QUANTITATIVE ANALYSIS OF EEG

Project Report

SUBMITTED TO

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Electroencephalographic (EEG) recordings are thought to reflect the network-wide operations of canonical neural computations, making them a uniquely insightful measure of brain function. As evidence of these virtues, numerous candidate biomarkers of different psychiatric and neurological diseases have been advanced. Presumably, we would only need to apply powerful machine-learning methods to validate these ideas and provide novel clinical tools. Through this project we intend to analyze the EEG signals and with the most frequently used method to classify EEG waveforms is by the frequency, so much so, that EEG waves are named based on their frequency range using Greek numerals .the most commonly studied waveforms include delta (0.5 to 4Hz); theta (4 to 7Hz); alpha (8 to 12Hz); sigma (12 to 16Hz) and beta (13 to 30Hz).Through this project we would like to analyze major features of eeg and its variations during different conditions

1. INTRODUCTION

The human brain is one of the most complex systems in the universe. Nowadays various technologies exist to record brain waves and electroencephalography (EEG) is one of them. This is one of the brain signal processing technique that allows gaining the understanding of the complex inner mechanisms of the brain and abnormal brain waves have shown to be associated with particular brain disorders. EEG is most often used to diagnose epilepsy, which causes abnormalities in EEG readings. It is also used to diagnose sleep disorders, depth of anesthesia, coma, encephalopathy, and brain death. At different stages of time our brain reacts differently. These brain signals are used for various purposes so that it is possible to study the functionalities of brain properly by generating, transforming and interpreting the collected signal. This process is known as brain signal processing.

BASICS OF EEG

- The EEG records electrical activity from the cerebral cortex.
- Number of possible sources
    1. Action potentials
    2. Post-synaptic potentials (PSPs)
- The resting membrane potential (electrochemical equilibrium) is typically–70 mv on the inside.
- At the post-synaptic membrane the neurotransmitter produces a change in membrane conductance and trans-membrane potential.
- If the signal has an excitatory effect on the neuron it leads to a local reduction of the trans-membrane potential (depolarization) and EPSP.
- The resting membrane potential (electrochemical equilibrium) is typically–70 mv on the inside.
- At the post-synaptic membrane the neurotransmitter produces a change in membrane conductance and trans-membrane potential.
- If the signal has an excitatory effect on the neuron it leads to a local reduction of the trans membrane potential (depolarization) and EPSP.

- IPSPs result in local hyperpolarization typically located on the cell body ofthe neuron.
- The combination of EPSPs and IPSPs induces currents that flow within and around the neuron with a potential field sufficient to be recorded on the scalp.
- The EEG is essentially measuring these voltage changes in theextracellular matrix.
- The mechanisms of EEG rhythmicity, although not completely understood, are mediated through two main processes.
- Interaction between the cortex and the thalamus.
- Functional properties of large neuronal networks in the cortex that have an intrinsic capacity for rhythmicity.

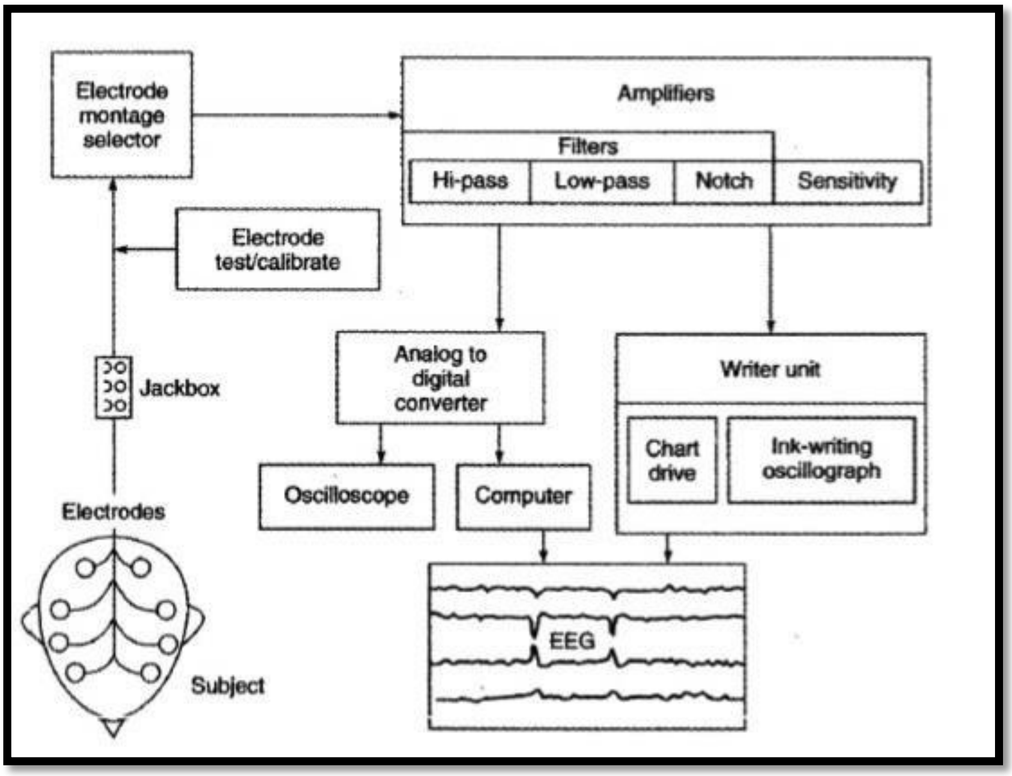


Fig 1.1 Schematic Diagram of an EEG Machine

2. ELECTRODES

They are small, non-reactive metal discs or cups applied to the scalp with a conductive paste. Gold, silver/silver chloride, tin, and platinum. The electrode contact must be firm in order to ensure low impedance (resistance to current flow) minimizing both electrode and environmental artefacts.

2.1 ELECTRODE PLACEMENT:-

Electroencephalography records the electrical activity of the brain using electrodes placed on the scalp. Allows EEGs performed in one laboratory to be interpreted in another. There are mainly two methods 10-20 international system10-10 international system, The Skull is taken in three planes – sagittal, coronal, and horizontal. The summation of all the electrodes in any given plane will equal 100%. Electrodes designated with odd numbers are on the left; those with even numbers are on the right.

2.1.1 The 10-20 international system:-

The system is based on the relationship between the location of an electrode and the underlying area of cerebral cortex. The numbers „10" and „20" refer to the fact that the distances between adjacent electrodes are either 10% or 20% of the total front- back or right-left distance of the skull. Each site has a letter to identify the lobe and a number to identify the hemisphere location

The 10/20 system or International 10/20 system is an internationally recognized method to describe the location of scalp electrodes. The system is based on the relationship between the location of an electrode and the underlying area of cerebral cortex. The numbers „10" and „20" refer to the fact that the distances between adjacent electrodes are either 10% or 20% of the total front- back or right-left distance of the skull. Each site has a letter to identify the lobe and a number to identify the hemisphere location.

Electrode	Lobe
F	Frontal
T	Temporal
C	Central
P	Parietal
O	Occipital

Table 2.1.1.1: Letter to Identify the Lobe

- No central lobe exists; the „C" letter is used for identification purposes only.
- The „z" (zero) refers to an electrode placed on the mid line.
- Even numbers (2,4,6,8) refer to electrode positions on the right hemisphere.
- Odd numbers (1,3,5,7) refer to electrode positions on the left hemisphere.
- Four anatomical landmarks are used for the essential positioning of the electrodes: first, the nasion which is the point between the forehead and the nose; second, the inion which is the lowest point of the skull from the back of the head and is normally indicated by a prominent bump; the pre auricular points anterior to the ear.
- Extra positions can be added by utilizing the spaces in between the existing 10/20 system.

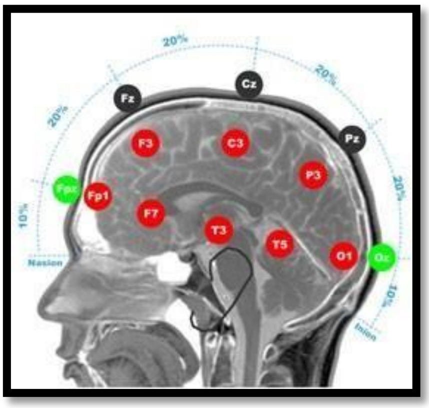


Fig 2.1.1.1: Electrode placing of the 10/20 system

2.1.1.1 The electrode placement procedure:-

The steps for proper placement of electrodes are as follows:

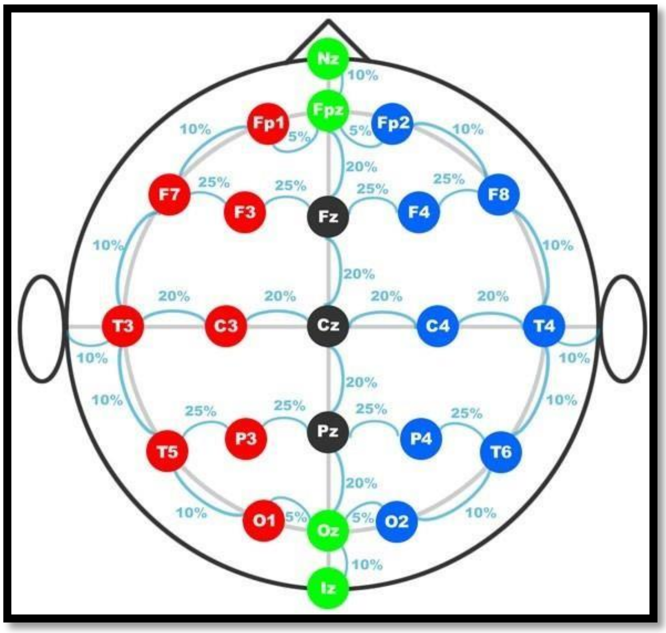


Fig 2.1.1.1.1: Proper electrode placement

ELECTRODE PLACEMENT PROCEDURE

The steps for proper placement of electrodes are as follows:

1. Measure over the center line of the scalp, from the to the Inion. Note the total length and Measure and mark 50% of the totals in the previous step. These are the preliminary marks of C3 and C4.
2. Measure and mark 10% up from the Nasion and 10% up from the Inion. These are the preliminary mark Fpz and Oz. Measure from preauricular point to preauricular- point. Lightly run your finger up and down just anterior to the ear; the indentation above the zygo-matic notch is easily identified. Note the total length
3. Measure 50% of the total circumference from Fpz to the back of the head. At the cross section with your preliminary Oz mark is your true Oz mark. Measure and mark 50% of the total. At the intersection with the previous 50% mark from the Nasion to the Inion is your true Cz mark
4. Measure and mark 10% up from the pre auricular points. These are the preliminary marks of T3 and T4 Measure from the first mark of T3 to Cz. Note the total length.

