



EMBEDDING BRAIN WITH SMART DEVICES USING DEPRECIATED TECHNOLOGY

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Abstract— Embedding a brain with computer is a system that evolves and examines neural signals and that creates the direct nerve pathway between human brain and computer. This paper describes the processing activities with brain & peripheral devices. The proposed method controls the desktop application using FFT & thresholding schemes in MATLAB with 1 channel EEG amplifier and non-invasive tool. In this paper we highlight the capabilities of BCI system using depreciated technology.

Keywords— BCI; EEG; EOG; Artificial Neural Network; Smartphones

I. INTRODUCTION

Ability to control certain objects by simple thought is an attribute that is often depicted in science fiction movies that we are watching from many years. The issue of moving around this idea into science fact has become more and more popular over the last couple of years. In 1924, Hans Berger discovered electrical activity of human brain. He also established and developed EEG for the first time. Berger recorded EEG signal from human brain and analyzed that signal, from that he found the oscillatory activity in the brain. These waves are called alpha or Berger's wave, the frequency range for this wave is 8-12 Hz. This technology is very useful for paralyzed person. BCI is a technology is to augment human capabilities by enabling people to interact with a computer through their brainwaves after a short training period. BCI translates brain's electrical activity into messages or commands. It performs like a closed loop system where information is visually fed back to the user. EEG is the electrical signal that can be recorded from the brain, either directly or through the scalp by or from the electrodes. A useful way of observing human brain activity and a new communication channel is BCI [2] [3].

II. OPERATING PRECEPT

BCI operates as similar way like our brain works. As we know that human brain is filled with thousands of neurons and neurons are signal carriers in the brain that transfer information from sensory inputs of the body (eyes, ears, nose, tongue and skin) to the processing unit of the brain (hippocampus). There are normally four major blocks available in BCI system and these are as discussed below:

1. Signal acquisition, 2. Preprocessing, 3. Signal classification and 4. Computer/Application interface.

A. Signal Acquisition

The electric signals generated by the nerve cells are evolved and processed by the signal acquisition and processing techniques and devices. In general, there are two types of brain signal acquisition techniques:

1. Invasive method and
2. Non-invasive method

1. Invasive method- In this method of acquisition, the device is directly implanted or inserted into the brain scalp. The signals are generated and given to any computer or application interface. This technology has highest quality signals because when signals are generated they are immediately captured by chip which is implanted in the brain hence skull does not distort the signal. This technology provides one type of permanent solution for paralyzed patient who had lost the limb. But this method has high risk due to surgery and it is dangerous method [2].

2. Non-invasive method- This method does not need the surgery for implanting the chip but, electrodes are placed or mounted on cap or headbands. It is very preferable and portable method. Signals are generated by this method have poor quality due to the distortion generated by skull, but it is safer method compared to others. There are several technologies under non-invasive method which are EEG, functional Magnetic Resonance Imaging (fMRI), Magneto- Encephalogram (MEG), the Electro Cortico Graphic

(ECoG), P-300 based BCI etc. Among non-invasive BCIs, EEG are the electrical signals that can be recorded from the brain, either directly or through the scalp by hooking up the electrodes. On the scalp the amplitudes commonly lie within 10–100 μ V. EEG is the most popular method used from couple of years. EEG is simple and also easy to use hence it is advantageous for practical usage and also improves portability. [9][10].

B. Preprocessing

This block stands for first passes through a unity gain amplifier to boost the level of processing then analog to digital conversion, Digital signal processing part which analyzes the acquired and amplified digital signals. These signals are fed to Feature Extraction block where feature might be related to different parameters like time and frequency analysis, power density spectrum, Short time Fourier transform and etc.

C. Computer-Application Interface

Once the signals are classified, they will be used by an appropriate algorithm for the development of different applications. In this work, we are going to control AAKASH Tablet by using BCI. As we are thinking about media player, the tablet will operate the media player. Like this, we may be able to operate many other applications in Tablet. The schematic block diagram is shown here in figure 1 below.

