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INTERFACING MOBILE ROBOT WITH COMPUTATIONAL BRAIN

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Abstract: This project discusses about a brain controlled robot based on Brain–Computer Interfaces (BCI). BCIs bypass the conventional communication channels and translates different patterns of the brain activity into commands, to enable direct communication between the human brain and physical devices. The mobile robot can be controlled, using these instructions. Main objective of this project work is to develop a robot that can assist the disabled people in their daily life to do some of their works independently. There are millions of interconnected neurons in the human brain. The interactivity between these neurons are signified as thoughts and emotional states. The Brain Wave signal pattern changes according to the human thoughts, which in turn produces different electrical waves. The muscle contraction generates a unique Voltage signal. The Brain wave sensor detects the brain waves, converts the data into packets and transmit through Bluetooth medium. Level analyzer unit (LAU) receives and extracts the data from the sensor and processes the signal using MATLAB platform. Then, the control commands are transmitted to the robot module. With this entire system, a robot is operated corresponding to the human thoughts and it can be turned by the contraction of blink muscle.

***Keywords:** Brain Activity, Brain-Computer Interface, Electroencephalography (EEG), Level analyzer unit (LAU)*

1. INTRODUCTION

In recent days, Brain-Computer Interface (BCI) is an emerging technique that allows restoration of movement in the paralyzed limbs through the direct transmission of brain signals to the muscles or to external prosthetic devices. The BCI also known as a Brain-Machine Interface is a computer system that enables a person to control a computer or electronic device. The BCI can detect the wishes and commands of the user, by monitoring the brain activity of the user. Traditionally, the electroencephalographic activity or other electrophysiological measures of the brain functions are used as BCI. Messages and commands are not expressed not using the muscle contractions, but rather expressed by the electrophysiological phenomena such as evoked or spontaneous EEG features or cortical neuronal activity. The EEG is mainly used to evaluate the neurological disorders and investigate the brain function in the clinical applications.

There are two main approaches for the BCI to detect the user commands from the EEG. In the first approach, the subject concentrates on a few mental tasks (for example, imagining the left hand movement or the cube rotation). Concentrations on these mental tasks produce different EEG patterns. Then, the BCI can be trained to classify these patterns. In the second approach, the user learns about the self-regulation of their EEG response. The BCI is not trained as in the pattern recognition approach, but it detects for the particular changes in the EEG signal.

The BCI can perform classification of the mental tasks and provision of the feedback in the form of cursor control. It has also "reject" option, if the probability of the classification does not exceed some predefined level. The purpose of this chapter is to explain the concept of the BCI. First, the other part of the interface, the human brain, is examined. Then, the basic principles of electroencephalography (EEG) are explained. BCIs are divided into two above mentioned approaches. Then, the EEG measurement and the components of BCI system are defined. Feedback, human training issues and BCI performance measurement are explained afterwards.

This project discusses about a brain controlled robot based on the BCI. Main objective of this project work is to develop a robot that can assist the disabled people in their daily life to do some of their works independently. With this entire system, a robot is operated with respect to the human thoughts and it can be turned by the contraction of the blink muscle.

The rest of the paper is organized as follows: Section II describes the proposed methodology. Section III illustrates the results of the project. Section IV describes about the conclusion and future work.

2. PROPOSED METHODOLOGY

Depending on the level of consciousness, normal people's brain waves show different rhythmic activity. For instance, the different sleep stages can be seen in EEG. Different rhythmic waves also occur during the waking state. These rhythms are affected by different actions and thoughts, for example the planning of a movement can block or attenuate a particular rhythm. The fact that mere thoughts affect the brain rhythms can be used as the basis for the BCI.

DELTA RHYTHM**:**

EEG waves below 3.5 Hz (usually 0.1-3.5 Hz) belong to the delta waves. Infants (around the age of 2 months) show irregular delta activity of 2-3.5 Hz (amplitudes 50-100 _V) in the waking state. In adults delta waves (frequencies below 3.5 Hz) are only seen in deep sleep and are therefore not useful in BCIs.

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THETA RHYTHM:

Theta waves are between 4 and 7.5 Hz. Theta rhythm plays an important role in infancy and childhood. In normal adults theta waves are seen mostly in states of drowsiness and sleep. During waking hours the EEG contains only a small amount of theta activity and no organized theta rhythm.

ALPHA RHYTHM:

The alpha rhythm occurs at 8-13 Hz over the posterior regions of the head, generally with higher voltage over the occipital areas, during the resting state of the person. The amplitude of the alpha rhythm varies, but it is mostly below 50V in adults.

BETA RHYTHMS:

Beta rhythm is defined as any rhythmical activity in the frequency band of 13-30 Hz. The amplitudes of the Beta rhythm are often larger than 30V. Beta rhythms can mainly be found over the frontal and central region. A central beta rhythm is related to the mu rhythm. It can be blocked by motor activity and tactile stimulation.