Measure from the first mark of T4 to Cz. Measure and mark 50% of the total. This is the preliminary Cz mark.

5. Draw a cross section mark on Fpz. This is the true Fpz mark. Measure and mark 5% of total circumference to the left and right of Oz. These will be the true marks of O1 and O2.
6. Mark 20% from either the first mark of Fpz or Cz. These will be your preliminary marks of Fz and Pz.
7. Measure and mark 5% of total circumference to the left and right of Fpz. These will be the true Fp1 and Fp2 marks. Measure and mark 10% down from Fp1 and Fp2. These are your marks for F7 and F8
8. Measure from F7 to F8 and note your distance, Measure and mark half of the distance between F7 and F8. At the intersection with the preliminary Fz mark is the true mark for Fz. , Measure from F7 to Fz, note the distance. Measure from F8 to Fz, note the distance
9. Measure and mark 20% of the Nasion-Inion distance from FP1 to F3. At the intersection will be the true F3 mark. Measure and mark 20% of the Nasion-Inion distance from FP2 to F4. At the intersection will be the true F4 mark.
10. Measure and mark half of the distance between F7- Fz and F8-Fz. These are the preliminary marks for F3 and F4.Measure from Fp1 to O1, to obtain the preliminary mark of C3. Measure from Fp2 to O2 to obtain the preliminary mark of C3 Measure and mark half of the distance Fp1-O1. Where the first and second marks intersect will be the true C3. Measure and mark half of the distance Fp2-O2. Where the first and second marks intersect will be the true C4

Left	Right	Electrode
Left	**Right**	**Electrode**
		Parasagittal/supra-Sylvain electrodes
Fp1	Fp2	Front polar, located on the forehead-post scripted numbers are different than other electrodes in this sagittal line (3,4)
F3	F4	Mid-frontal
C3	C4	Central-roughly over the central sulcus
P3	P4	Parietal
O1	O2	Occipital-post scripted numbers are different from other electrodes in this sagittal line (3,4)
Left	**Right**	**Electrode**
		Parasagittal/supra-Sylvain electrodes
Fp1	Fp2	Front polar, located on the forehead-post scripted numbers are different than other electrodes in this sagittal line (3,4)
F3	F4	Mid-frontal
C3	C4	Central-roughly over the central sulcus
P3	P4	Parietal
O1	O2	Occipital-post scripted numbers are different from other electrodes in this sagittal line (3,4)
		Lateral/temporal electrodes
F7	F8	Inferior frontal/anterior temporal
T7	T8	Mid-temporal-formerly T3, T4
P7	P8	Posterior temporal/parietal – formerly T5, T6
		Other electrodes
Fz,Cz,Pz		Midline electrodes: Frontal, central and parietal.
A1	A2	Earlobe electrodes. Often used as reference electrodes from contralateral side. Of note, they record ipsilateral mid-temporal activity.
LLC	RUC	**Left lower canthus/right upper canthus** (placed on the **lower and upper outer corners** of the eyes). These electrodes are used to detect eye movements and can help distinguish eye movements from brain activity. Sometimes designated LOC,ROC.

Table 2.1.1.1.1: Standard Electrode Designation

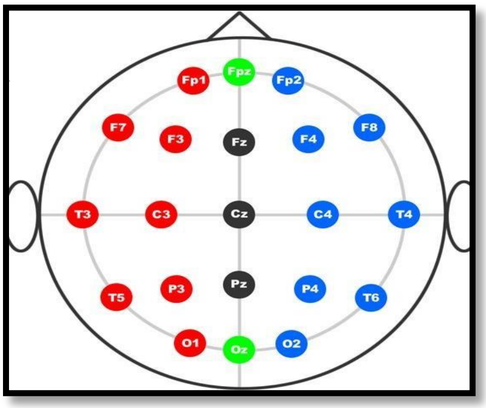


Fig 2.1.1.1.2: 10/20 System

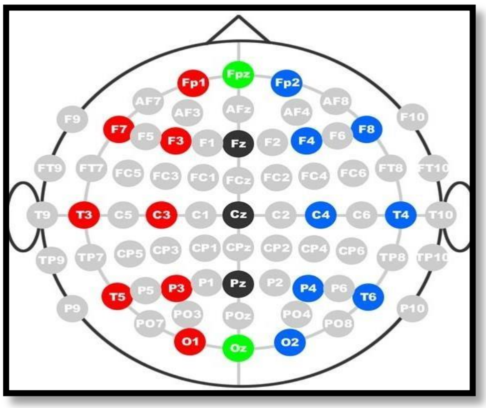


Fig 2.1.1.1.3: 10/10 System

3. POTENTIAL FIELDS

- The summation of IPSPs and EPSPs in a neuronal net createselectrical currents.
- The flow of current creates a field that spreads out from the origin of an electrical event such as same as the concentric rings created on a glassypond when one tosses a pebble onto its surface.
- Field's effect diminishes as the distance from the source increases.

4. AMPLIFICATION:-

There are mainly two types of amplifiers used in machine – the voltage amplifier and buffer amplifier, the voltage amplifiers are designed to serve the following two main functions Differential Discrimination and Amplification while the buffer amplifier is used

For amplification of all small input signals are received at pre-amplifier circuit which has the ability to pick the signal of 5uV-100uv. It has the properties like High input impedance and Low output impedance; each amplifier has main two inputs.

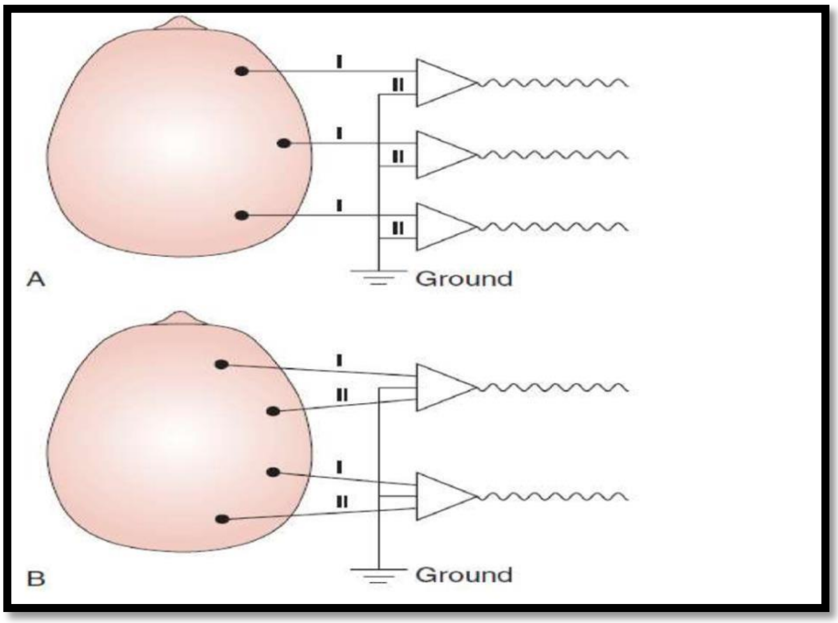


Fig 4.1: Amplifiers in EEG machines

5. COMMON MODE REJECTION RATIO (CMRR):-

The differential amplifier cancels out (rejects) those signals which are common to both inputs (I & ll), this is called common mode rejection and signals are said to be "in Phase or in Common Mode". In EEG machines the polarities of both inputs (I&II) work with convention as If Input I is more negative than Input II deflection would be upward. Input I is less negative than Input II deflection would be downward. Signal have equal potentials on both input l and ll will be canceled out and there would be no deflection

6. MONTAGE SELECTION:-

Montage refers to the pattern of systematic linkage of the scalp electrodes designed to obtain a logical display of the electrical activity. In bipolar recording the longitudinal arrangement is perhaps the most popular (known in the trade as the "double banana," and by some as the queen square montage)

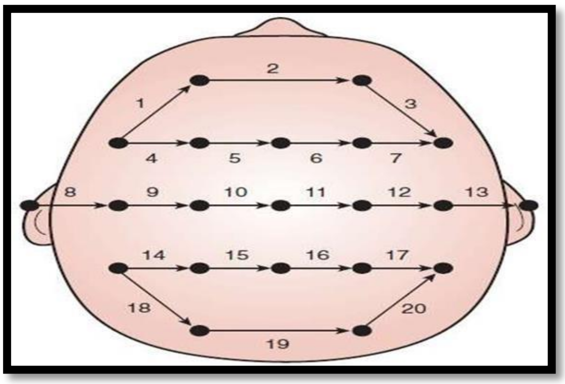


Fig 6.1: Transverse bipolar montage

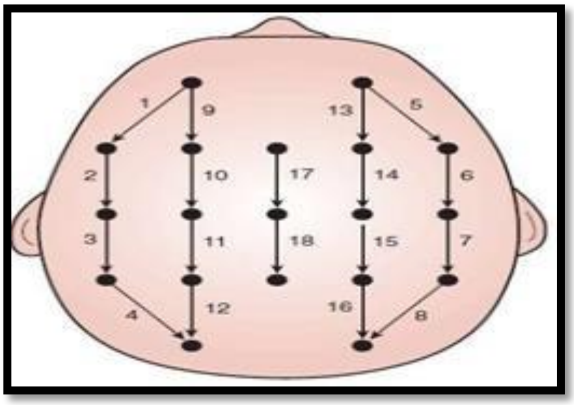


Fig 6.2: A typical longitudinal bipolar montage

7. CALIBRATION:-

Standard display time base is 30 mm/sec with 10 seconds of EEG per display. The sensitivity of each channel refers to the amplitude of the display produced by the received signal. Standard sensitivity is 7 µv/mm. Impedances should not exceed 5 kohms.

8. FILTERS:-

The use of filters in recording and displaying EEG data is an indispensable tool in producing interpretable EEG tracings. Without filters, many segments of EEG would be essentially unreadable. The main benefit of filters is that they can appear to “clean up” the EEG tracing, making it easier to interpret and generally more pleasing to the eye. Certain filter settings can also be used to accentuate particular types of EEG activity. Filters can, however, be used improperly, and at times their use can lead to unintended consequences. For e.g. High pass filter, low pass filter, band pass filter etc.