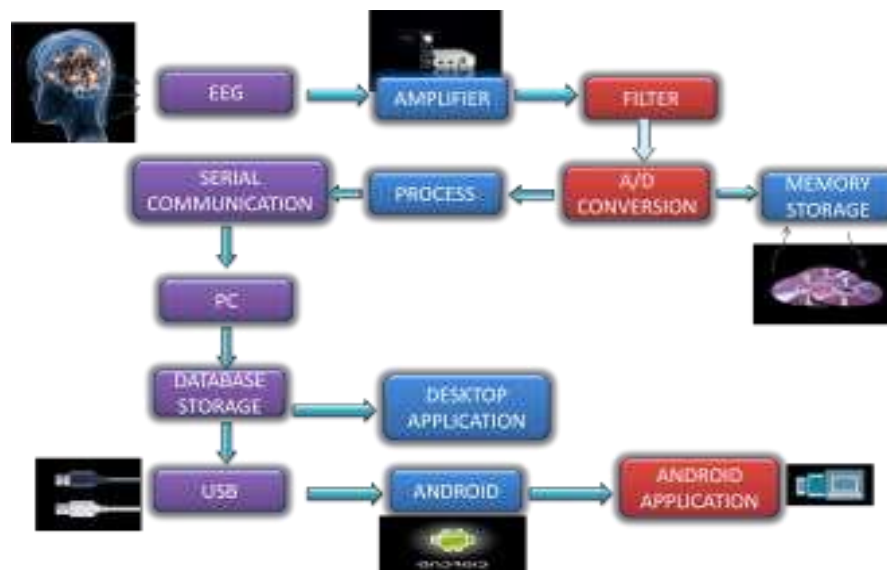


Figure 1. Schematic of BCI

III. APPLICATIONS OF BCI

One of the major applications of BCI is well suited on paralyzed person or for patient of comma. Intelligent prosthetics in which the person can live normal life using BCI who have lost their limb can be controlled by brain. When patient is locked-in state so used in virtual keyboard and can say control computer cursor by thoughts. BCI makes us able to control a video game by thought also. Disabled or handicapped person can work effectively and independently [4] [6]. Using this application to come out of depression [12]. Keim and Aunon developed a BCI system for patients with life-threatening physical impairment that enabled them to enhance specific code words. They placed electrodes on the whole surface of the scalp and by enabling the system to detect the difference in lateralized spectral power levels [13]. The most important application is to be expected in relation with cloud computing. What if, through BCI, we are continuously connected with internet via cloud? Also imagine that we can swap the Television channel via thoughts. Mind reading, in this non-invasive BCI has much higher potential. Imagine the power of being capable to read the person's mind. This would find tremendous application in future, all of which are imagine to hard now. As the intellectual ability of the person will be threatened, access to such mind-reading devices has to be very limited.

IV. IMPLEMENTATION

EEG Electrode Positioning

The International Federation of Societies for Electroencephalography and Clinical Neurophysiology has recommended the conventional electrode setting (also called 10–20) for 21 electrodes (excluding the earlobe electrodes), as depicted in Figure 2.

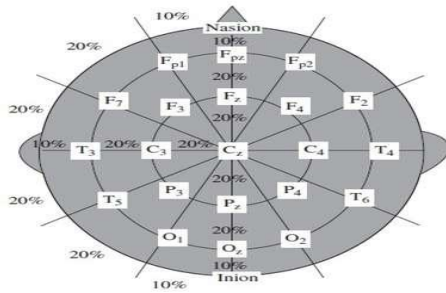


Figure 2. EEG10-20 Electrode Placement with 21 electrodes [27]

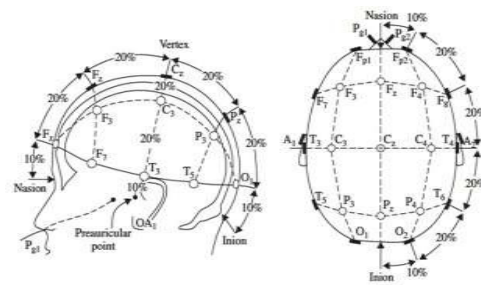


Figure 3. EEG10-20 Electrode Placements [27]

Often the earlobe electrodes called A1 and A2, connected respectively to the left and right earlobes, are used as the reference electrodes. The 10–20 system avoids both eyeball placement and considers some constant distances by using specific anatomic landmarks from which the measurement would be made and then uses 10 or 20% of that specified distance as the electrode interval [8]. The International Federation of Societies for Electroencephalography and Clinical Neurophysiology has recommended the conventional electrode setting (also called 10–20) for 21 electrodes (excluding the earlobe electrodes), as depicted in Figure 3. To make replicable setups, there are standardized sets of locations for electrodes on the skull. One of these sets of electrode positions or montages is the 10/20 system. To make the results of this experiment reproducible, this system is taken as a vantage point for determining a suitable electrode placement. The name of the system is derived from its method for finding the exact electrode positions. Head size is a variable measure [8]. RMS is simple software for the Portable EEG that implements an experimental Brain Computer Interface (BCI). Nowadays, BCI research is a highly active field, but the existing technology is still immature for its use outside of a lab's settings.

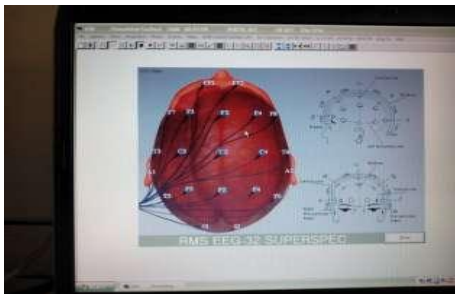


Figure 4. Electrode placement



Figure 5. Electrode placement and computer interface

By doing interfacing, brain with computer using 10-20 international electrode placement system, we can get below different combinational signals using RMS brain mapping software. Figure 4 shows the pattern of RMS Super Spec software which follows the 10-20 electrode placement system. Even numbers of electrodes are placed on the left part of the brain and odd numbers of electrodes are placed on the right part. Also in central part center electrodes are placed. Figure 5 shows the placed electrodes are interfaced with computer by portable EEG module and hence we can simulate and compare results.