2.1 EVENT-RELATED POTENTIALS (ERP)

Event-related potentials is a common title for the potential changes in the EEG that occur in response to a particular "event" or a stimulus. These changes are so small that in order to reveal them, EEG samples have to be averaged over many repetitions. This removes the "random" fluctuations of the EEG, which are not stimulus-locked. Event-related potentials can be divided into exogenous and endogenous. Exogenous ERPs occur up to about 100 ms after the stimulus onset. They depend on the properties of physical stimulus (intensity, loudness etc.). The potentials from 100 ms onward are called endogenous. They depend largely on psychological and behavioral processes related to the event. The most commonly studied ERP is P300. This positive deflection in the EEG occurs about 300 ms after the stimulus onset. P300 is commonly recorded during an "odd-ball paradigm". In it the subject has been told to respond to a rare stimulus, which occurs randomly and infrequently among the other, frequent stimuli. Evoked potentials (EPs) is a subset of the ERPs, that rise in response to a certain physical (visual, auditory, somatosensory etc.) stimulus. A typical evoked potential is the Visual evoked potential (VEP) that reflects the output features of the entire visual pathway. The EEG over the visual cortex varies at the same frequency as the stimulating light. Fig.1 shows the block diagram of the brain computer interface system.

This project discusses about a brain controlled robot based on the BCI. Main objective of this project work is to develop a robot that can assist the disabled people in their daily life to do some of their works independently. With this entire system, a robot is operated according to the human thoughts and it can be turned by blink muscle contraction. The BCI translates different patterns of brain activity into real time commands. A mobile robot can be controlled, using these commands. Level analyzer unit (LAU) receives and extracts the data from the sensor and processes the signal using MATLAB platform. Then, the control commands will be transmitted to the robot module.

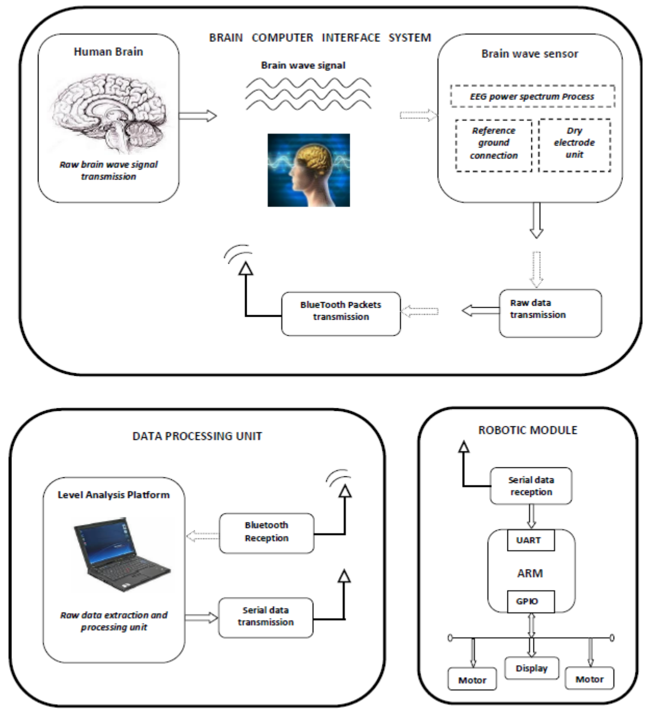

Fig.1 Block Diagram of brain computer interface system.

3. SIMULATION RESULTS

This section describes the simulation results of this project work. Fig.2 describe the initialization of the code that is checking for errors and if its over Its starts the execution of code.

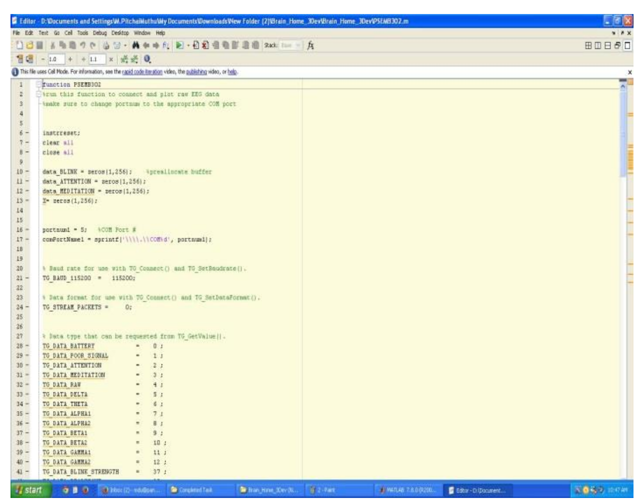

Fig.2 Initialization of Code

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Fig.3 describes the starting status of the code execution and eyes detection calculation. The calculation is done for every blink. The eye detection is calculates the depth of the eye blink these are sensed by the electrodes that present in the sensor.

