Computer Cursor control using EEG based approach.

Practical implementation of EEG to control the application that has been embedded with computer/laptops software architecture.

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***Abstract* — In the contemporary era, Computer and silicon technology has become indispensable part of 21st century and advanced in such a way that it can be used in each and every section for development. This paper imposes a light on the technological phenomenon of controlling software architecture of the computer/laptop using an electroencephalogram that has been generated as a result of the electrical activity of the neurons. Electroencephalograph are very complex to read and identify which has been employed here by making FFT transformation of signal. EEG interface with computer in real time to control the effect of cursor to perform left click, double click, and right click. This technology can be used to give an assistive platform for person suffering from paralysis or having arm amputee to operate laptop as well to control a wide range of applications.**

***Index Terms*— EEG signal Acquisition, EEG signal analyzing, FFT of EEG, Controlling cursor of the Laptop/computer.**

1.INTRODUCTION

The human brain is the most dominant part of the body which is involved in all the typical decisions of entire postures of the body. Human Brain has been divided into three segments that are cerebrum, cerebellum, Brainstem and lies within the cranial cavity of the skull. The brain stem is also subdivided into midbrain, pons, medulla oblongata [1]. The superficial part of the brain comprises of the grey matter and deep inner has composed and deposited with the white matter [1]. Brain signals are generated as a measure of the electrical activity of the brain which is done by the neurons lies in the layer of the cerebellum. In the standard definition, it is recognized to be Electroencephalogram. EEGs are multi-complex and convoluted to determine and classify for the purpose to control hardware. The conventional and most preferred method to acquire the EEG (brain signals) are putting multichannel electrodes on the entire scalp, grounding one electrode in reference to all to close the circuit. The electrode should be placed properly by means of the appropriate brain segment and polarity of each and every electrode. Because the change in polarity of the electrodes alters the entire meaning of the output signal that becomes worthless for the learner to study it and identify. Standard Electrode placement system that has been used worldwide is a 10/20 electrode placement system and adopted by the American EEG society [2]. This electrode placement system covers all the lobes of the brain like frontal, parietal, occipital, and temporal [3]. This electrode placement system is bipolar and multichannel, therefore brain signals become superimposed on each other which needs to get in convoluted calculations to estimate exact dealing of the signal. EEG signals are classified into different states of the brain like calm, anxious, having deep sleep, normal sleep, some activity regarding the thoughts. It is known as to be Delta, Theta, Alpha, Beta which are lying in the different frequency range and having different shape structures. As many times shape structures get alteration due to superimposition of one wave on another knows as a polymorphic waveform which has illustrated in figure 2. All these signals frequency lying in the range of Hz and from1 Hz to up to some Hz. Its detailed description has given in figure 2.

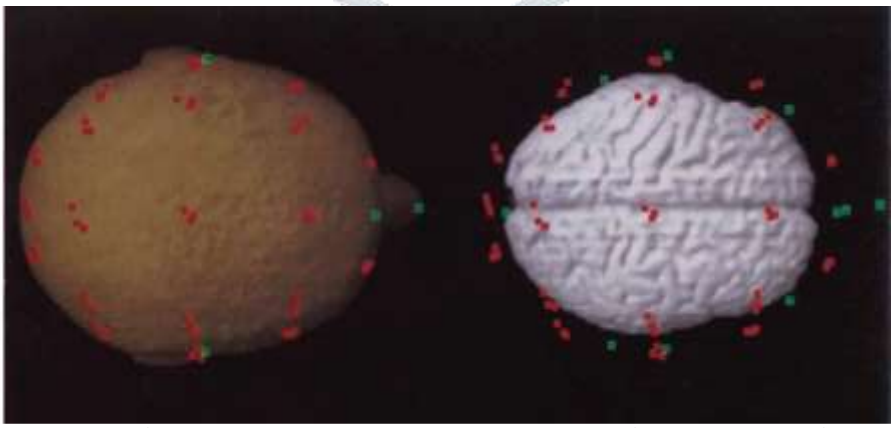

Figure 1. The location of a 10/20 system electrodes on 3D MRI reconstructions of the brain and scalp of the subject [4]