V. RESULTS

After doing the interfacing of brain with computer using 10-20 international electrode placement system, we can get below different combinational signals using RMS brain mapping software. Here in Figure 5, the placed electrodes are interfaced with computer by portable EEG module and hence we can simulate and compare the results. When the person thinks about right arm of body and also the eye movement, the Occipital (O) and Frontoparietal (FP) lobes spikes are generated by motor cortex movement.

The O lobe is responsible for eye movements and the FP lobe is responsible for combine movements like thinking and motor movements. As respectively in Fig.6 and 7 there is shown results while thinking about left, upwards and downwards movement with accordingly eye movements. Here, FP1-FP3, FP2-FP4, FP2-F8 and FP1-F7 these all combinational Frontal and FP lobes have fluctuation while doing thinking. As we can see there is change or activity occurs in these lobes. Combination of T6-O2 lobes get fluctuated when there is eye movement occurs. Also when there is thinking with the eye open and eye movements, then P3-O1 and T5-O1 lobes are affected. And finally, when any one does thinking about left body movements and left side eye movements then we find activity in C4-P4, T4-T0, P3-O1 and T5-O1 lobes.

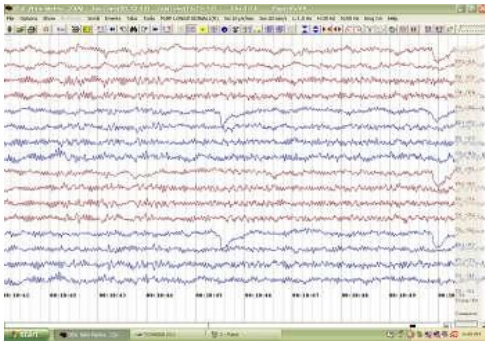


Figure 6. Waveforms while thinking

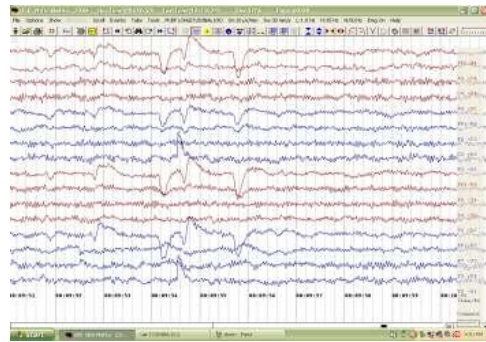


Figure 7. Waveforms while thinking about upside & upside eye movement

When anyone thinks about right body movements and right side eye movements, then there is fluctuation occurs in the P3-O1 and FP1-F7 lobes. Here we have used their customized software and electrodes. In this system we cannot communicate our hardware because of system limitation, we only get print out of that. Hence we will not be able to do real time device control by brain waves. In Figure 8, there is shown an isolated 1 channel EEG amplifier circuit which will be interfaced with Gold plated electrodes. We were facing one problem with 1 channel EEG circuit, which was isolation problem of Arduino and EEG amplifier circuit. It was because of Arduino is operated at 5V and amplifier circuit is at 2.5V. Hence by doing isolation, we have solved this problem. The isolation circuit is also shown in Figure 13. Now after getting acquired brain signal, we have done some analysis on it and found some definite waveforms for some specific events. In Figure 9 there is shown different output for specific events. The important point is that the waveforms change with person to person; hence it is too complicated to differentiate between two person's specific activities. This is because of one person's background thinking process is different from other person.



Figure 8. EEG circuit with Isolation

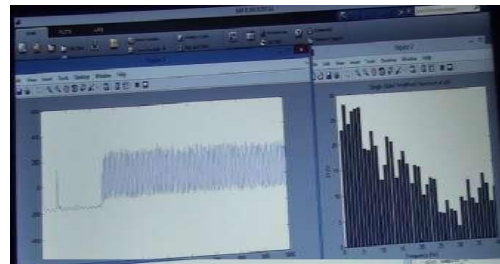


Figure 9. Acquired signal when relaxed

We have did some specific coding for different outputs, like below 12Hz it is relaxed and above that there is thinking or tension increases. As we know about 0-4Hz delta, 4-8Hz theta, 8-12Hz alpha and above 14Hz beta is present. So we will divide processes according to their frequency bands and after that we will do control commands to desktop application.

VI. CONCLUSION AND FUTURE WORK

The proposed system was implemented in such a way that, we can operate the most depreciated or debased technology which is not available in the market. By using the peripheral devices, we controlled the activities of the brain and we acquired brain waves by 1 channel EEG amplifier.

Right now work is progressing in the direction of depreciated technology using various channels.

VI. References

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