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Voice Assisting System Using Brain Control Interface

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ABSTRACT

This paper discusses the properties and temporal structure of the EEG signal with the aim of improving the accuracy of detecting mental states. Newly available, inexpensive, single-channel, dry-electrode devices makes electroencephalography (EEG) feasible to use outside the lab. We make use of trained classifiers to predict from the reader's EEG signal which is of the type the text read. The EEG signals associated with the word stimuli are analyzed for the existence of event-related potentials (ERP) that could distinguish the word type, which in turn could be exploited in classification. The various EEG signals from the brain are extracted, especially the MU and the Beta waves. The BCI can be used to interface the signals with the central nervous system. The signals emitted from the brain are taken and used to control the system. The intension of this project is to demonstrate the potential of exploiting the temporal structure of EEG signals in detecting mental states and to develop the equivalent codes for the analysed brain signals which are received during the thought of a single word so it helps people to be independent in expressing their thoughts in words.

Keywords**:** *EEG electrode, BCI, Text Read, Brain signals.*

I. INTRODUCTION

The brain is the most complex part of the human body each and every function, reflex, movement, thought and action performed by the human body is controlled by the brain. The signals and instructions for the whole human body are given by the brain. The simplest and complex functions and given and controlled by it.

Brain is divided into three sections: cerebrum, cerebellum, and brain stem [9]. The cerebrum part consists of left and right hemisphere with highly convoluted i.e. curved surface layer called cerebral cortex. The cortex is a dominant part of the central nervous system. Each cerebral hemisphere is formed of four lobes:

Frontal Lobe-Containing the motor area, Parietal Lobe-Containing the sensory area.

Temporal Lobe-Containing the area of hearing & memory, Occipital Lobe-Containing the area of vision.

According to the brain thoughts the patters keep changing in the brain. Delta waves has a frequency of 0.5-3 Hz and are found during sleep and deep meditation. Theta waves are of frequency 3-8 Hz and are found when a person is dreaming. Alpha has a frequency of 8-12 Hz and is found when the brain is in resting state. Beta waves are of frequency 12-38 Hz and is found when the state of brain is alert. Gamma wave are of range 38-42 Hz is related to expanded consciousness. Mu waves are of range 8-12 Hz are found in a very great amount and helps in attention.

The brain consists of millions of neurons which are interconnected. Some of the patterns of interaction between such neurons are represented as thoughts and emotions. In correspondence with the thoughts these

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pattern will change which in turn will produce different electrical waves. People with motor disabilities cannot perform the certain functions but the brain instructions still exist. So these instructions can be obtained by the brain signals through electrodes.

Neuroprothetics is an area where the nervous system is connected to a device. It uses the artificial devices to replace the function of impaired nervous system and brain related problems. The neural prostheses device can usually be linked to any part of nervous system but the accuracy of this is found to be low.Neural stimulation and recording can be used to communicate bi-directionally between the brain and external hardware.

The artificial pathways created by these neural interfaces have shown to be promising in replacing sensory and motor pathways lost due to neurological injury or disease [1], [2]. A multi-channel neural recording front-ends and neural stimulators has also been introduced for this application and compressed sensing, which allows a sampling rate lower than Nyquist rate without a significant sacrificing of the quality of the signal is also described so as to improve the wireless compatibility of the interfacing system. The wireless module in this increases the portability[3]. The primary goal of some brain-controlled mobile robots system is to help the paralyzed person by controlling robotic devices using the brain signals[4, 12].

The existing system consists of making a robot in assistance to disabled people in order to perform work independently. The sensor picks up ambient noise generated by human muscle, computers, light bulbs, electrical sockets and other electrical devices. Raw EEG data is a main source of information on EEG signals. The MATLAB section waits for three consecutive blink in order to send the Robot activation signal. Then based on the attention level value Robot Move Forward Command will be send to the Robot module through Zigbee transmission. After three consecutive blink, the program will scan for a left blink and right blink to turn the Robot right and left respectively. Brain characterization and visualization is experimented and presented in [10-11].

2. PROPOSED SYSTEM METHODOLOGY

This paper consists of the brain signals which are extracted from the temporal parts and are converted into text forms. The BCI system is thus used to form a bridge or an interface with the external system. The block diagram fig. 1, explains the proposed model more effectively.

The above block diagram describes the process of acquiring the signals from the brain through the electrodes.

