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Brain Wave Classification and Feature Extraction of EEG Signal by Using FFT on Lab View

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Abstract - *EEG signal is measurement of the electrical activity is produced by the neurons network of the brain when brain is made any mental task. The EEG signal is consist of very low frequency components and amplitude so diff. types of noises and artifacts are overlapping with EEG signal like as base line wondering, eye blinking, eye movement, breathing etc. EEG signal is complex signal. The doctors and medical researchers are face or interact to great complications to analysis these signals and extract the linear, non-linear information from these biomedical signals. We are filtering the EEG signal by using diff types of filters to remove the unwanted frequency components from the original signal and to extract the features or information about the signal with the help of different efficient DSP tools like DFT, FFT, STFT and wavelet transform. Here we are used the FIR band pass Butterworth filter to filter the EEG signal and analysing this filtered signal with the help of FFT. The lab view software tool is used to this work it is easier to mat lab .software because there is programming is not used in lab view*

Key Words: EEG (Electroencephalography), FFT (Fast Fourier transform), FIR (Finite impulse response), IIR (Infinite impulse response) and LAB VIEW.

1. INTRODUCTION

Electroencephalography is a method which is used to measurement of an electrical activity or signal is nothing but up to voltage level is produced by the brain. When perform the any mental task by the brain. The EEG produced when the multitudation in the neural population of the brain [1]. The brain signals are recorded from the electrodes or channels placed on the scalp or in some cases on the cortex of the patient. The captures the result waveform by using any computer component is known as the EEG signal. The EEG signal is very complex signal and analyzing of this signal is also complex. Electroencephalogram (EEG) is a highly difficult signal, containing a lot of information about the human brain function and neurological disorders. It is a test used to indicate brain damage and other problems, Sometimes it is used to assess brain death also. In short, EEG can be considered as a test to detect and indicates the ab-normalities in the electrical activity of the brain.

In this paper we are focus on the brain wave classification and feature extraction of the EEG signal with the help of the advance digital signal processing techniques that is Fast Fourier transform etc. Generally the range of EEG signal voltage amplitude is 10 to 100uV. Normally the 10 to 50uv of the amplitude range is used. The frequency spectrum range of the EEG signal is change from ultraslow to ultrafast frequency components. Brain wave frequency bands:-

There will be four types of brain waves according of the frequency [2]

1.1 Alpha waves:

This brain wave is produced when the person closing the eyes and in relaxed condition it is indicates as a normal waveform. The frequency range of the alpha waves is 7 to 12Hz. Alpha activity or wave form are generated rhythmically in the occipital part of brain

1.2 Beta waves:

The beta waves are produced when the person in alert or anxious state it is a dominant rhythm. It is usually generated on frontal and central part of the brain. It is normally rhythm and is noticed in all age of group. The frequency range of Beta wave is 13 to 30Hz.

1.3 Delta waves:

These wave bands are produced when the person in the deep or dream less sleep. The frequency range of the delta wave is 0.5 to 3Hz.

1.4 Theta waves:

The theta wave bands are produced when the person is in the sleep but in dream. The frequency range is 4 to 7Hz. These are slowest waves and appears with closing the eyes and disappears normally with opening of eyes. These are basically produced in adult. There will be the various method of analysis of the EEG signal. As we know that the EEG signal is having the different type of the noisy frequencies and artifacts. There will be most commonly used method power spectral analysis: the power spectrum is

calculated of the EEG signal to extract the features. Another method of feature extraction is FFT. The LABVIEW can considered as a most commonly computer software tool for analyse the EEG.

1.5 Gamma waves:

These waves are produced when person in the abnormal condition or there will be some mental disorder.

