

Real Time Modelling of Electronically Linked Brain to Brain Communication in Humans using EEG Recording in the Motor Cortex Region and Raspberry Pi

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ABSTRACT: In this paper we will be discussing about the electronically linked Brain to Computer Interface (BCI) and Modelling of Computer to Brain interface (CBI) to achieve Modelling of Electronically linked Brain to Brain Communication (B2B) in humans. In this system, non-invasive technology is deployed to achieve conscious Brain to Brain (B2B) communication. At BCI site, data is transmitted using Electroencephalography (EEG), a non-invasive method to record electrical activity of the brain along the scalp. We are modelling the CBI system using the Raspberry Pi. The proposed system gives a clear picture about information transfer between brains to do away with language or can send thoughts from one brain to another brain in a way not represented by sounds or words. Connecting brains with computers as well as other brains is profoundly important as it will change human society in future communication technology.

KEYWORDS: Brain to Computer Interface (BCI), Computer to Brain Interface(CBI), Brain to Brain(B2B), Electroencephalography (EEG).

I. INTRODUCTION

The main function of the brain is to control all the organs of the body through a centralized control system. The brain acts on the rest of the body both by generating patterns of muscle activity and by producing chemicals called hormones. The existing system [2]-[5] for communicating information between brains uses invasive technology which has limited practical application. Instead, our proposed system models a non-invasive direct brain to brain communication using well developed BCI technology and modelling the emerging CBI technology. The functions carried out by brain are shown in figure 1. At BCI site, motor imagery is used, in which individual rehearses or mentally simulates a given action. This type of phenomenal experience implies that the subject feels herself/himself performing the action. The stimulations which generate brain waves are detected by electroencephalography (EEG). The data recorded by EEG are encoded and transmitted to Raspberry Pi.

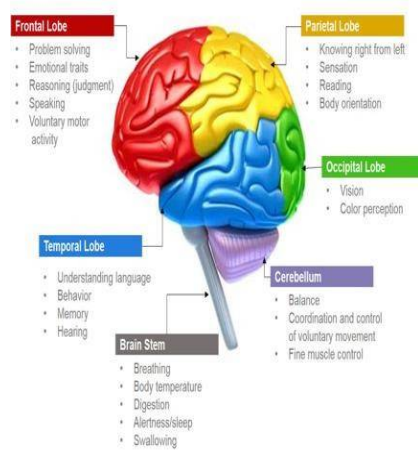


Figure.1. Functions of Brain

At CBI Site, The Raspberry pi is used to model the Brain in the Transmitted part. In normal Computer to Brain Interface, non invasive TMS or Trans cranial direct current stimulation (t DCS) technology is used to stimulate small regions of the brain.

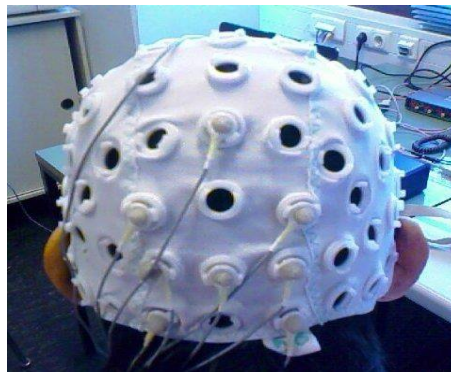
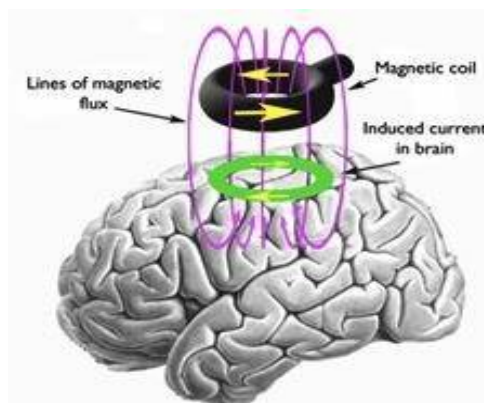


