EYE BLINK CONTROLLED ROBOT USING EEG TECHNOLOGY

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Abstract - This paper describes a brain controlled robot based on Brain–computer interfaces (BCI). BCIs are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time, with these commands a mobile robot can be controlled. In this paper the brain wave signals are analyzed and on the basis of Eye-Blink counts, the direction of the robot is controlled. The basic idea of BCI is to translate user produced patterns of brain activity into corresponding commands. A typical BCI is composed of signal acquisition and signal processing (including pre-processing, feature extraction and classification).

Keywords - Signal Acquisition, Feature Extraction, BCI, EEG

I. INTRODUCTION

Brain Computer Interface (BCI): often called a mind-machine interface (MMI) is a direct communication pathway between the brain and an external device. BCIs are often directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions. The field of BCI research and development has since focused primarily on neuroprosthetic applications that aim at restoring damaged hearing, sight and movement.

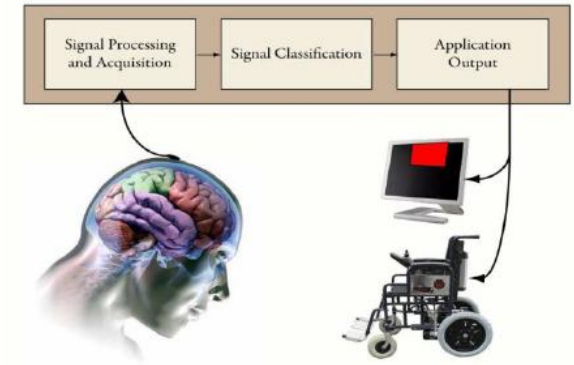

Fig. 1: General Structure of BCI System

The brain waves are extracted from the NeuroSky device placed on the scalp. These waves are then processed in the Matlab. The Arduino Mega 2560 is used as a robot controller. The device is programmed through the Matlab and the movements such as forward, backward, left and right are controlled based on the idea of Eye blinks. An electroencephalogram is a measure of the brain's voltage fluctuations as detected from scalp electrodes. It is an approximation of the cumulative electrical activity of neurons. Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost.

The different brain waves and its functions are given by the following table generally grouped by frequency (amplitudes are about 100 micro volts max)

Table 1: Brain Waves

State	Frequency (cps)	Amplitude (microvolt's)	Comment
Gamma	25-60	0.5-2	Hyper-aroused and dangerous to brain
Beta	12-25	1-5	Conscious brain state Fast de-synchronous activity.
Alpha	8-12	20-80	Conscious brain state Synchronous activity.
Theta	4-8	5-10	Usually Unconscious Slow rhythmic activity.
Delta	0.5 -4	100-200	Usually Unconscious Very large rhythmic activity.

The NeuroSky Mindset is a brainwave sensing headset which uses a medical grade probe to capture brain patterns and translate them into stuff you can do with a computer. The mindset module is shown in the below Fig.2

Fig. 2: NeuroSky Mindwave Mobile Headset

The neuroscience explore has incredibly expanded our insight about the cerebrum and especially the electrical signs radiated by neurons terminating in the mind. The examples and frequencies of these electrical signs can be measured by putting a sensor on the scalp. The Mindset contains NeuroSky think Gear™ innovation, which measures the simple electrical signs, generally eluded to as brainwaves, and procedures them into computerized signs to make the estimations accessible to restorative applications. ThinkGear is the innovation inside each NeuroSky

item that empowers a gadget to interface with the wear ears' brainwaves. It includes the sensor that touches the forehead, and contacts the reference points located on the ear pad, and the on-board chip that processes all of the data.