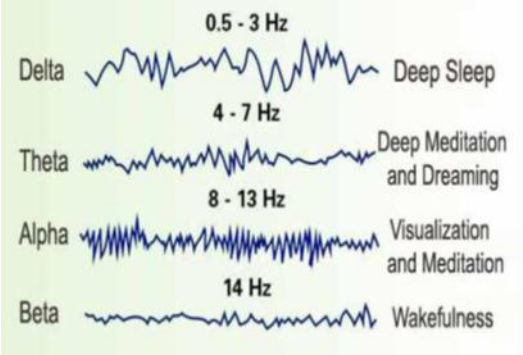

Fig.1: Types of the brain waves

Table-1: Types of the brain waves frequency ranges and corresponding human stages

Types of brain waves	Frequency ranges	Human mental stages
Alpha waves	8Hz to 12Hz	Relaxed but not drowsy
Beta waves	13Hz to 30Hz	Formerly SMR, Thinking, Aware of self and surrounding, alertness and agitation
Delta waves	0.5Hz to 3Hz	Deep, dream less sleep
Theta waves	4Hz to 7Hz	Fantasy, imaginary dream
Gamma waves	30Hz to 100Hz	Higher mental activity, motor function

2. LAB VIEW AND VIRTUAL INSTRUMENT

The full form of the lab view is (Laboratory Virtual Instrument engineering workbench) is invented for environment based on the graphical programming. The lab view is used terminology, icons and ideas are understandable to technician, scientist and engineers and relies on graphical symbols rather than textual language to make programming action. In contrast to text based programming language, where instructions determine program execution, Lab VIEW dataflow programming, where data determine execution. It is graphical programming that uses icons instead of lines of text to create applications [6].

3 METHDOLOGY

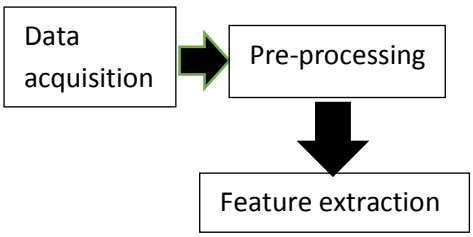

Fig.2 Over all structure of the whole process

3.1 DATA ACQUISITION

The EEG signal acquisition is very power full requirement in biomedical field for signal analysis. The main goal for analysis of the EEG signal is diagnosis and biomedical application. First the EEG signal is detected by different methods and techniques the nature and characteristics of the signal is properly understood by further analysis. There will be diff. advance techniques, better algorithms and upgrading methodologies to reduce the noise and acquire accurate EEG signal. The shape and frequency spectrum of EEG signal reflects the disorder related to brain.

In this paper we will take the data a normal person by using the 10-20 system it is the standard system for placement of the electrodes or channels on the scalp of the person. The 10-20 system the placement of the electrodes is based on the relationship between area of cerebral cortex (the 10 and 20 refers to the 10% and 20% inter-electrode distance) and location of electrode. The placement of the electrodes is adjusted acc. to the parts of human brain: F (frontal), C (central), T (temporal), 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 [4].

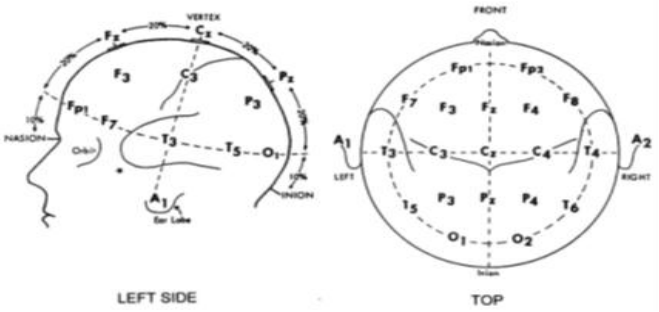

Fig.3 10 to 20 system for electrode placement

Material of the electrodes is gold and silver chloride with the 1cm diameter. Electrodes conducts voltage potential as microvolt level signals taken it into amplifiers that's are amplify the signal approximately ten thousand times.

3.2 PRE-PROCESSING/FILTERING

EEG signal is consists of the very low range of the frequency components and amplitude the main problem in analysing the EEG signal is detection of the different kind of interference waveforms (artifacts) mixed to the EEG signal during the recording process [3]. Medium of the artifacts in biomedical signals:

- 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.