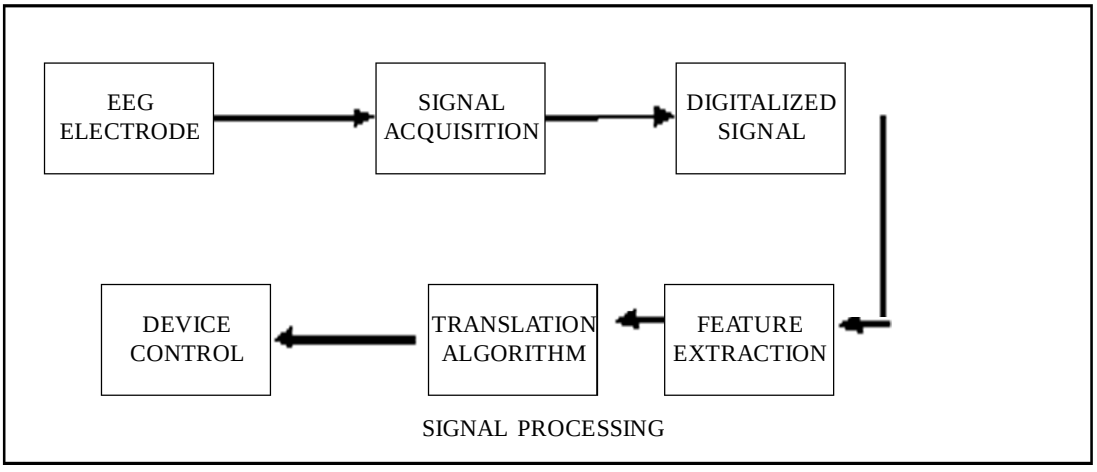


Figure 1: Block diagram for conversion of the thoughts signals to text format.

1. Eeg Electrodes: There are various electrodes which are used for acquiring the signals from the brain. Disposable EEG electrodes, Reusable EEG Electrodes, EEG CAP Electrodesare various types of electrodes used. We make use of mind wave headset fig. 2 it acts as a wireless USB adapter and also help in acquiring the proper signals from the brain. The sensor used to sense the brain wave in this system is MW001. This system works on battery for power. This enables to read the signals from the brain accurately and provide the output which is expected.
2. Signal Acquisition: Signal acquisition in a BCI helps in the measurement of brain signals using a sensor modality. The sensor is basically a device implanted in the brain usually multi-electrode arrays that records the signals directly related to the movement.

   The signal acquisition system consist of the following processes: Sense-Sensing the data reality by sensors, Condition-Analog signal conditioning, Acquire-Data acquisition system including analog-to-digital (Ad)conversion, Store-Data storage and display, Process-Digital signal processing to suppress noise and to extract specific information.
3. Digitalized Signal: Digitizing or digitization is the representation of an object, image, sound, document or signal (usually an analog signal) by generating a series of numbers that describe a discrete set of its points or samples. The result is called digital representation for the object. The term digitization is often used when diverse forms of information, such as text, sound, image or voice, are converted into a single binary code. Digitization performs discretization and quantization.
4. Feature Extraction: Feature extraction in Brain Computer Interface (BCI) is the process of analyzing the digital signals to distinguish signal characteristics and represent them in suitable form for translation into output commands. Feature extraction involves reducing the amount of resources required to describe a large set of data. We make use of Kullback-leibler divergence algorithm which is non-symmetric and does not satisfy the triangle inequality law so can be used for this process.
5. Translation Algorithm: Resulting signal features are passed to the feature translation algorithm, which converts the features into the commands for the output device (i.e., commands that accomplish the users need). It makes use of Gaussian Mixture Model and Maximum Likelihood Linear Regression.
6. Device Control: The commands from the algorithm are feed to the device which completes the loop of the brain computer interface. The device controller consist of the ARM microcontroller and a voice playback device which have a pre recorded voice of words and also of the signals related to these words, this helps in sensing the right word and acquiring it. This word is then let out through a speaker which is also attached to the voice playback device.

Figure 2: Mind wave headset used to acquire the signals.

3. BCI INTERFACE SECTION

BCI is popularly known by the names Brain Machine Interface (BMI), Synthetic Telepathy Interface (SMI), Direct Neural Interface (DNI), or by Mind-Machine Interface (MMI). At first this BCI work was carried out only on animals but now it is being done on humans which has helped to overcome many milestones which were only a mystery for science.

The interfacing of the software and the hardware is done using the BCI system i.e. brain computer interface. Interfacing requires a lot of effort as it is a equipment used for humans. Interface exist between several parts and it can be hardware and software interface. Hardware interfaces can be parallel with several electrical connections carrying parts of the data simultaneously, or serial where data is sent one bit at a time. This system interface is given below in fig. 3. The BCI system provides a link between the brain signals and the external device.