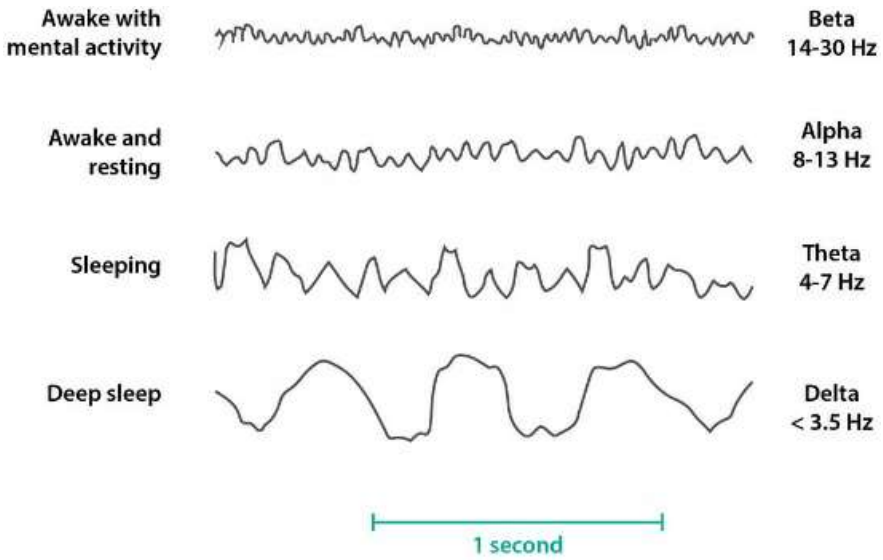

Figure 2. EEG Waveform and its characteristics [5]

Brainwave Type	Frequency Range	Mental State
Delta	0.1-3Hz	Deep dreamless sleep, unconscious
Theta	4-7Hz	Intuitive, creative, recall, fantasy, imaginary, dream
Alpha	8-12Hz	Relax but not drowsy, tranquil, conscious
Low Beta	12-15Hz	Relaxed yet focused, integrated
Midrange Beta	16-20Hz	Thinking, aware of self and surroundings
High Beta	21-30Hz	Alertness, agitation
Gamma	30-100Hz	Motor functions, higher mental activity

Table 1 : Brain States Associated with EEG Waveform [6]