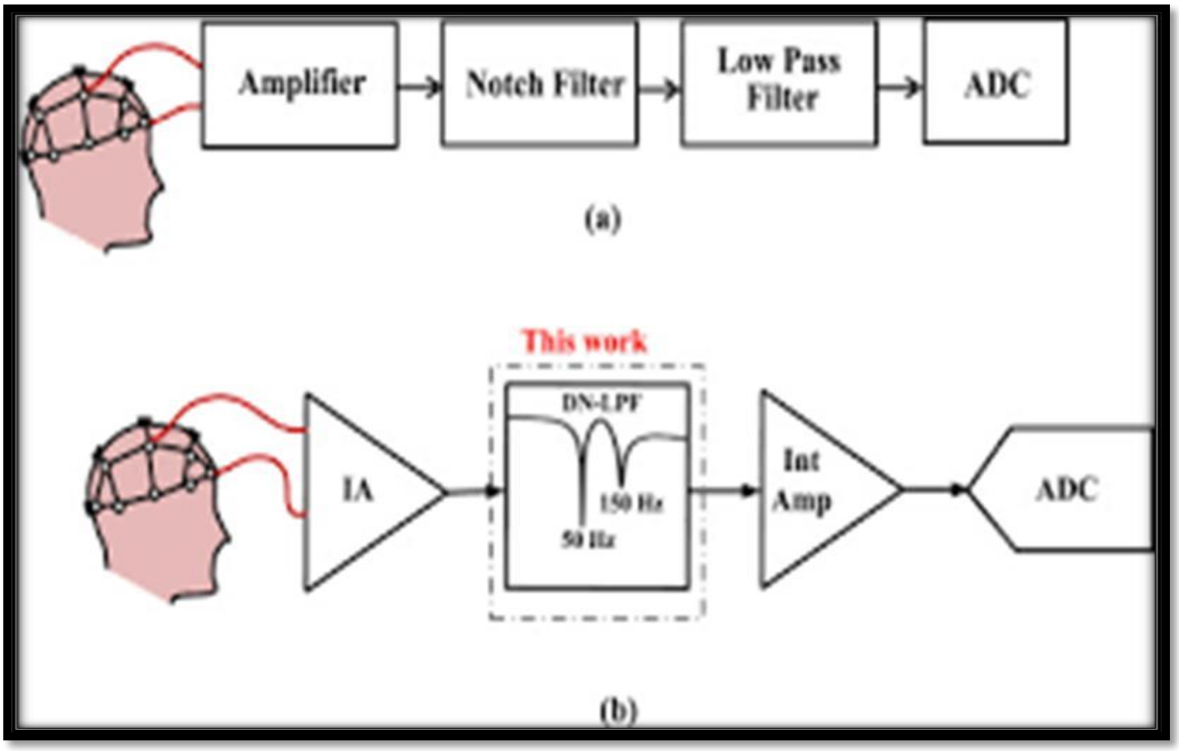


Fig 8.1: Filtering of EEG

Types of filters:

- High-frequency filters - attenuates undesirable high frequencies (e.g., Muscle action potentials) and passes low frequencies. The standard HF setting is 70 Hz.
- Low-frequency filters - marked attenuation of slow potentials below the cutoff frequency (such as those caused by sweat artifact, respirations, and tongue movement), with little effect on rapid potentials such as spikes or muscle artifacts. The LFF is typically set at 1 Hz.
- Notch filter - selectively reducing environmental interference.

Fig 8.2: EEG with LFF of 1Hz

9. ANALYSIS OF EEG DATA

9.1 VARIATION OF EEG DURING MEDITATION:-

Many studies on mindfulness meditation, assessed in a review by Cahn and Polich in 2006, have linked lower frequency alpha waves, as well as theta waves, to meditation. Much older studies report more specific findings, such as decreased alpha blocking and increased frontal lobe specific theta activity. Alpha blocking is a phenomenon where the active brain, normally presenting beta wave activity, cannot as easily switch to alpha wave activity often involved in memory recall. These findings would suggest that in a meditative state a person is more relaxed but maintains a sharp awareness. Two large, comprehensive review works, however, point to poor control and statistical analyses in these early studies and comment that it can only be said with confidence that increased alpha and theta wave activity exists.

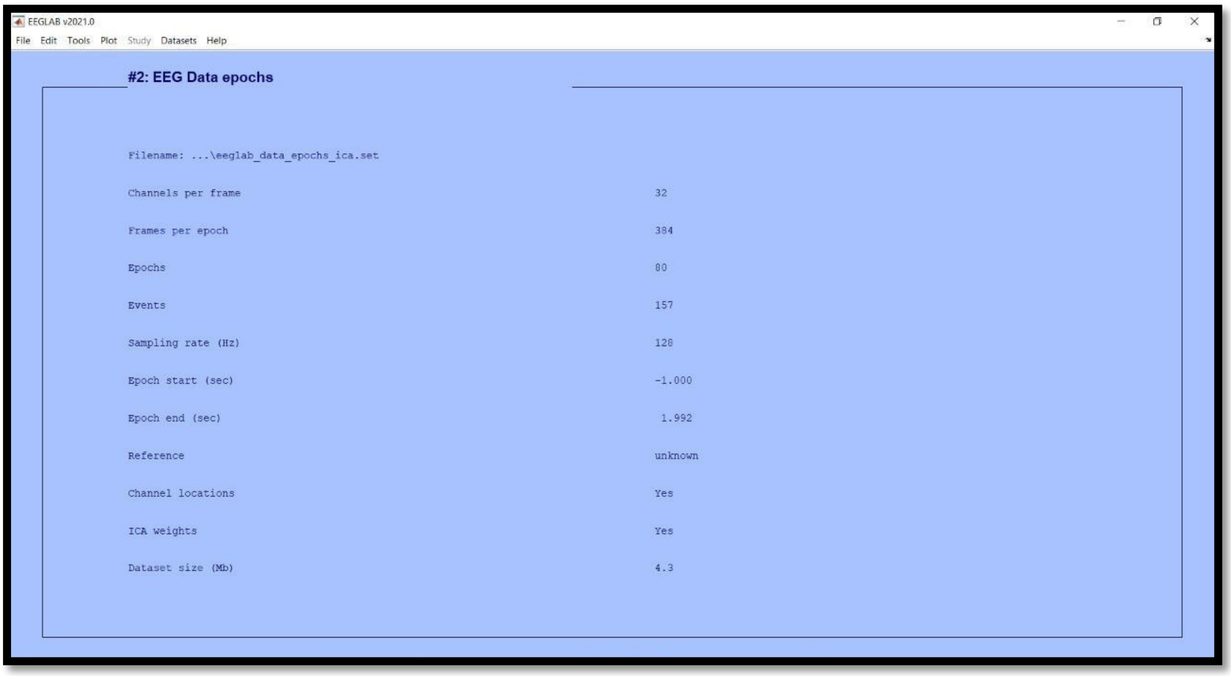


Fig 9.1.1: Details of data set obtained

Data set taken from: https://www.kaggle.com/abyssjumper/meditation-eegdata

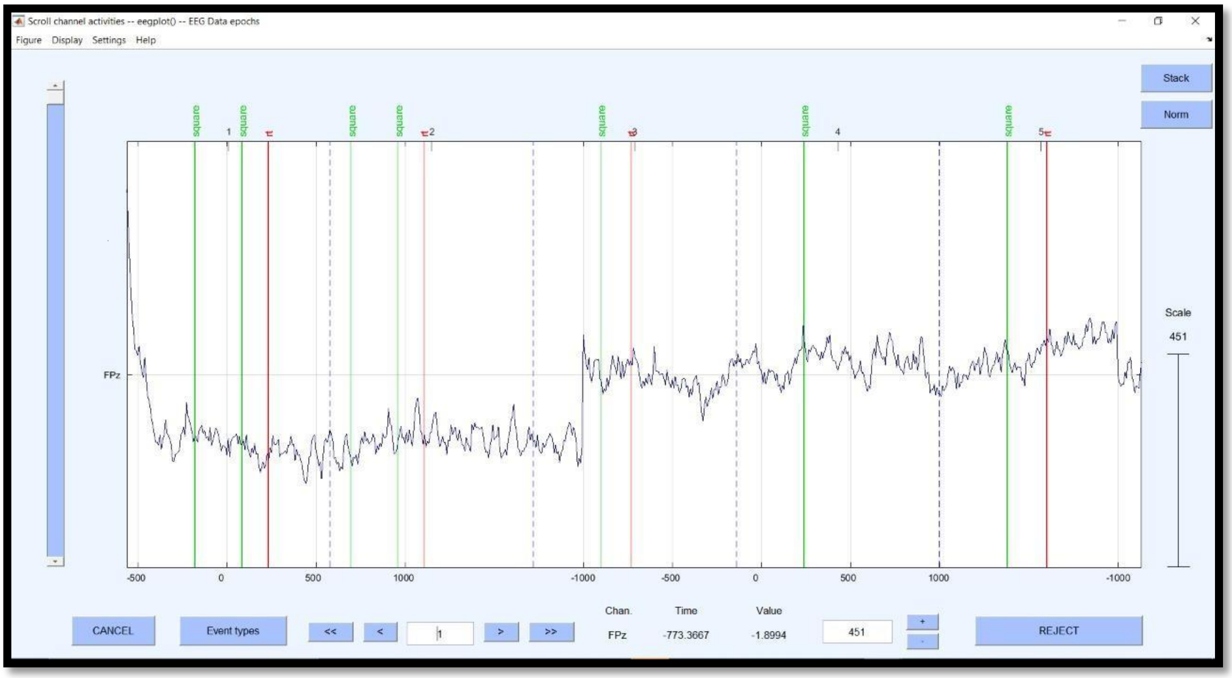


Fig 9.1.2: Output of the data plotted using EEG Lab

9.2 VARIANTION IN EEG DURING THINKING ACTIVITIES

When the brain is aroused and actively engaged in mental activities, it generates beta waves. These beta waves are of relatively low amplitude, and are the fastest of the four different brainwaves. The frequency of beta waves ranges from 15 to 40 cycles a second. Beta waves are characteristics of a strongly engaged mind. A person in active conversation would be in beta. A debater would be in high beta. A person making a speech, or a teacher, or a talk show host would all be in beta when they are engaged in their work.