The most important application of this system is to energize the paralyzed organs or bypass the disabled parts of the body. BCI systems may appear as the unique communication mode for people with severe neuromuscular disorders such as spinal cord injury, stroke and cerebral palsy.

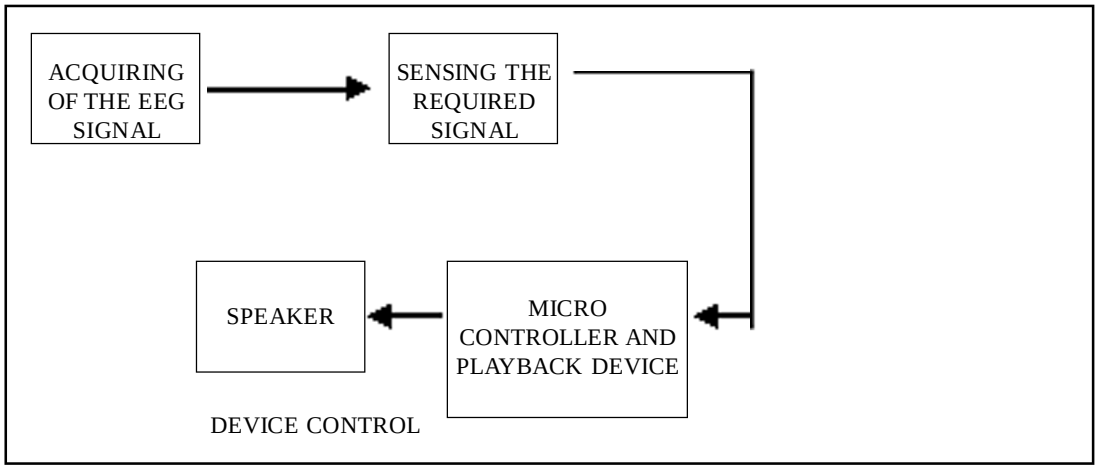


Figure 3: BCI interface section

It can also be used for sensory metric disorders and thus can be used to take the suppressed or available thoughts to be converted to text analyzing the acquired signal.

A BCI usually monitors brain activity via variety of methods, these are further classified as mentioned below.

1) Invasive BCI
2) Partially Invasive BCI
3) Non Invasive BCI

We make use of the non-invasive type thus using the wireless electrode technique. Further it can be classified under different categories based on which type of signals are used, whether invasive or non invasive, whether feedback is provided or not. Computer-based analyses reveal the mu rhythm in most adults. Some analyses also show that mu-rhythm activity comprises a variety of different 8–12 Hz rhythms, distinguished from each other by location, frequency, and/or relationship to concurrent sensory input or motor output.

Motor imagery is described as the mental rehearsal of a motor act without over movements by muscular activity, is assumed to involve to a large extent the same cortex areas that are activated during actual motor

preparation and execution. Similar brain signals, i.e. oscillations in the mu and beta frequency bands, are reactive to both motor imagery and observation of biological movement. There is evidence from functional magnetic resonance imaging (fMRI) studies that the observation of manual actions, such as grasping a cup and raising it to the mouth, is associated with activation of pre motor cortical structures.