Figure.2. EEG Cap

During a TMS procedure, a magnetic field generator, or "coil" is placed near the head of the person receiving the data. The coil produces small electric currents in the region of the brain just under the coil via electromagnetic induction. The



coil is connected to a pulse generator, or stimulator, that delivers electric current to the coil as shown in fig 3. And in modelling, the Raspberry pi is programmed for acting as the brain. TMS is based on the laws of electromagnetic induction: a current passing through a coil of wire generates a magnetic field perpendicular to the current direction in the coil. A rapid change of this magnetic field creates or generates a transient electric field. This electric field affects the membrane potential of the nearby neurons, which may lead to depolarization and neuron discharging or interfere with the ongoing action potentials. In this project, a voltage is assigned for each activity and we have programmed the corresponding activity. So as in brain, the output of BCI is used to trigger corresponding activity in Raspberry pi. Using EEG and TMS technology, mental telepathy will be implemented based on existing internet system as shown in below figure 4.

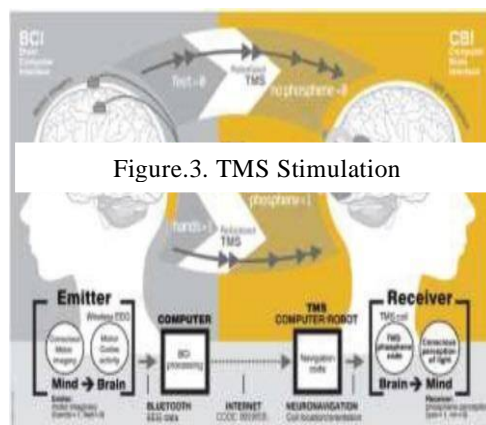


Figure.3. TMS Stimulation

Fig.4. Brain to Brain Communication (Courtesy PLOS one)

II. IMPLEMENTATION

In the proposed implementation, the EEG systems are used for data acquisition from the transmitter brain at BCI site. An electroencephalogram (EEG) is a test that is used for measuring and recording the electrical activity of brain. Special sensors known as electrodes are placed to head. They are connected by wires to a computer. The computer records brain's electrical activity on the screen. Despite limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis, especially when millisecond-range.

Temporal resolution (not possible with magnetic resonance imaging (MRI) and computed tomography (CT)) is required. The EEG waveform can be processed using freely available EEG software such as EEGLAB. EEGLAB is a MATLAB toolbox distributed under the free GNU GPL license for processing data from electroencephalography, and other electrophysiological signals. Along with all the basic processing tools, EEGLAB implements independent component analysis (ICA), time/frequency analysis, artifact rejection, and several modes of data visualization. EEGLAB allows users to import their electrophysiological data in about 20 binary file formats; pre-process the data, visualize activity in single trials, and perform ICA. Artifactual ICA components may be subtracted from the data. Alternatively, ICA components representing brain activity may be further processed and analyzed. EEGLAB also allows users to group data from several subjects, and to cluster their independent components.

The Raspberry Pi is a series of credit card-sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation. The Raspberry Pi 3 uses a Broadcom BCM 2837 So C with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache. The Raspberry Pi 3, with a quad-core Cortex-A53 processor, is described as 10 times the performance of a Raspberry Pi 1. This was suggested to be highly dependent upon task threading and instruction set use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelized tasks. The Raspberry pi 3 is assigned with different voltage levels for every motor activity. And it is acting as the second brain for computer to brain interface.