II. METHODOLOGY

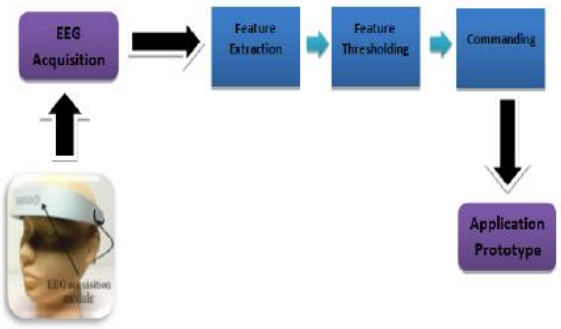

Fig. 3: Functional Block Diagram

The EEG sensor distinguishes and increases the little electrical voltages that are created by mind cells (neurons). The frequencies most ordinarily for EEG are between 1 to 40 Hz. The EEG sensor records a "crude" EEG flag, which is the continually changing contrast of potential between the positive and negative anode, and the product forms that flag by applying an assortment of computerized channels to the recorded flag, keeping in mind the end goal to concentrate recurrence space data. The EEG flag has different recurrence groups, including the "delta" band (0.5-4Hz), which compares to rest action, the "theta" band (4-8Hz), which is identified with laziness, the "alpha" band (8-13 Hz), which speaks to unwinding and inventiveness, and the "beta" band (13-25Hz),which relates to readiness. A reduction in the power changes in the "alpha" recurrence band and an expansion in the theta/delta recurrence band demonstrates languor.

The whole idea is as described below:

1. Mindwave mobile headset is paired with PC using Bluetooth.
2. The physical Robot is interfaced with PC(Arduino is connected to PC using UART cable)
3. The levels of attention are detected. If the attention level is below threshold, buzzer is activated and the Robot is stable. If the attention level exceeds the threshold value, eye blink detection is considered.
4. Based on the number of eye blinks, Robot is controlled.

For example,

1. If eye blink count =1, Robot is moved forward.
2. If eye blink count =2, Robot is programmed to move left.
3. If count=3, then it moves right.
4. Else if count =4, it moves backward.

Electroencephalography (EEG) equipment is becoming more available on the public market, which enables more diverse research in a currently narrow field. The Brain-Computer Interface (BCI) community recognizes the need for systems that makes BCI more user-friendly, real-time, manageable and suited for people that are not forced to use them, like clinical patients, and those who are disabled.

The principle center have been building a framework which empowers utilization of the accessible EEG gadget, and making a model that joins all parts of a working BCI framework. These parts are 1) getting the EEG flag 2) handle and order the EEG flag and 3) utilize the flag characterization to control a component in a framework. The arrangement technique in the venture utilizes the NEUROSKY mentality for section 1, the signs are prepared through the MATLAB and a fake neural system for ordering mind wave designs to some extent 2, and framework utilizes the characterization results to control the framework developments to some extent 3.

The objective of this paper is to pick up information in the two areas, i.e. Cerebrum Computer Interfaces, particularly techniques for examining mind waves, and the NEUROSKY EEG hardware. From this examination, a model programming application ought to be actualized that can read mind wave contribution from an EEG gadget, arrange them, and make them be a piece of the or the main, client contribution to a diversion. A basic illustration situation is as per the following: A client is wearing the NEUROSKY mentality that advances cerebrum wave signs to the product application. Keeping in mind the end goal to get general data about the client's cerebrum wave design, a progression of mental assignment situations must be executed by the client. This data will then be utilized to prepare a characterization framework so it can figure out how to perceive and in this way delineate mind examples to activities. The client can then begin a framework, and the arrangement framework will consistently dissect the approaching mind waves and guide them to the proper activities and in this manner control some feature(s) of the running framework.

A. Identifying Brain Activity Patterns

Brain Activity patterns can be identified based on the different waves described below with their frequency ranges.

Gamma waves are in the frequency range of 31Hz and up. It is thought that it reflects the mechanism of consciousness. Beta and gamma waves together have been associated with attention, perception, and cognition.