Fig 9.2.1: Details of data set taken during various thinking activities

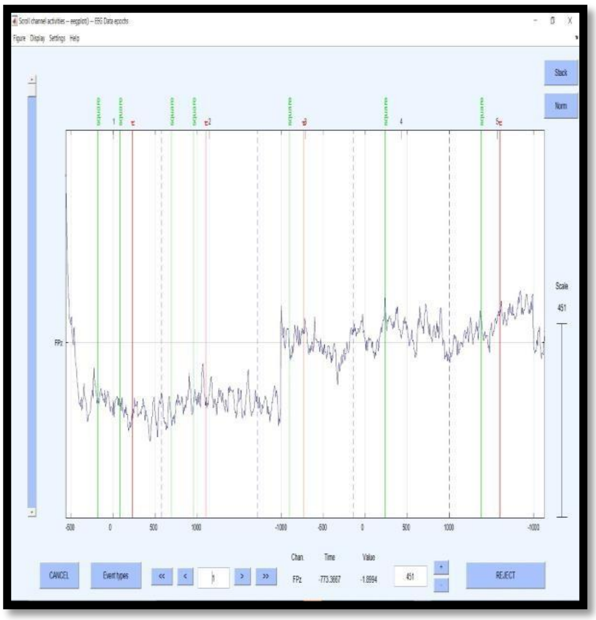


Fig 9.2.2: Output of the data plotted using EEG Lab

Data set taken from: https://www.kaggle.com/abyssjumper/meditation-eegdata

9.3 EPILIEPTIC SEIZURES

Epilepsy is a disorder of the brain characterized by repeated seizures. A seizure is usually defined as a sudden alteration of behavior due to a temporary change in the electrical functioning of the brain. Risk Factors: Traumatic brain injury.

What causes seizures?

Triggers are situations that can bring on a seizure in some people with epilepsy. Some people's seizures are brought on by certain situations. Triggers can differ from person to person, but common triggers include tiredness and lack of sleep, stress, alcohol, and not taking medication.

The original dataset from the reference consists of 5 different folders, each with 100 files, with each file representing a single subject/person. Each file is a recording of brain activity for 23.6 seconds. The corresponding time-series is sampled into 4097 data points.Each data point is the value of the EEG recording at a different point in time. So we have total 500 individuals with each has 4097 data points for 23.5 seconds. All subjects falling

in classes 2, 3, 4, and 5 are subjects who did not have epileptic seizure. Only subjects in class 1 have epileptic seizure

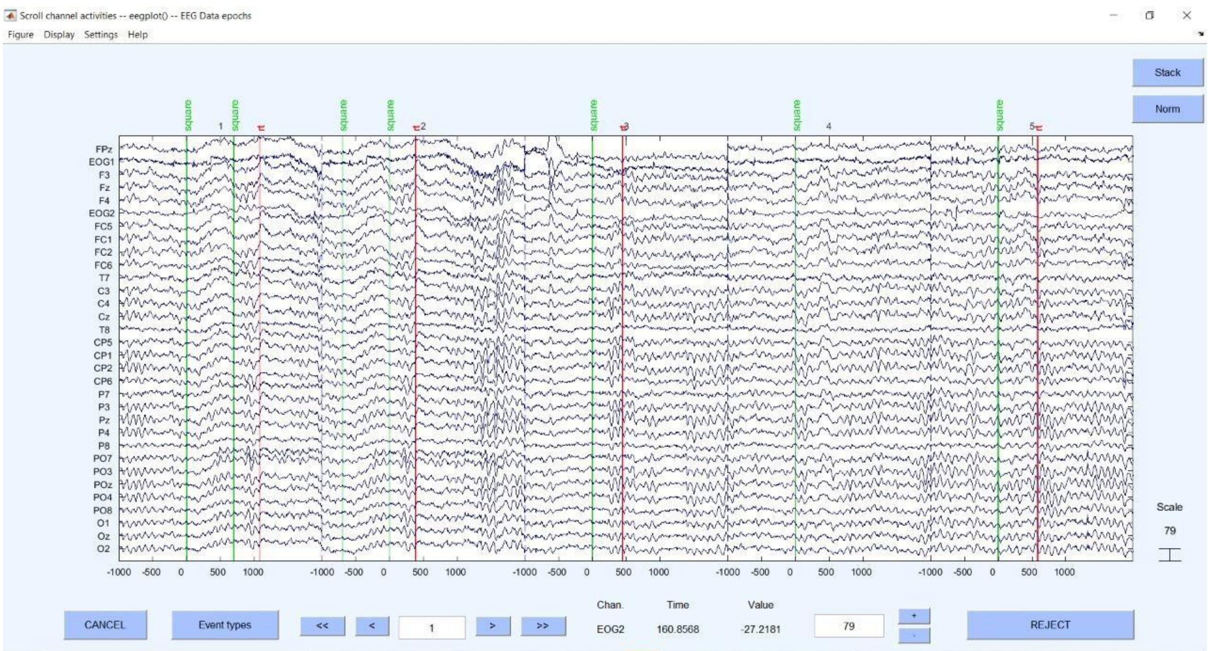


Fig 9.3.1: The output of the data plotted using EEG Lab

Data set taken from: https://www.kaggle.com/abyssjumper/meditation-eegdata

9.4 CLASSIFICATION OF ALPHA, BETA, THETA AND GAMMA WAVES:-

Tasks include:

- Mental arithmetic (high concentration)
- Reading technical articles (medium-high concentration)
- Listening to technical podcasts, reading the transcript (medium-high concentration)
- Browsing the internet (low-medium concentration)
- Just sitting there, eyes open or closed (low concentration)

Content

- Data includes alpha, beta, gamma, delta and theta waves of four different electrodes, each row has a self-assigned concentration value between 0 and 1, including high values for mental arithmetic and technical reading, low values for relaxation and browsing.

10. RESULTS AND DISCUSSIONS

For this we processed and analyzed the sample data provided on downloading the EEGLAB toolkit.

10.1 PROCESSING OFF EEG DATA:-

We processed the sample data following the given steps:

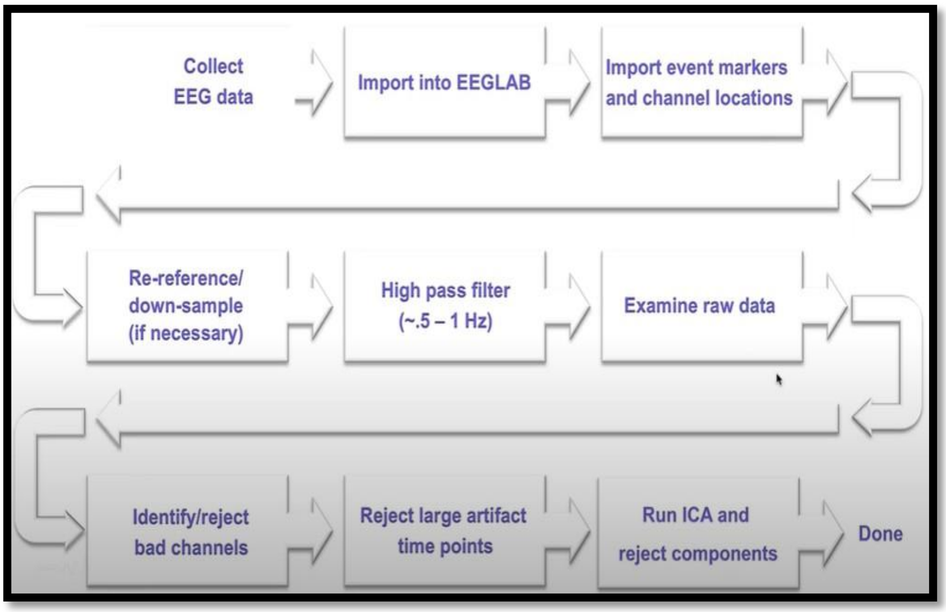
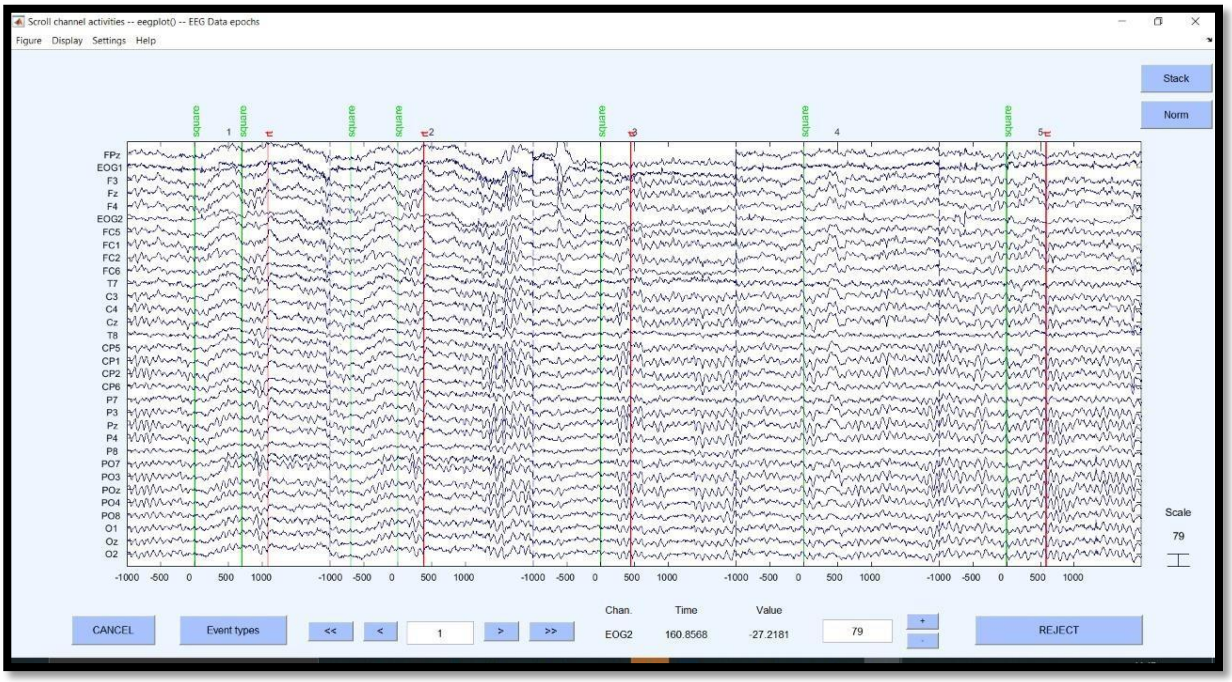


