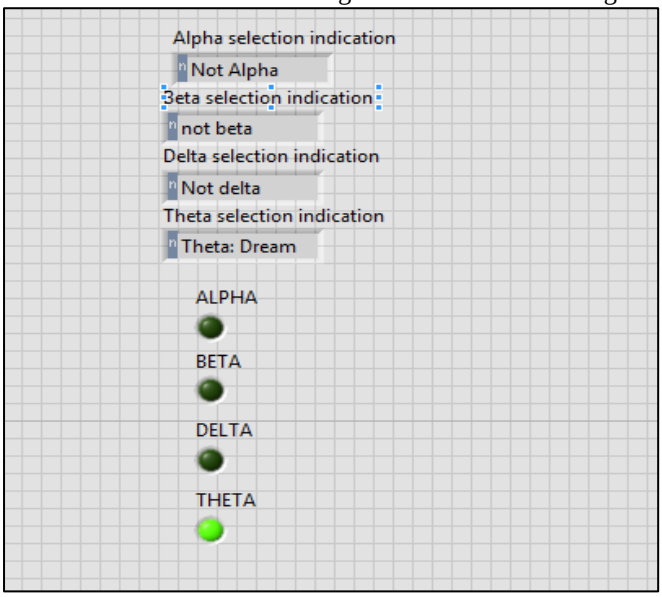

Fig. 11: Front panel of detection of human sleep stages on lab view

In this work we are done the work on EEG or brain signal it is very complex signal. First we are acquire the EEG signal with the help of electrode and the recorded signal is store in the computer as edf file and is transfer in the labview filter the signal by using FIR filters, signal processing is done with the help of FFT and fig.7 is shows the windowing and frequency spectrum of the EEG signal. Detection of the human stages is represented by using lab view as shawn in fig.10,11.

VI. CONCLUSION

In this paper pre-process the signal by using the FIR filters remove the artifacts second analysis the EEG signal with the help of FFT extract the different features for detection of human sleep stages based on brain waves Alpha, Beta, Delta, Theta

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