2. RESEARCH METHODOLOGY

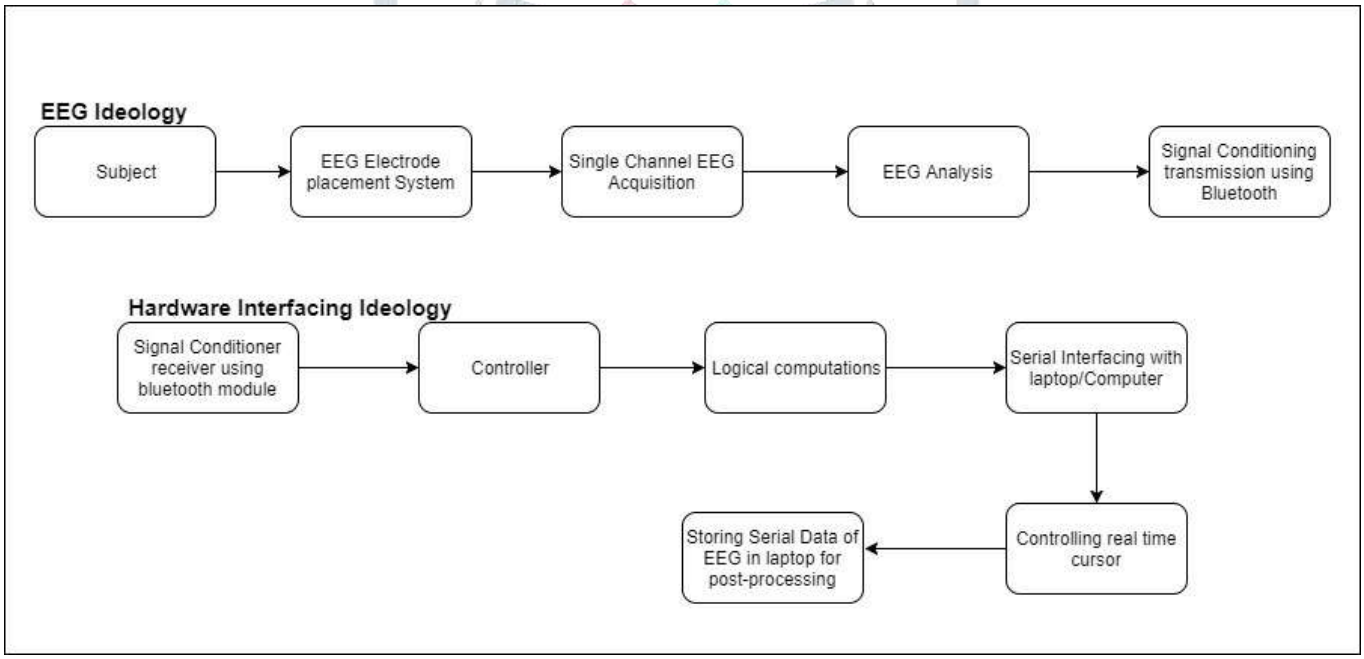

Figure 3. Real time Cursor control using EEG

The aforementioned Block-Diagram portrays typical information about the flow system of the Real-time cursor control using EEG. It has divided into two methodologies 1) EEG measuring Ideology (EEG Ideology) 2) Hardware Interfacing Ideology.

a) EEG measuring Ideology: It includes the basic fundamental part of the real-time cursor control using EEG Waves. As we have seen in the introduction that polymorphic signals are very complex to identify and classify. We had to make use of single-channel and additional multiplexers to perform activities based on computer software architecture. This can be called a monomorphic signal. We had employed the NeuroSky EEG acquisition module to readily acquire and transmits signals to the laptop via the controller.

1) Subject: We had implemented this experiment on our one of the team members with the oral consent. The subject is 23 years old and does not have abnormal mentality or abnormal physical health.

2) EEG electrode placement and acquisition: we had employed NeuroSky with single channel phase. It is easy to apply on the scalp. As NeuroSky is based on the monomorphic ideology, it is needed to ground that circuit by clipping ear with the hook type structure having metal spherical electrode on surface. Clipping ear with hook ensures that circuit becomes close and ready for the further operations.

Sr. No	Electrode Placement
1	Frontal polar 1 Fp1
2	Frontal polar 2 Fp2
3	Front polar 3 Fp3

Table 1: Place Selection for Electrode Placement

Although, NeuroSky gives a smooth filtered signal, in order to acquire signal by separate method includes designing of instrumentation amplifier with an appropriate filter that can only pass signal that is in the range of Hz while avoiding all other signals. This signal needs to get classification and identification based on a practical experiment.

b) Hardware Interfacing Ideology: It includes essential part that transcends simple computer to brain controlled computer by sensing EEG signals and sending command to software architecture. Figure 4 portraits the NeuroSky that can be worn on the scalp.

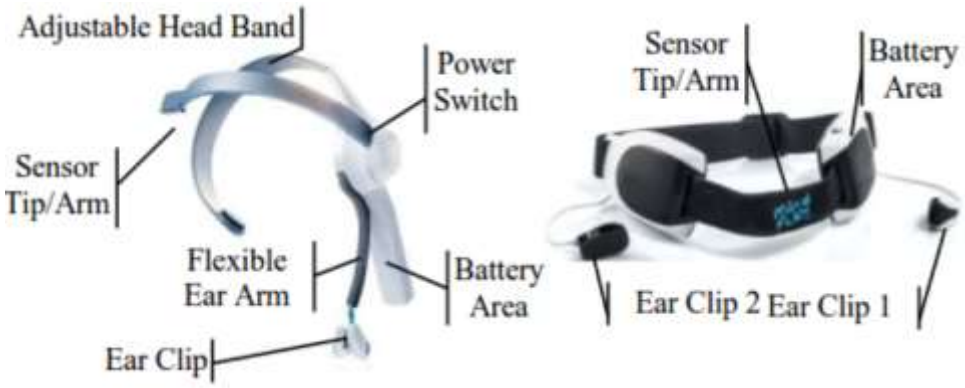

Figure 4. Neurosky Mindwave Mobile [7][8]