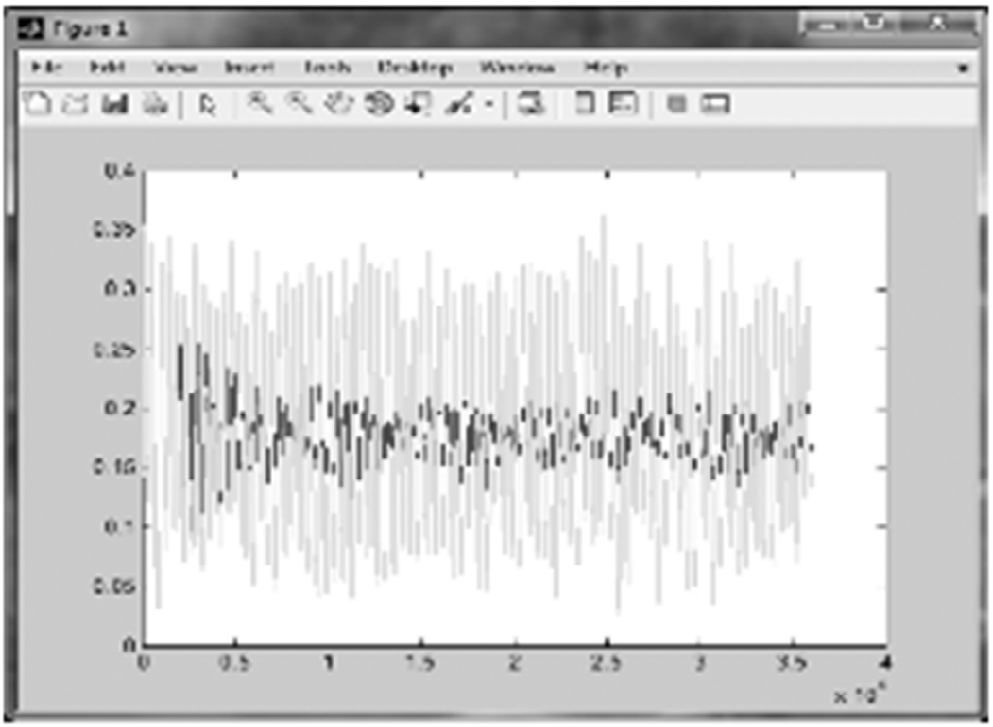
The EEG based BCI research is based on recording and analyzing EEG brain activity and recognizing EEG patterns associated with mental states. Since brain takes charge of each opposite side body, imagining a movement of the right hand is associated with a pattern of EEG activity in the left side of the motor cortex. Normally EEG signals of the right side is used to analyze the movement of the left arm and EEG signals of the left side brain for the right arm. Hence mental tasks are carefully chosen so that they activate different parts of the brain, which makes them easier to detect.

In general, the process of EEG signal analysis and classification consists of three steps: signal preprocessing, feature extraction and classification. The EEG signals recorded from the scalp electrodes are amplified, digitized, preprocessed and then these signals are subjected to one or more of a variety of feature extraction procedures, such as spatial filtering, voltage amplitude measurements, spectral analyses or single-neuron separation. Present BCI researches all over the world focuses on improving the speed and accuracy of BCI communication by implementing better feature extraction and classification algorithms.

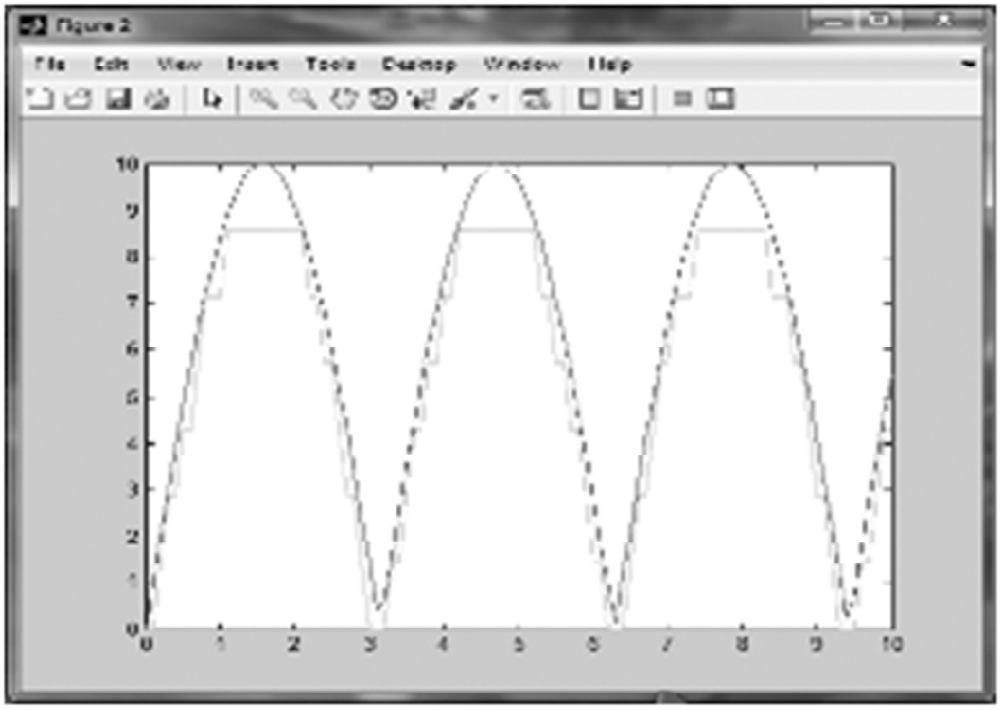
4. RESULT

Making use of the Matlab software we simulate the given signal to produce the desired output. When a word “INDIA” is thought in the brain, a signal is generated by the brain, we gather all the signals generated by the brain and take the required signals from them excluding the unwanted brain signals this is given in fig. 4 (a). It shows both the wanted and unwanted brain signals the required signals are indicated in between the large lines, i.e the small middle lines indicate the brain signals required.