Fig 10.1.1:- Step to process sample data



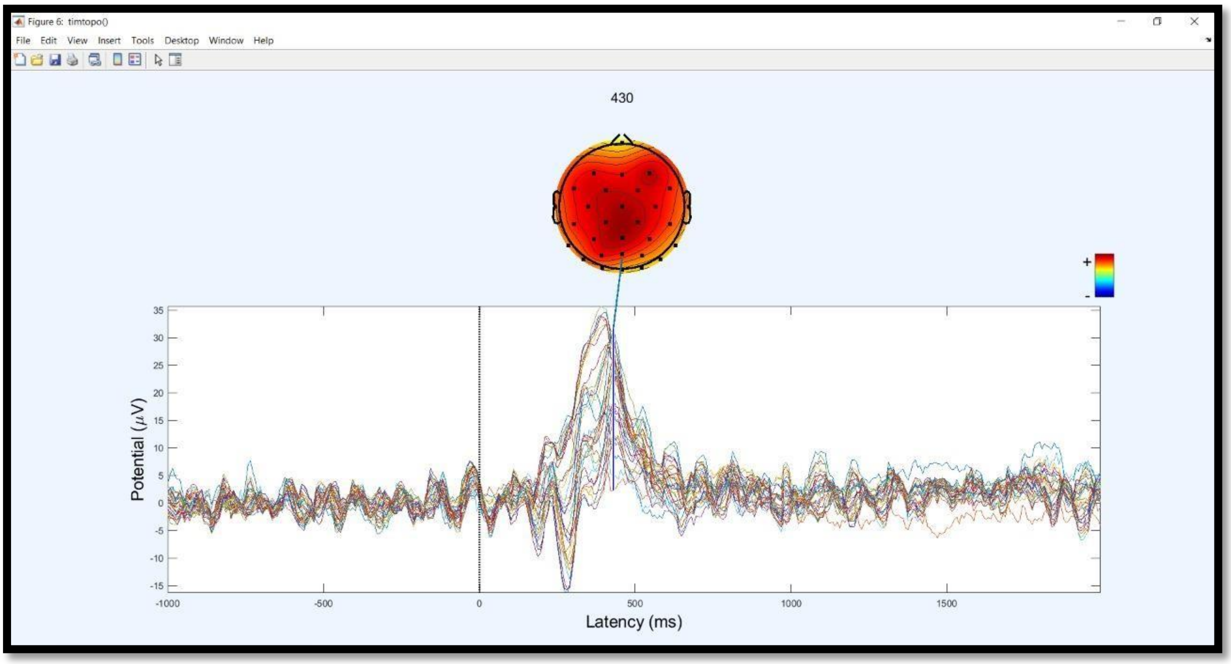


Fig 10.1.2:-Plotting the EEG sample data through EEG Lab

Fig 10.1.4: Plotting the channels or the position of electrodes during the recording on a 2D head plot

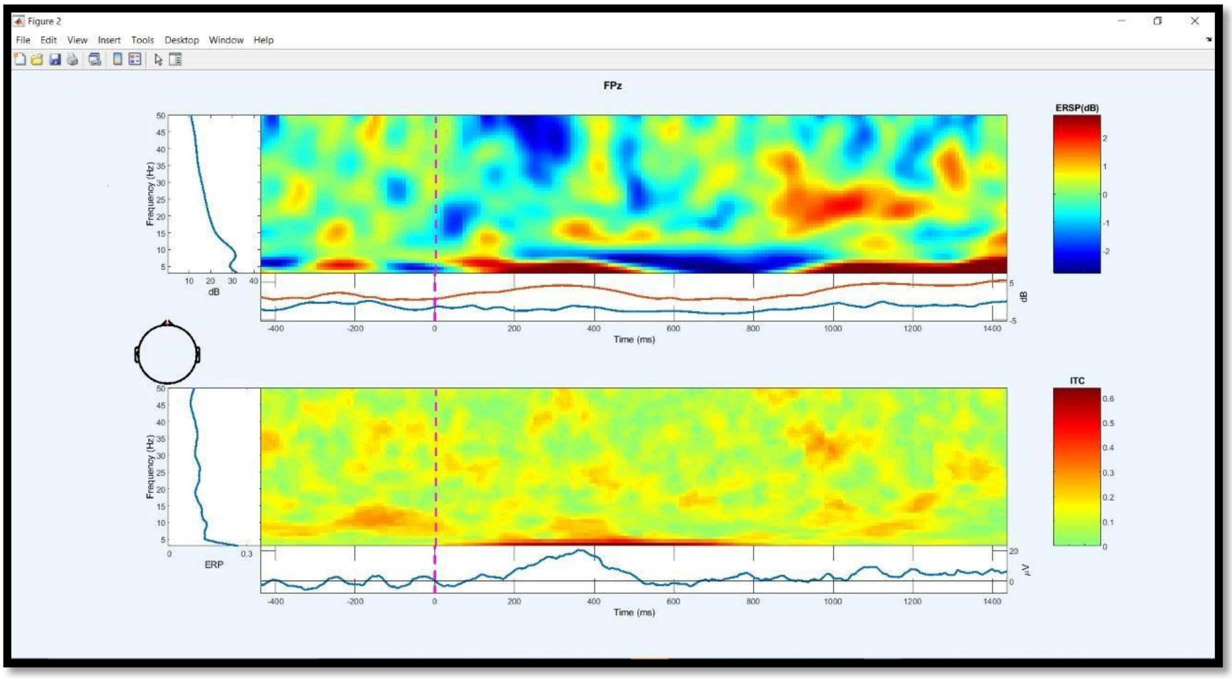


Fig 10.1.4: The plotted EEG data

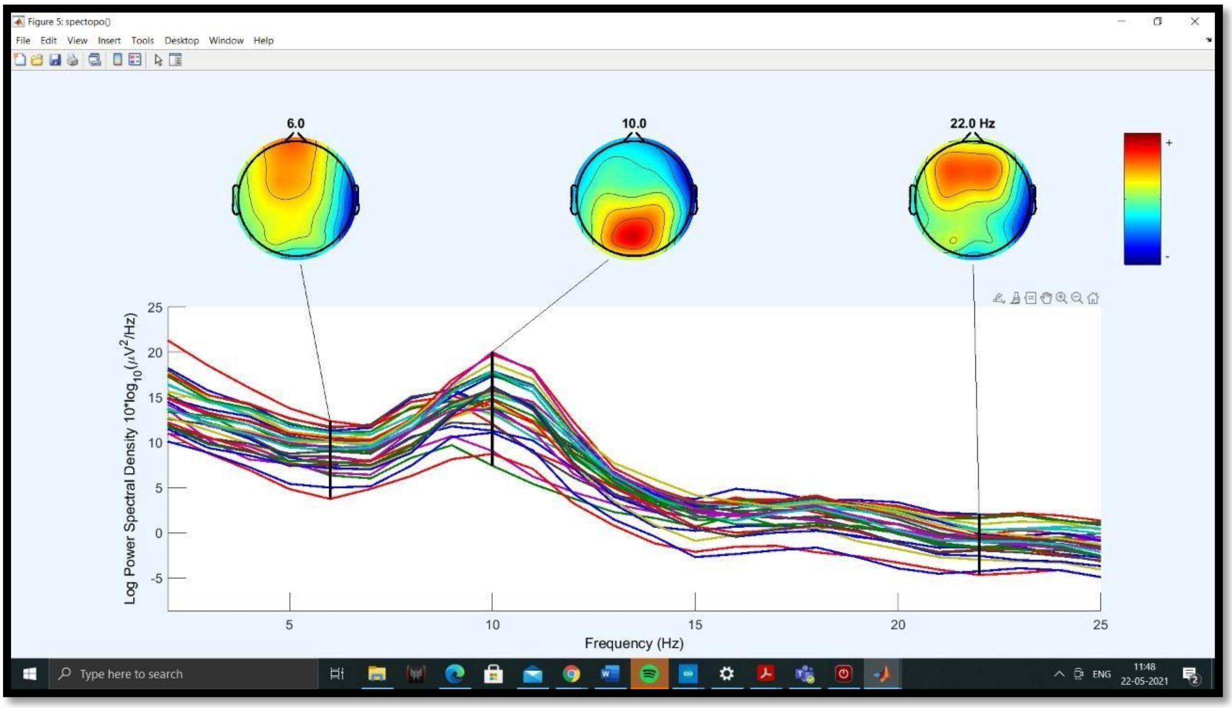


Fig 10.1.5: The power spectrum frequency plot of the sample data. The graph is drawn between the log value of power and the frequency of the recorded EEG signals

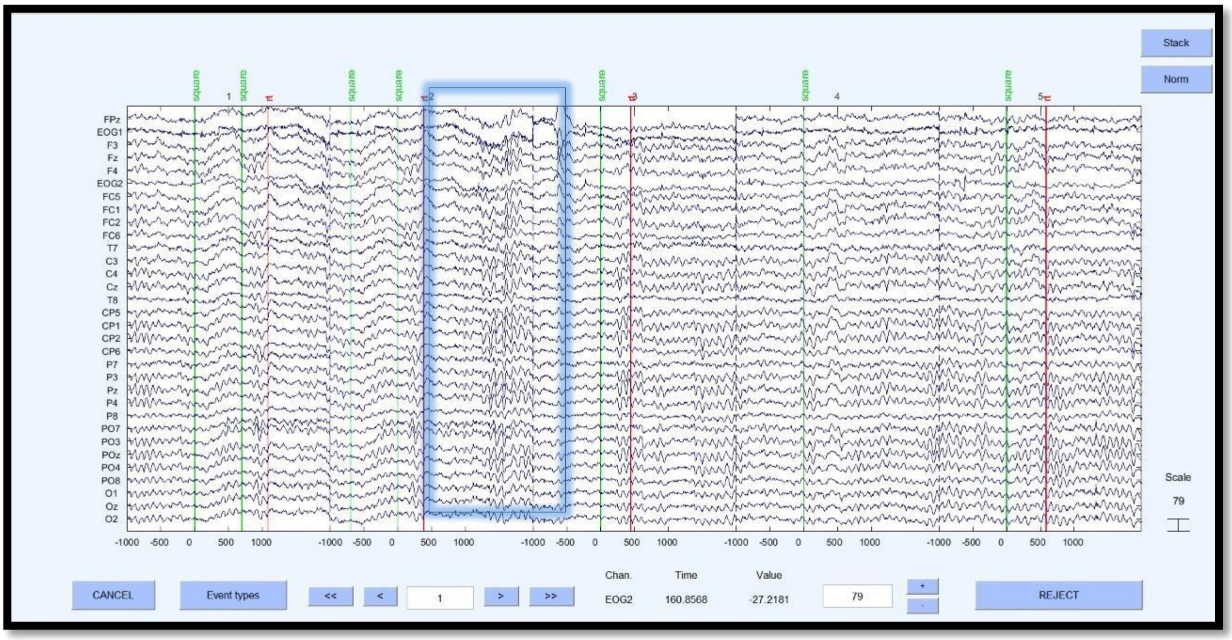


Fig 10.1.6: The final step in processing the data is to remove the unwanted or noise signals

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11. WHAT IS EEGLAB?

EEGLAB is an interactive MATLAB toolbox for processing continuous and event-related EEG, MEG and other electrophysiological data incorporating independent component analysis (ICA), time/frequency analysis, artefact rejection, event-related statistics, and several useful modes of visualization of the averaged and single-trial data. EEGLAB runs under Linux, Unix, Windows, and Mac OS X.