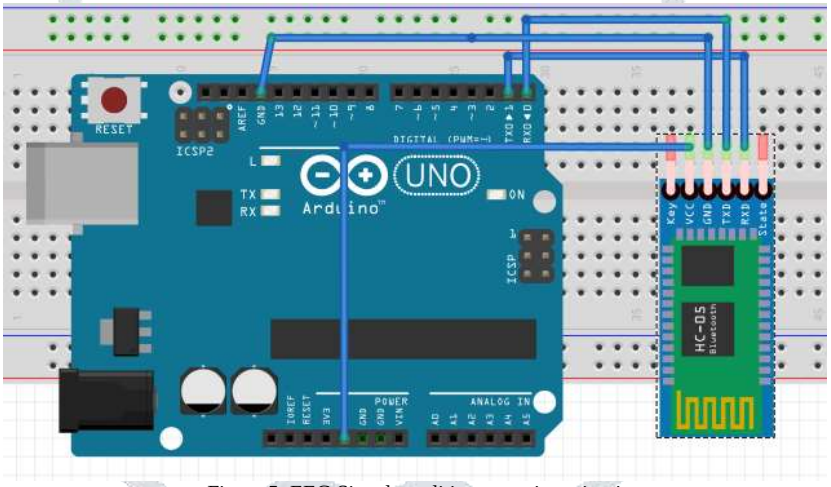

Figure 5. EEG Signal conditioner receiver circuit

BLEUTOOTH MODULE: We did employ Bluetooth module HC-05 and interfaced it with controller. In first stage, Bluetooth need to configure in such a way that it can search for the Neurosky automatically and pair with it. Therefore, Neurosky will work here as a slave control and Bluetooth module will works as a master mode. To configure Bluetooth module in to master mode, it needs to be get communicated with commands by entering it in command mode. Any serial software can be used to communicate and turn Bluetooth module in to the master mode as it is in slave mode by default.

CONTROLLER: Arduino has employed here to collaborate with HC-05 and empowered using 5V power source, as the subject has no direct contact with power supply it satisfies with the extremely safe position here. Controller working here as computational unit which communicate with both the terminals 1) EEG Neurosky 2) Serially with Computer/Laptop. In this way, controller becomes the link between the computer and the Neurosky.

3. RESULT

Monomorphic EEG signals can be gathered by placing Neurosky electrode on the frontal polar lobe Fp1 or Fp2. Both the polar lobe deals with the concentration of the subject. Therefore, if the subject is willing and striving for making the concentration on some action, this can be classified under customization to perform. Here, the Subject should not have mental disabilities or overstress during the operation of this novel technology. Hence Arduino can be interfaced serially with the computer cursor using the library mouse, it has been utilized here. Additionally, the movement of the cursor can be organized up to a certain horizontal or vertical axis by making use of extracted results of the Neurosky and computed algorithms. The result has computed here by using the LabVIEW software that has come with graphical programming.

CONVOLUTED POLYMORPHIC EEG DATA

In this Figure, standard figure has shown which portray information about the EEG Waves that are generated as a function of each and every waves mentioned in table 1. This can be estimate that the subject is active and having so much thought going on his mind. In order to control mouse, we need only particular brain waves that becomes active when person thinks something.

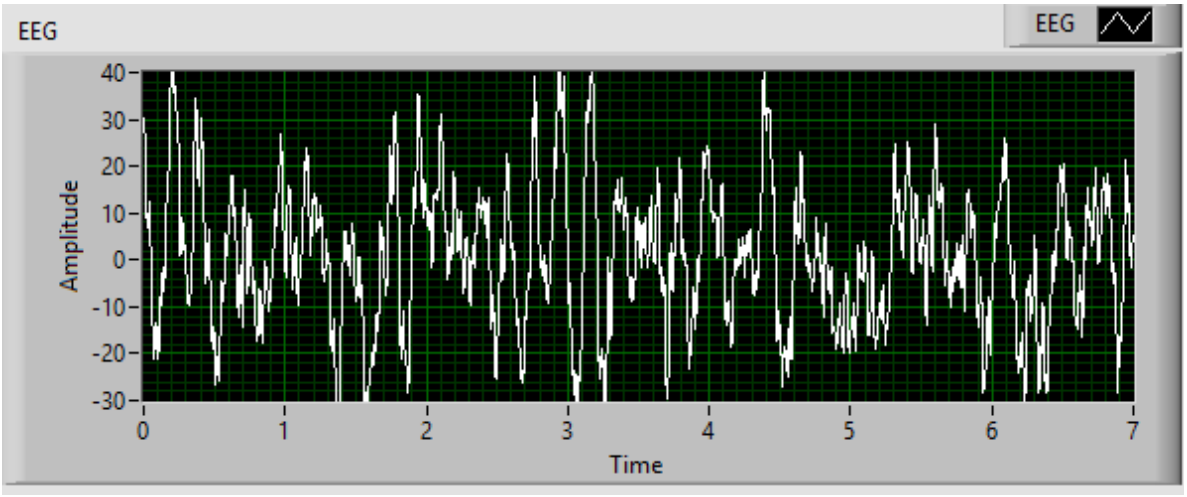

Figure 6. Actual (Polymorphic) EEG data gathered directly from the subject by placing multichannel electrodes.