These signals are then converted into digital form, as shown in fig. 4 (b) which is the converted signal in the digitalized form. The lines which are represented in between the sin waves are the required EEG



(a)



(b)

Figure 4 (a, b): The thought signals captured from the brain and converted.

Figure 5: Output text form

signal. This is taken before the feature extraction of the signal is done. In order to read this signal it has to be first coded. These signals can be coded as there is a set of codes which are used for this purpose of coding and the output of the word which is thought is given in the command window

The output "INDIA" is given in the command window indicating the output of the acquired signal. This brain signal acquired is given in command window as shown in fig. 5. The signal thus got from the brain are analysed and a word is produced with the help of the simulation software. This output is then given to the external playback device and given out through the speaker.

6. CONCLUSION

This paper describes a technique where the brain computer interface can be used to solve various problems that science still faces. The use of BCI system in acquiring the signals through electrodes and then interfacing

it with external device has proved to be quite a dream turn reality for disabled people. The people with sensory motor disabilities need not depend on others. The thoughts which are inside the brain can be collected using the wireless EEG electrode and can be analyzed.

These signals are pre stored for all the words, this is done by a predefined set where each word is thought and the signal is checked using two three people thus we create a set of all the words thought with its signal. This is then compared to the signal received from the brains of people with sensory motor disabilities. Then it is compared o the predefined set and then given out in the form of voice output using a voice playback device and a speaker. Thus using the BCI system can be useful for sensory motor disabled people and help them also express their thoughts freely in words to everyone.

REFERENCE

[1] L. R. Hochberg *et al.*, "Reach and grasp by people with tetraplegia using a neutrally controlled robotic arm," *Nature*, vol. 485, pp. 372-375, 2012.

[2] J. E. O'Doherty *et al.*, "Active tactile exploration using a brain-machine-brain interface," *Nature*, vol. 479, pp. 228-231, 2011.

[3] Xilin Liu, Milin Zhang, "The Penn BMBI: Design of a General Purpose Wireless Brain-Machine-Brain Interface System" IEEE transaction on biomedical circuits and systems, vol. 9, no. 2, April 2015.

[4] More Vrushali Shivaji, Sajid Shaikh, "Proposed System for Controlling of the Robot using the Brain Signal" Asian Journal of Convergence in Technology Volume1, Issue 6 Issn No.: 2350-1146, I.F-2.71, 2015.

[5] X. Perrin, "Semi-autonomous navigation of an assistive robot using lo throughput interfaces," Ph.D. dissertation, ETHZ, Zurich, Switzerland, 2009.

[6] "Current Trends in Graz Brain–Computer Interface (BCI) Research", G. Pfurtscheller, C. Neuper, C. Guger, W. Harkam, H. Ramoser, A. Schlögl, B. Obermaier, and M. Pregenzer, June 2000 vol. 8, no. 2, IEEE transaction on rehabilitation engineering.

[7] "A brain–computer interface using electrocorticographic signals in humans", Eric C Leuthardt, Gerwin Schalk, Jonathan RWolpaw, Jeffrey G. Ojemannand Daniel W. Moran 2004 Journal of neural engineering. J. Neural Eng. **1** (2004) 63-71.

[8] "Brain-Computer Interface: Next Generation Thought Controlled Distributed Video Game Development Platform", Payam Aghaei Pour, Tauseef Gulrez, Omar AlZoubi, Gaetano Gargiulo and Rafael A. Calvo, 2008 IEEE Symposium on Computational Intelligence and Games (CIG'08)

[9] M. Teplan "FUNDAMENTALS OF EEG MEASUREMENT" MEASUREMENT SCIENCE REVIEW, Volume 2, Section 2, 2002.

[10] Suresh Manic, K., Aravind, C.V., Saadha, A., Pirapaharan, K., "Implementation of real time brainwave visualisation and characterization" Journal of Engineering Science and Technology, Vol 10 Special issue 3, 50-59, 2015.

[11] Suresh Manic, K., Saadha, A., Pirapaharan, K., Aravind, C.V., "Characterisation and separation of brainwave signals", Journal of Engineering Science and Technology, Vol. 10 Special issue 1, 32-44, 2014.

[12] G.P. Ramesh, C.V. Aravind, R. Rajparthiban, N. Soysa, "A Body Area Network through Wireless Technology", International Journal of Computer Science and Engineering Communications, vol. 2, issue.4, August. 2014, pp. 432-437.