EEGLAB provides an interactive graphic user interface (GUI) allowing users to flexibly and interactively process their high-density EEG and other dynamic brain data using independent component analysis (ICA) and/or time/frequency analysis (TFA), as well as standard averaging methods. EEGLAB also incorporates extensive tutorial and help windows, plus a command history function that eases users' transition from GUI-based data exploration to building and running batch or custom data analysis scripts. EEGLAB offers a wealth of methods for visualizing and modelling event-related brain dynamics, both at the level of individual EEGLAB 'datasets' and/or across a collection of datasets brought together in an EEGLAB 'study set.'

EEGLAB offers an extensible, open-source platform through which they can share new methods with the world research community by publishing EEGLAB 'plug-in' functions that appear automatically in the EEGLAB menu of users who download them.

The algorithm behind EEGLAB is almost similar to a MATLAB code for plotting the EEG waveforms from a given dataset for example

EEGLAB is an interactive MATLAB toolbox for processing continuous and event-related EEG, MEG and other electrophysiological data incorporating independent component analysis (ICA), time/frequency analysis, artefact rejection, event-related statistics, and several useful modes of visualization of the averaged and single-trial data. EEGLAB runs under Linux, Unix, Windows, and Mac OS X.

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12.MATLAB CODE TO STUDY THE EEG SIGNAL

We will demonstrate EEG signal processing techniques and interpretation. A 10 s signal, with sampling rate of 512 samples per second, has been provided. The signal was monitored and obtained using the C4 and P4 electrodes, and is a differential voltage signal.

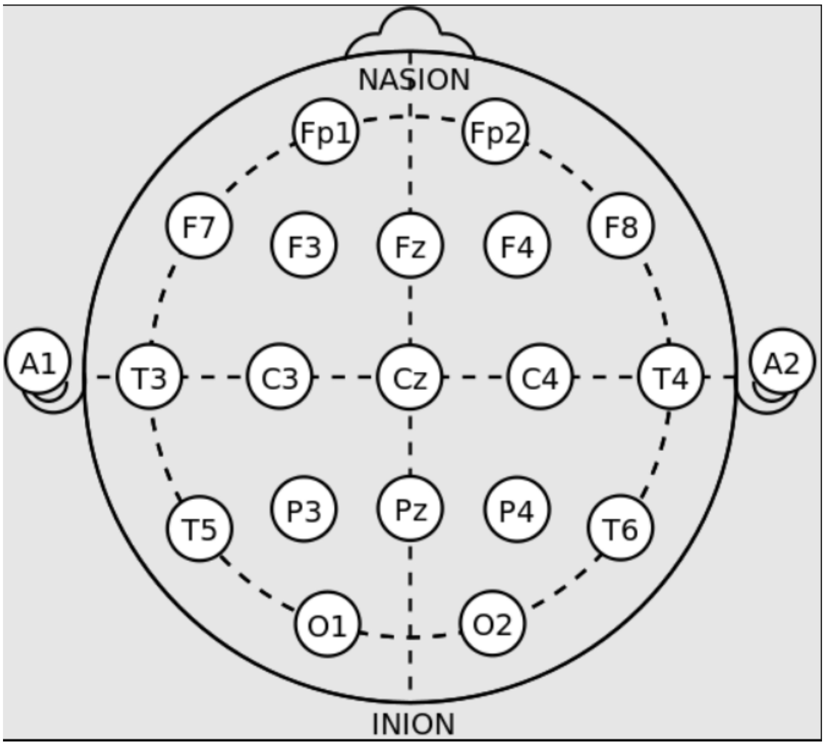


Figure 12.1: Electrode Placement

a) We will do an analysis on the EEG signal zooming in to get a better analysis of the EEG Signal

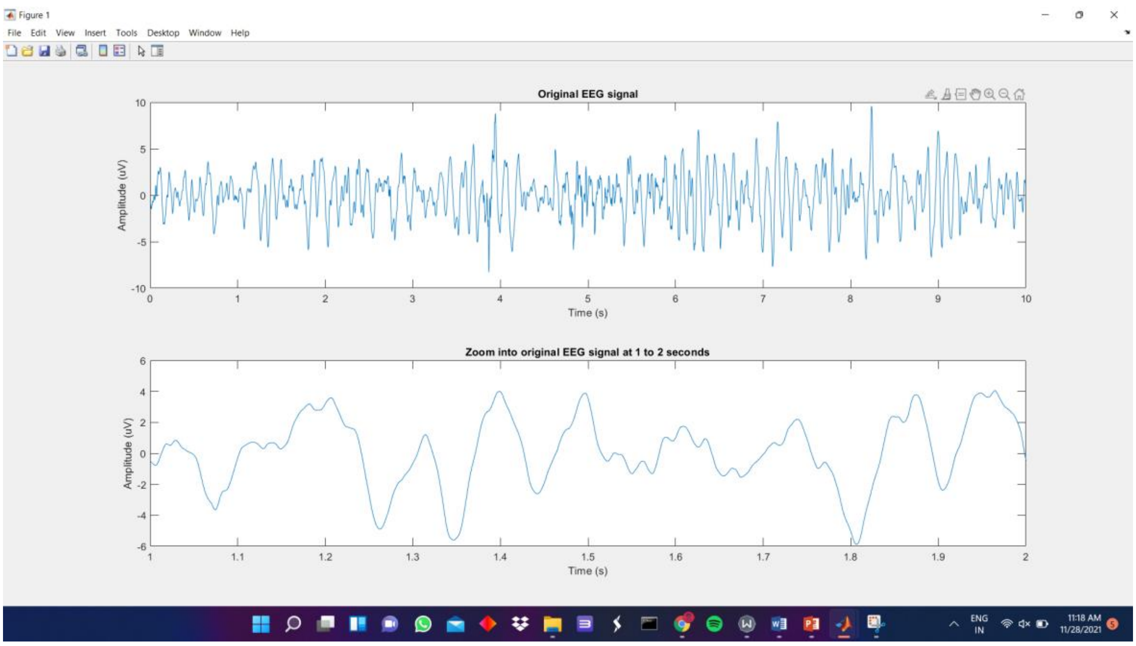


Figure 12.2-EEG Signal analysis

It will also give us mean of EEG signal max value of EEG signal and also the threshold of EEG signal

The dominant frequency is 8.3Hz, which indicates that the EEG signal is for Theta wave (8-13Hz).

The maximum power occurs at 8.3 Hz

The power estimate is 0.67

Code

```
close all;
clear all;
clc;
fs = 512; % fs — Sampling frequency, positive scalar. Sampling frequency,
specified as a positive scalar. The sampling frequency is the number of samples
per unit time. If the unit of time is seconds, the sampling frequency has units
of hertz.
T = 1/fs;% sampling rate or frequency
load('C:\Users\Mujeeb\Downloads\hmwk_EEGs') % contains eeg1 and fs
N =length(EEGsig);
ls = size(EEGsig); % find the length of the data per second
tx =[0:length(EEGsig)-1]/fs;% Make time axis for EEG signal
fx = fs*(0:N/2-1)/N;%Prepare freq data for plot
figure;
subplot (211), plot(tx,EEGsig);
xlabel('Time (s)'), ylabel('Amplitude (uV)'), title('Original EEG signal'); %EEG
waveform
subplot(212), plot(tx,EEGsig);
xlabel('Time (s)'), ylabel('Amplitude (uV)'), title('Zoom into original EEG
signal at 1 to 2 seconds'), xlim([1,2]) % Used to zoom in on single ECG
waveformfigure;
%The mean of the PSDs of xl
mean_EEGsig = mean(EEGsig)
max_value=max(EEGsig)
mean_value=mean(EEGsig)
threshold=(max_value-mean_value)/2
```

Output

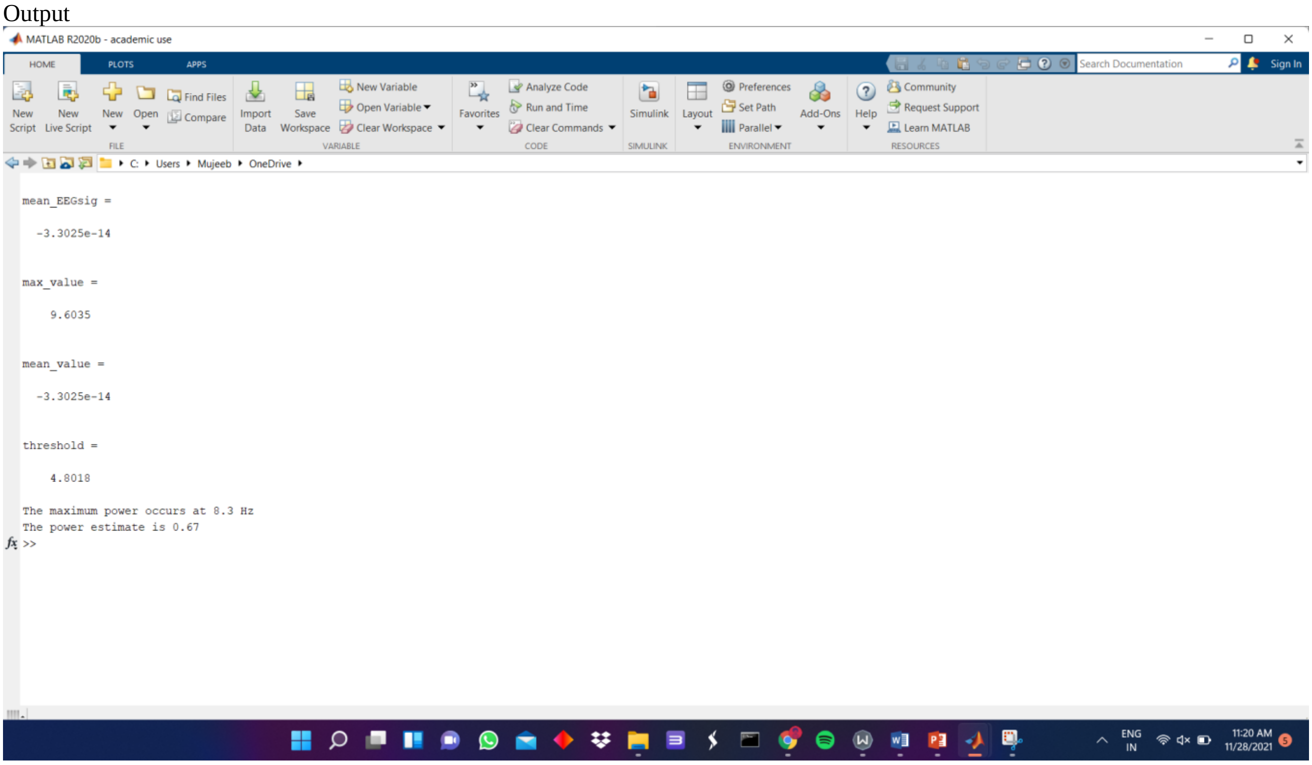


Figure 12.3: EEG Signal Mathematical values

b) Design a low-pass filter to be used on the EEG signal. Choose a cut-off frequency that retains the energy in the dominant frequency region found in part b. Discuss your choice of cut-off frequency and how well your filter worked.