Filtered and required EEG DATA

EMG signal are lying in the frequency range of 2Hz to several Hz, and most dominant EEG signal are lying in the range as portrayed on the table 1.

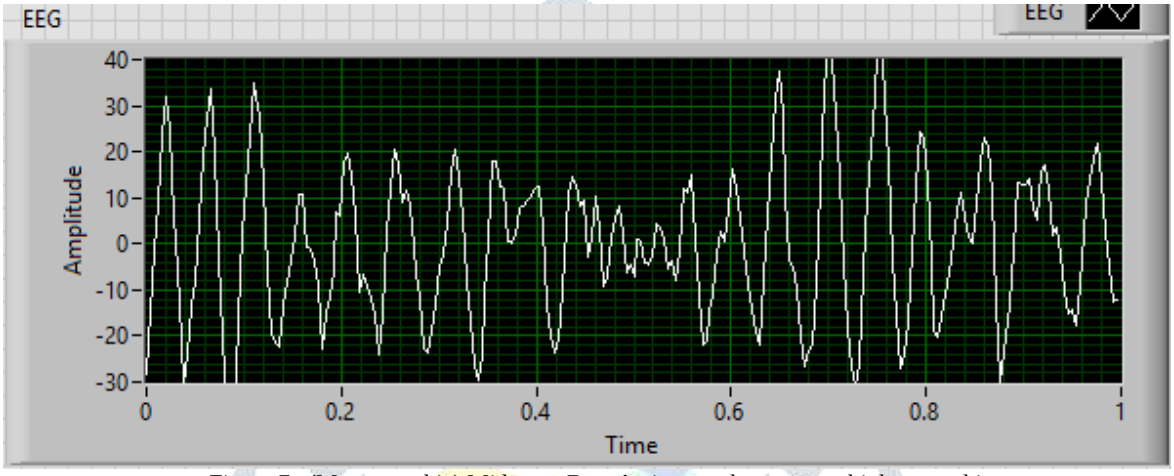

Figure 7. (Monomorphic) Midrange Beta Activates when person thinks something.

Time - EEG	Amplitude - EEG
0	11.4971
0.003906	-1.15454
0.007812	-10.237
0.011719	-18.9928
0.015625	-23.2162
0.019531	-17.7167
0.023437	-4.13609
0.027344	4.66501

Figure 8. Graph Statistics of the EEG signals.

Computational Algorithms

Midrange Beta signal has employed here to estimate when a person is trying to operate the mouse. The subject makes focus on the mouse and the mouse pointer gets movement. Algorithms have designed in such a way that if a person thinks to move mouse pointer for more than 3ms it gets shifted to 10mm horizontally. In the same way, if the subject tries to move the mouse pointer vertically he needs to press the external push button that will switch the axis and vertical movement will be handled by the controller.

4. CONCLUSION

In this research paper, we had derived the fundamental terms of the EEG. We have mentioned appropriate and standard methods of EEG based polymorphic signal. Although we had worked on the monomorphic signals as polymorphic EEG signals are superimposed and convoluted enough to work. We had control cursor of the laptop using this method. Similarly, we had sent data serially which get stored inside the computer as a log file, to cross-verify whether cursor has made any mistakes or makes any movement that is not relevant with the subject's thoughts.

5. DISCUSSION

The most critical part of this novel method was acquiring the EEG signal. Although we had utilized Neurosky Mindwave module which is a patented device for acquisition of the EEG. We had developed a pathway and provides a link in the form of a controller to control the cursor of the laptop/computer which can prove useful in many cases, such as playing games, determining attention level of subject with some customizations. The most useful case that could we list out is for disabled persons or persons having amputations. A person with an amputation can be extremely blessed or can get help with this novel method as operating computer

surely a challenging task for him/her. Technology portrayed here is based on the monomorphic EEG spectrum with real-time operation, it might have a time difference of milliseconds or microseconds that has been taken by the controller to communicate with laptop/computer. With higher baud rates this time gap can be decreased.

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