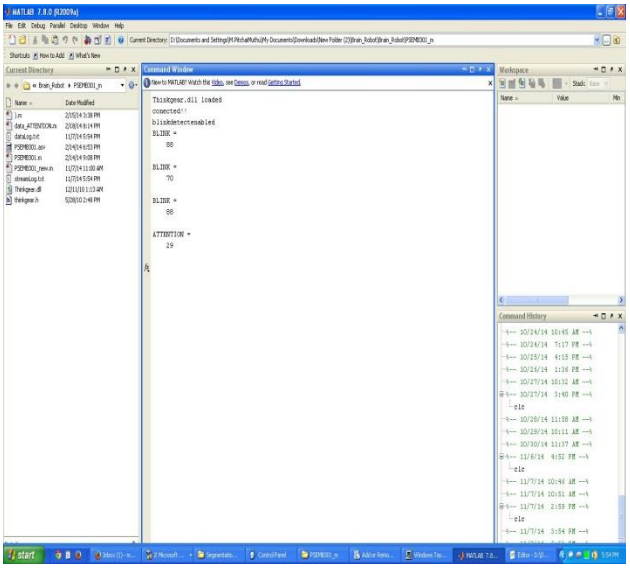

Fig.3 Calculated Depth of Eye Detection

Fig.4 shows the fully completed process of the attention level and the eye blinking level status. The wave with star marks the eye blinking depth detection and other wave is the level of attention of the person.

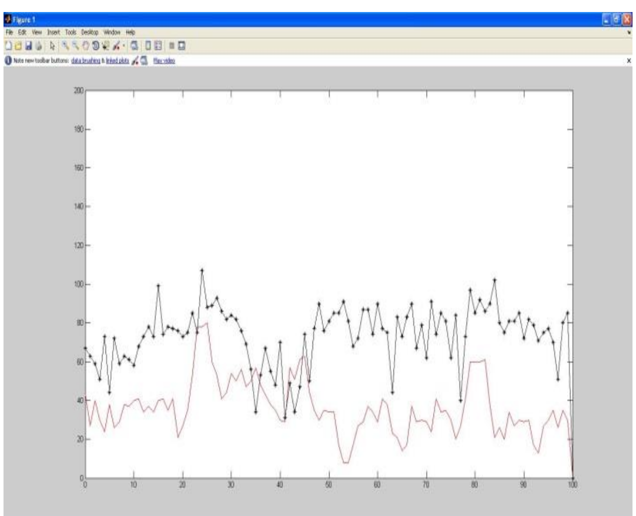

Fig.4 Completed process of the attention and eye blinking

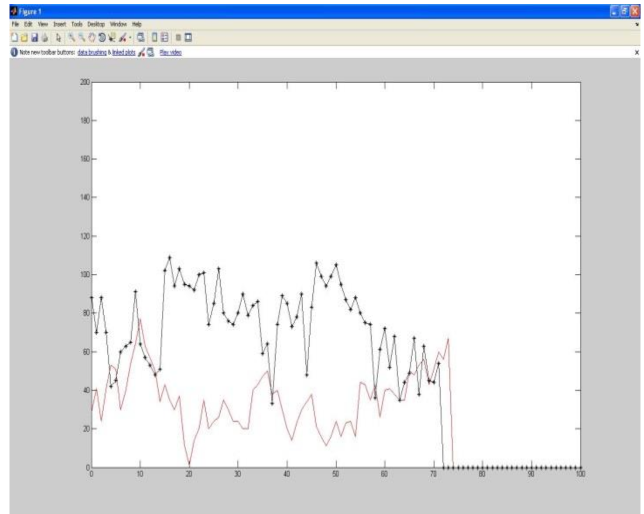

Fig.5 Incomplete process of the attention and eye blinking

Fig.5 shows the incomplete process of the attention level and the eye blinking level status. The wave with star marks the eye blinking depth detection and other wave is the level of attention of the person. The wave went completely down this may be occurs due the electrodes synchronization may be disconnected

4. CONCLUSION

This project discusses about a brain controlled robot based on the BCI. Main objective of this project work is to develop a robot that can assist the disabled people in their daily life to do some of their works independently. With this entire system, a robot is operated according to the human thoughts and it can be turned by blink muscle contraction. From the comparison of performance and training duration of various BCI systems, it is clearly observed that there is inadequate reporting of the results. Main requirement is the standardization of reporting the experiments and results. The results from each recording or training duration is presented, for the evaluation of the performance of the BCI system. The pattern recognition approach of the BCI seems to be more credible and requires much shorter training duration, when compared to the operant conditioning approach. However, high variability in the EEG patterns during the actual usage, will cause more problems with this approach. Currently none of the BCIs are capable of handling proper cursor control. In the future work, a comprehensive research about the mental tasks is required. Vast study about the left and right hand movements using high-resolution EEG and Magnetoencephalography (MEG) is planned in the future research. Localization of the brain activity during the mental tasks and study about the change in EEG with respect to time are also included in the future research topics.

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