The cut-off frequency is 175Hz; because the dominant frequency is 8-10 Hz and the plot become flat after 175Hz. After 175Hz signal has a lot of noise.

Low-pass filters will pass low frequencies without change, but attenuate (i.e. reduce) frequencies above the cut off frequency

c) Plot the low-pass filtered signal using the filter you designed , then commenting on the new signal

Code

```
%% low pass filter
lpfLength=127; % Order/Number of Filter coefficients
fc = 30; %% cutoff frequency
Wn=(2*fc)/fs;
h1=fir1(lpfLength,Wn);
figure; plot(h1);
xlabel('Time in Seconds');
ylabel('Magnitude');
title('Low-pass filter');
fi = filtfilt(h1,1,EEGsig);
figure;
plot(fi);
title ('filtfilt');
%Compute the Fourier transform
Tr1 = conv(EEGsig,h1);
figure;
plot(Tr1);
```

Graphs

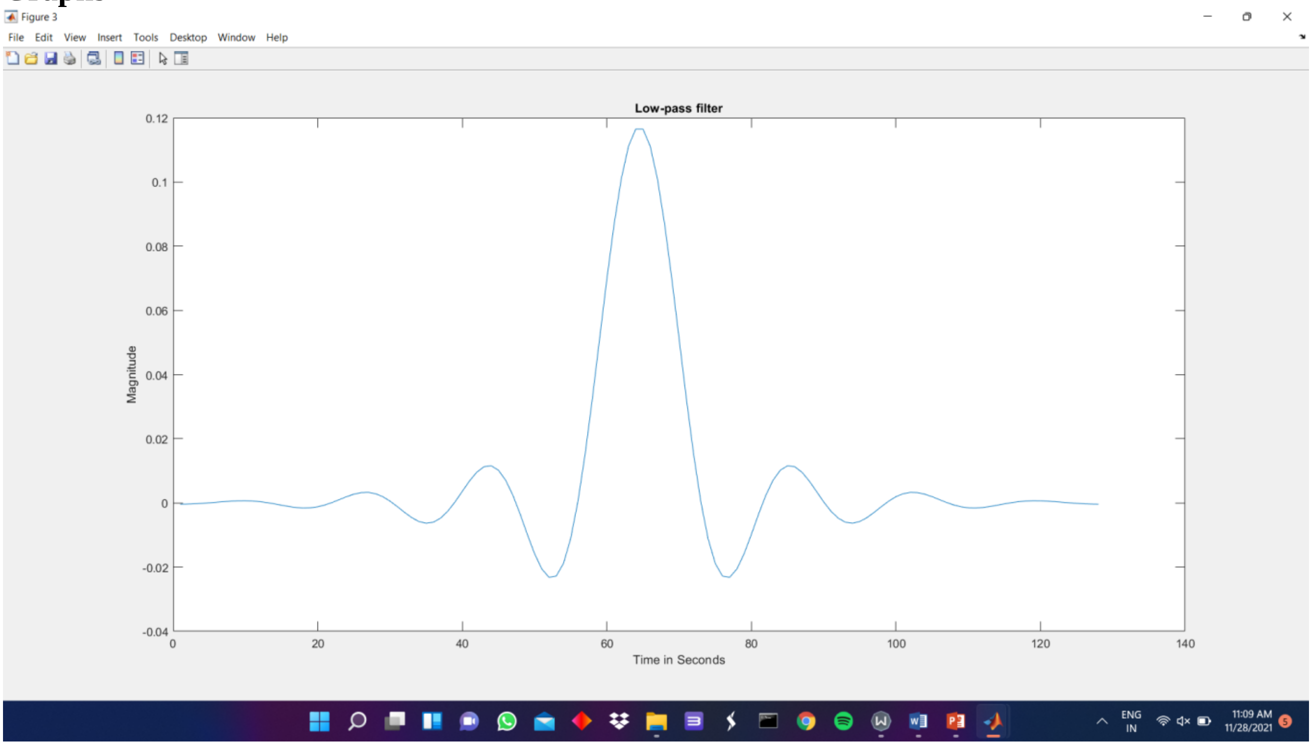


Figure 12.4-The time for which low pass filter works

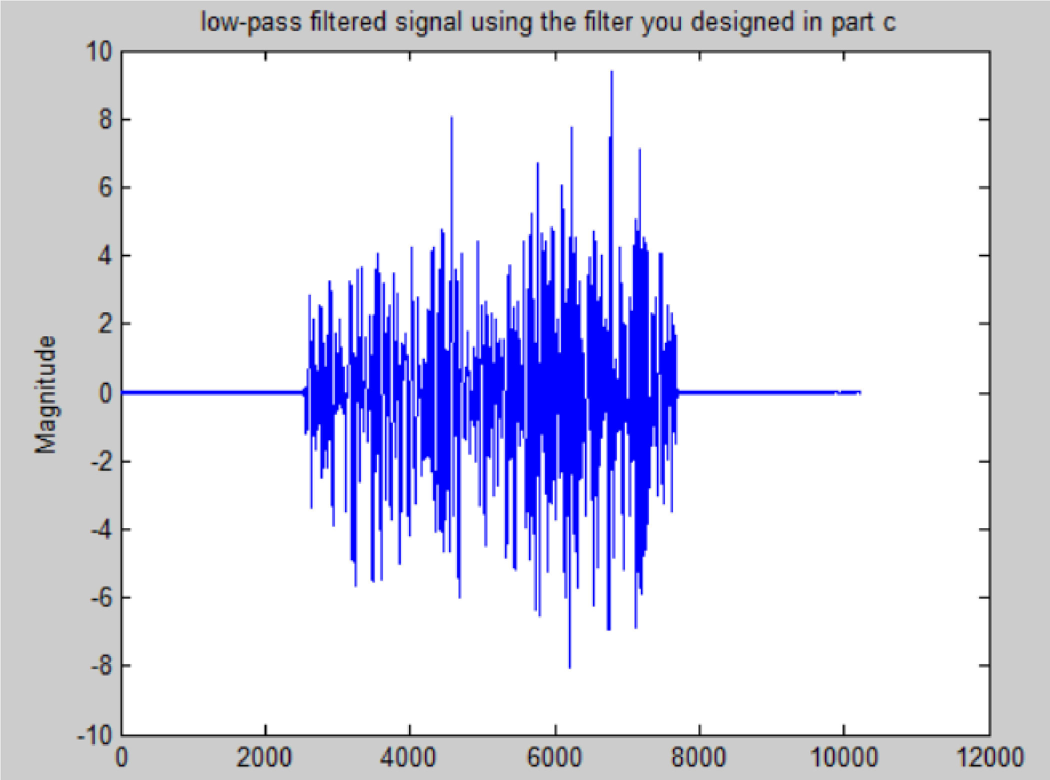


Figure 12.5:Low pass filter Frequency vs magnitude graph

13. PROTEUS SIMULATION OF EEG

The motive of this Simulation is to design a low-cost wireless EEG acquisition system for easily monitoring of the patient. Using local effort and low-price employment, this system can be built which includes data acquisition, data transmission, and receiving unit which contains the patient monitoring site.

The developed wireless EEG system is also suitable for the applications such as remote control of devices, rescue, etc. Real time decoding and mobile EEG signal processing with high information transfer rate (ITR) are incorporated in the system. The specialty of the proposed research is inclusion of forth order Butterworth low pass filter which has better stability and Sharpe cut off with reasonable cost. Using this techniques hardware implementation is possible and GSM system can be added with hardware for long distance wireless transmission of EEG signal. The system performance is simulated by some simulation Software Proteus. The proposed system is reliable, and cost is about 950 BDT or 12 USD which is reasonable.