Various types of the filters are available in lab view to filter the biomedical signals basically IIR and FIR filter. IIR filters are designed to provide the non-linear phase response and FIR filters are designed to provide the linear phase response IIR filter are not necessary in signal monitoring application. In this bi-directional 2nd order Butterworth filter is used it is a signal processing filter designed to have as flat frequency response as possible to band pass [8]. It is used to extract the different frequency bands such as Delta, Theta, Gamma, Beta, and Alpha. Butterworth band pass filter having cut-off frequency 0.5 to 60 Hz. The IIR filter having the slower response as compare to FIR filter response.

- In this paper FIR band pass filter are used a band pass filter having the band. pass frequency is 8Hz and band stop frequency 12Hz is called alpha frequency band pass filter.

A band pass filter having the band pass frequency 13Hz and band stop frequency is 30Hz is called the beta frequency band pass filter.

- A band pass filter having the band pass frequency 0.5Hz and band stop frequency is 3Hz is called the delta frequency band pass filter.
- A band pass filter having the band pass frequency 4Hz and band stop frequency is 7Hz is called the theta frequency band pass filter.

The amplitude and frequency are extract of each frequency band by using the single tone measurement. For loop is used to execute the program N no. of time.

3.3 FEATURE EXTRACTION

There will be the 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].

3.4 FAST FOURIER TRANSFORM

The FFT is an important and efficient tool for the feature extraction. FFT algorithm is involved a wide range of mathematical operation from simple real and complex numbers arithmetic to group theory and no. theory. The FFT is can compute the result O (N log N) operation.

Where N is the length of the vector

There will be the range of the N is thousand or million so that DFT is not the suitable method so we are used the FFT. The calculation is very complex and time consuming to reduce the operation time and increasing the speed by using FFT [3, 5]. FFTs are of most importance tool to a wide variety of applications, from digital signal processing and solving partial differential equations to algorithms for quick multiplication of large integers. The result of power spectrum analysis of EEG signal on the lab view [7].

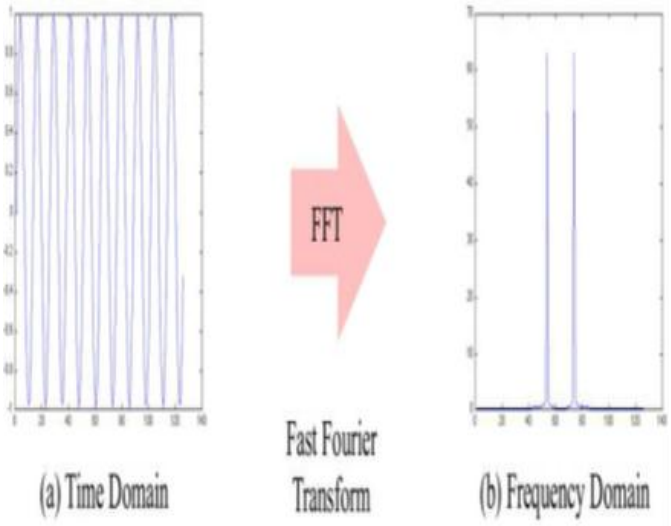

Fig.4 Fast Fourier Transform

The diagram of power spectral analysis using FFT and feature extraction in lab view shown in fig.5