A. BRAIN TO COMPUTER INTERFACE

Brain-computer interface (BCI) is collaboration between brain and a device. The interface enables a direct communications pathway between the brain and the object. The captured signals are processed in the system using BCI 2000- software suite for brain-computer interface. It is commonly used for data acquisition, stimulus presentation, and brain monitoring applications. BCI2000 supports a variety of data acquisition systems, brain signals, and study/feedback paradigms. During operation, BCI2000 stores data in a common format (BCI2000 native or GDF), along with all relevant event markers and information about system configuration [6]. Brain pattern in motor imaginary for Binary Number 1 and 0 is stored from BCI site to CBI site via e -mail to be controlled. By reading signals from an array of neurons and using computer chips and programs to translate the signals into action, BCI can enable a person suffering from paralysis to write a book or control a motorized wheelchair or prosthetic limb through thought alone. Neurons and using computer chips and programs to translate the signals into action, BCI can enable a person to do things that he is unable to do by using only brain. Two anatomical landmarks are used for the essential positioning of the EEG electrodes: first, the nasion which is the distinctly depressed area between the eyes, just above the bridge of 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. By reading signals from an array of The electrodes. 10– 20 system or International 10– 20 system is an internationally recognized method to describe and apply the "10" and "20" refer to the fact that the actual 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 letters F, T, C, P and O stand for frontal, temporal, central, parietal, and occipital lobes, respectively. (Note that there exists no central lobe; the " C" letter is used only for identification purposes.) Even numbers (2,4,6,8) refer to electrode positions on the right hemisphere, whereas odd numbers (1,3,5,7) refer to those on the left hemisphere. A "z" (zero) refers to an electrode placed on the midline. In addition to location of scalp electrodes in the context of an EEG test or experiment. This method was developed to ensure standardized reproducibility so that a subject's studies could be compared over time and subjects could be compared to each other. This system is based on the relationship between the location of an electrode and the underlying area of these combinations, the letter codes A, Pg and Fp identify the earlobes, nasopharyngeal and frontal polar sites respectively.

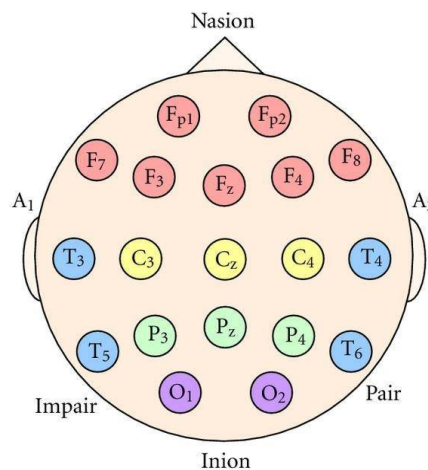


Figure.6. Position of electrodes

B. COMPUTER TO BRAIN INTERFACE

In CBI site, the modelling is done using Raspberry pi 3 module. The Raspberry pi module is programed in which different voltages will be assigned for different activities. Here the raspberry pi module can be used in two different ways. The main one is as a CBI and the second one is as a cyborg, that is a machine that can think and act according to the situation. Here, we will be giving commands using brain to computer interface to the raspberry pi module. But the module will not respond as in the command. Instead, it will check if there is a need of doing that activity. For example,

we will be assigning the command for switching on the light to one of the motor activities, which is the output of the BCI site. So this command will pass onto the raspberry pi module. But the Raspberry pi module will not Switch on light when it receives the command. Instead the raspberry pi module will check all the conditions when it get a command. It will check conditions like whether there is sufficient light in the surroundings or not . If there is sufficient light, the command will not work and it will give a display in LCD as there is no need of Light and even then if they want to switch on the light, they may have to change the mode from AI mode to Robotic mode. If there is not sufficient light, the command will activate the corresponding output. Here, the light will be switched ON. In this way the CBI part is modelled to get the output. This can be work as CBI site or as a cyborg who can take decisions only after checking the need for doing that activity. This has a major implication that energy conservation can be done more easily. Energy crisis will be one of the main p

IV. CONCLUSION

The review on the project is being done and the brain to brain communication with use of sensory or motor system is achieved with Raspberry pi module as the second brain. Two modes are used in the Raspberry pi module, they are Robotic mode and AI mode. The AI mode will be very useful in energy conservation. The Artificial intelligence mode and the Robotic mode can be switched according to the requirement of the user. AI mode is always preferred.

The project can be developed in two ways as

1. Modelling of Brain to Brain Communication.
2. Brain controlling machine which can take its own decisions according to the prevailing condition.

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