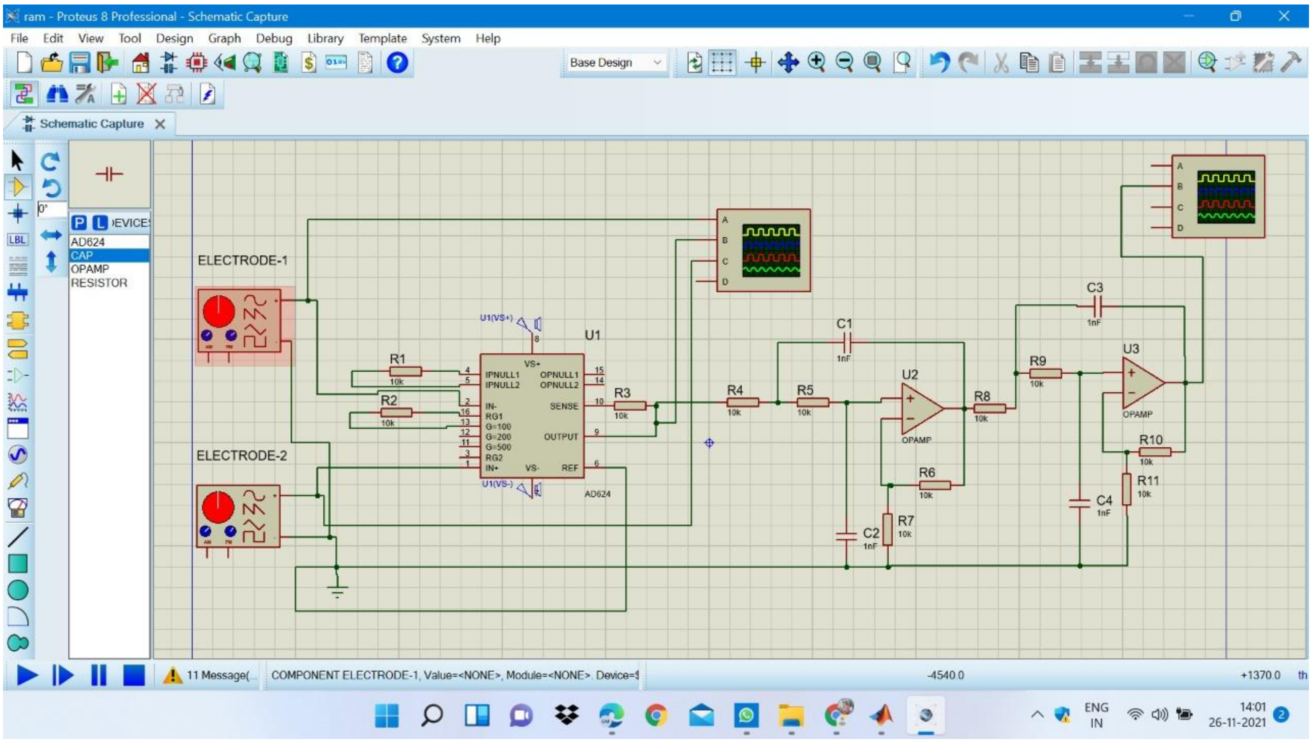


Figure 13.1 Architecture of the simulation

Results

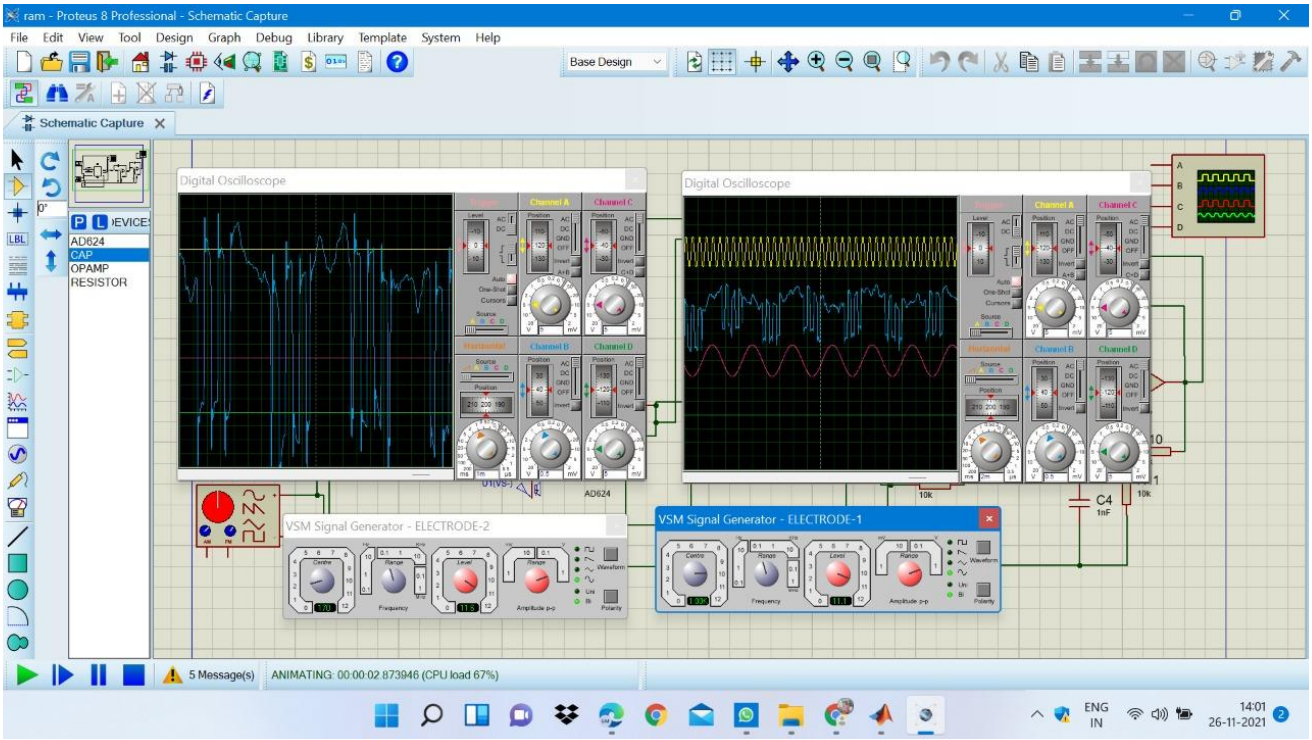
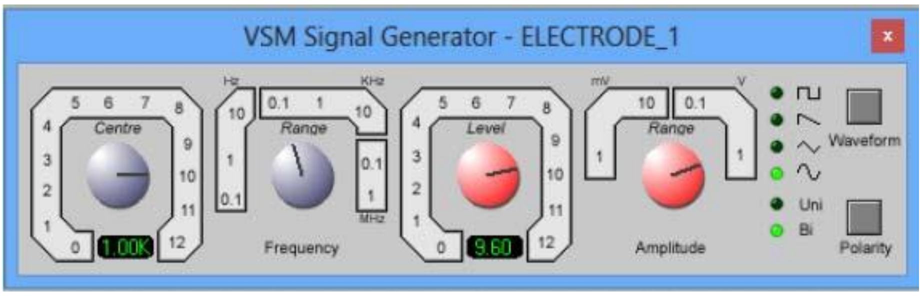
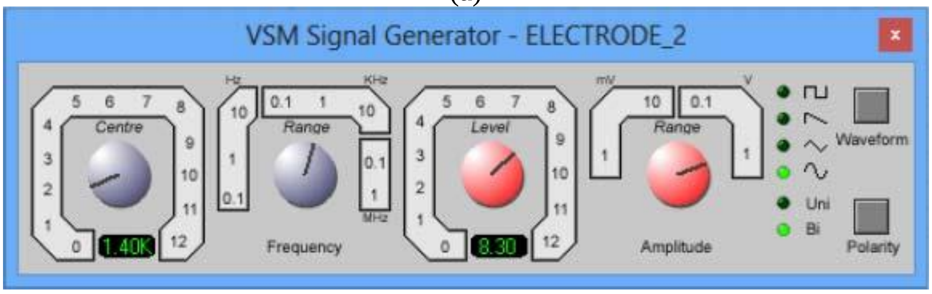


Figure 13.2 The whole simulation results



(a)



(b)

Figure 13.3. Input generator of variable amplitude and frequency wave for (a) Electrode 1 & (b) Electrode 2.

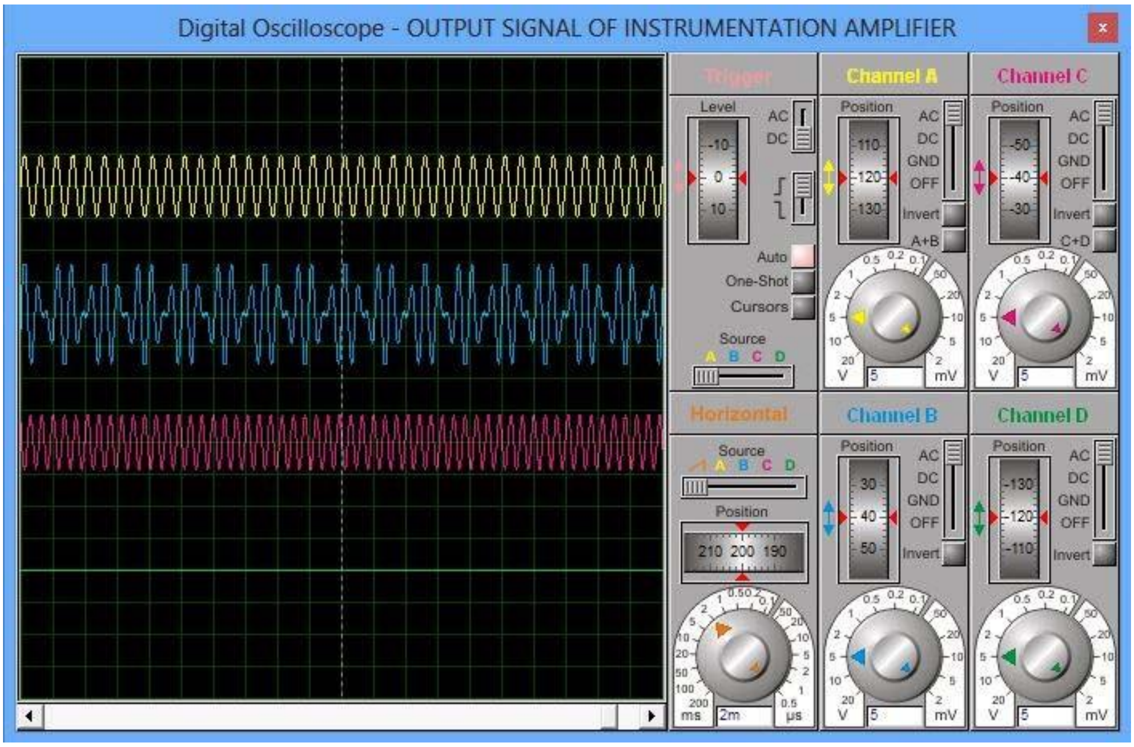


Figure 13.4. Simulation result of instrumentation amplifier.

14.CONCLUSION

The above-mentioned project has clearly demonstrated the concepts about program running under the platform MATLAB environment and its ability to process biophysical data by different way such as - using simplicity of its command line language or using the many

MATLAB functions and the methodology related to the analysis of the brain signal processing through MATLAB software toolbox. The processing has been described in the processing of EEG signals and insight brain signals recorded.

The use of EEG for electronic and computer engineering undergraduate projects has been shown to have a broad scope.

It also helps us in the analysis of the EEG signal through MATLAB Code and also help us give a better understanding about filters and their use through MATLAB where we made a low pas filter and Proteus where we made the whole EEG Simulation using Proteus in which we used Butterworth filter.

We had a good engagement with applications for brain- computer interfacing, for surgical procedure, meditation, sleep, thinking and different brain activities and epileptic seizures. The projects provided practical applications of curriculum content, particularly, computer interfacing and signal processing. The project also provides an opportunity to connect with technology and applications of relevance to current research, of which there is a growing body of relevant open access literature. This report has outlined the projects, the challenges and some potential directions for future projects. While these projects did require additional initial support, from our project guide Prof. Dr. Kanimozi.G, it felt that this was a worthwhile investment.

15.REFFERENCE

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List of abbreviations

EEG	**Electroencephalogram**
PSP and EPSP	**Post-synaptic potentials and Excitatory postsynaptic potential**
IPSP	**Inhibitory postsynaptic potential**
HF	**High-frequency filters**
LFF	**Low frequency filters**
AED	**Antiepileptic drug**
IEDs	**Interictal epileptiform discharges**
TIRDA	**Temporal Intermittent Rhythmic Delta Activity**
ACTH	**Adrenocorticotropic hormone**
LLC	**Left lower canthus**
RUC	**Right upper canthus**
LOC	**Lower outer corners**
UOC	**Upper outer corners**
MATLAB	**Matrix laboratory**
ICA	**Independent component analysis**
MEG	**Magneto encephalography**
GUI	**Graphic user interface**
TFA	**Time/Frequency analysis**