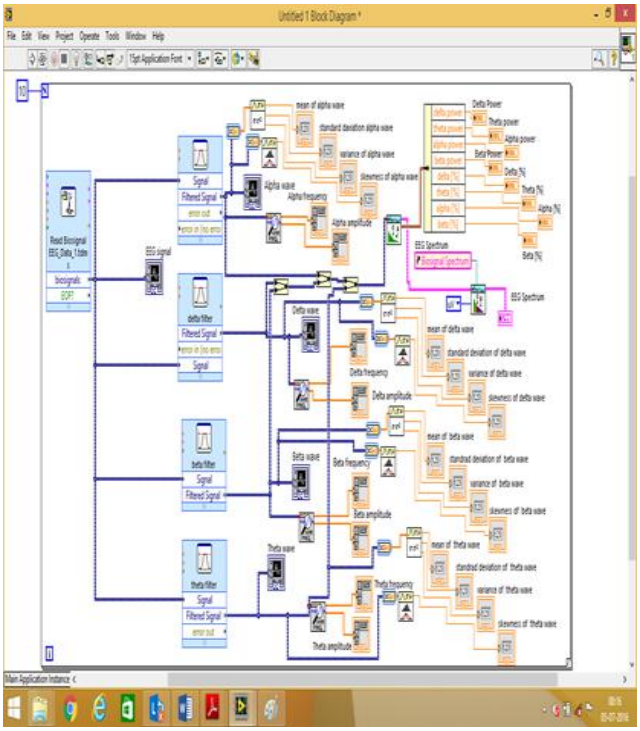

Fig.5 FFT spectral analysis and feature extraction of EEG signal on lab view

Fig.6 Front panel of the feature extraction of EEG signal

3 RESULT AND DISCUSSION

In this paper we are describe the EEG signal filtering FIR band pass Butterworth filter the output is shown in fig.7

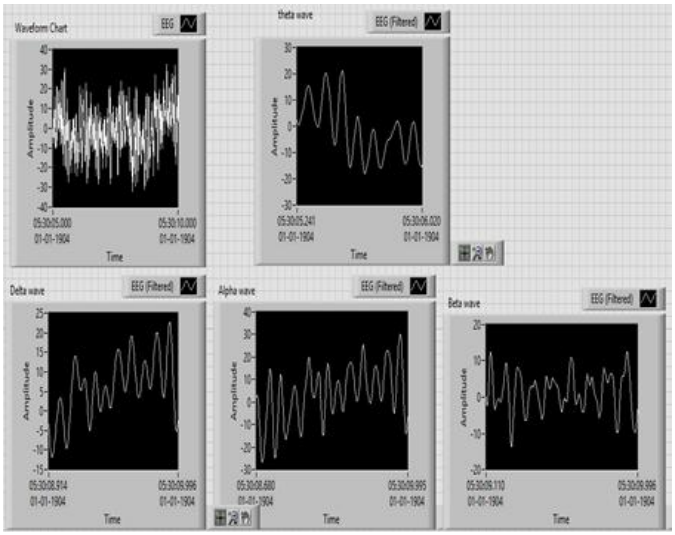

Fig.7 Front panel of the original and filtered signal of diff. frequency band filters Alpha filter, Beta filter, Delta filter, and Theta filters

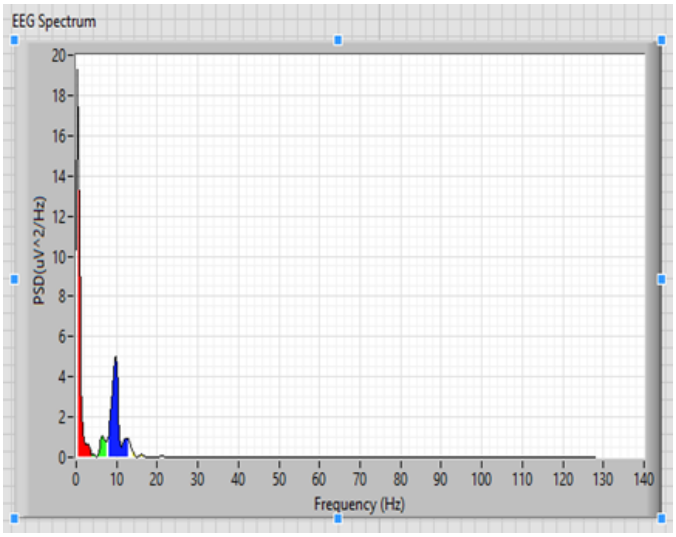

Fig.8 FFT Power spectrum of EEG signal

The features extracted by using FFT power spectral analysis the EEG signal on lab view fig7 shows the front panel of values of features or parameters of signal. Here we are used the FFT for increasing the speed and reduction of the time consumption in mathematical calculation.

4 CONCLUSION

EEG signal is the complex signal and its analysing and information extraction is very complicated. EEG signal is consist of the very low frequency components different types of the artifacts and noises and power line frequencies are mixed with the original signal very great problems are generate so that first we are filter the signal by using the FIR Butterworth filter and extract the important information about EEG signal with the help of efficient DSP tool FFT.

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