Fig.4:Gamma Wave

Beta waves are in the frequency range of 12 and 30 Hz, but are often divided into 1 and 2 to get a more specific range. The waves are small and fast, associated with focused concentration and best-defined in central and frontal areas. When resisting or suppressing movement, or solving a math task, there is an increase of beta activity.

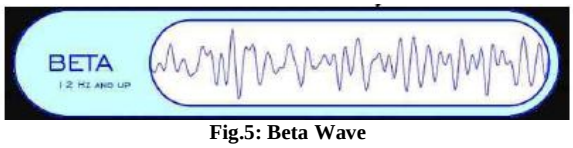

Fig.5: Beta Wave

Alpha waves, ranging from 7.5 to 12 Hz, are slower and associated with relaxation and disengagement. Thinking of something peaceful with eyes closed should give an increase of alpha activity. Several studies have found a significantly rise in alpha power after smoking.

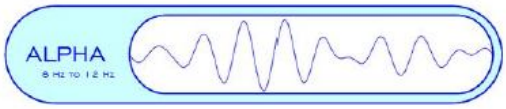

Fig.6: Alpha Wave

Theta waves, ranging from 3.5 to 7.5 Hz, are linked to inefficiency, day-dreaming, and the very lowest waves of theta represent the fine line between being awake or in a sleep state. Theta arises from emotional stress, especially frustration or disappointment. It has also been associated with access to unconscious material, creative inspiration and deep meditation. High levels of theta are considered abnormal in adults.

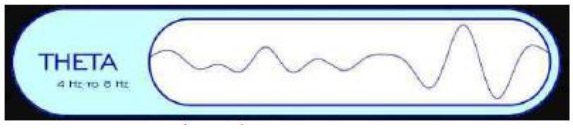

Fig.7: Theta Wave

Delta waves, ranging from 0.5 to 3.5 Hz, are the slowest waves and occur when sleeping. If these waves occur in the awake state, it thought to indicate physical defects in the brain. Movement can make artificial delta waves, but with an instant analysis (just observing raw EEG records), this can be verified or unconfirmed.

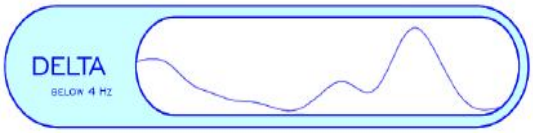

Fig.8: Delta Wave

B. Design Theory

1) Matlab Platform:

The MATLAB permits including ThinkGear. This environment has wide backing in tool stash, which makes it perfect for an experimental examination. This paper introduces how recording and preparing the crude EEG signal in MATLAB environment is done utilizing MINDWAVE sensor. The Communication Protocol demonstrates an arrangement of advanced guidelines for message trade between MATLAB environment and MINDWAVE MW001 gadget. This area likewise shows the fundamental parameters of think apparatus library.

2) Communication Protocol:

The proposed communications protocol is a system of simple rules for message exchanges between MATLAB and the EEG device. It consists of 7 basic steps, which are presented in following steps.

- Load ThinkGear library into MATLAB.
- Get a connection ID handle to ThinkGear.
- Attempt to connect the connection ID handle to serial port "COMx".
- Waiting to establish the connection.
- Read packets from the connection.
- Close the connection.
- Unload ThinkGear library.

3) Software Implementation:

Arduino (IDE): The IDE (Integrated Development Environment) is an exceptional framework running on your PC that licenses you to form traces for the Arduino board in an essential tongue showed after the Processing. The charm happens when you press the catch that exchanges the depiction to the board: the code that you have made is deciphered into the C vernacular (which is all around completely hard for a learner to use), and is passed to the avr-gcc compiler, a basic piece of open source programming that makes the last translation into the tongue fathomed by the microcontroller. This last walk is completely key, in light of the way that it's the place Arduino makes your life fundamental by concealing without end however much as could sensibly be anticipated from the complexities of programming microcontrollers.

The programming cycle on Arduino is basically as followed by Fig.9:

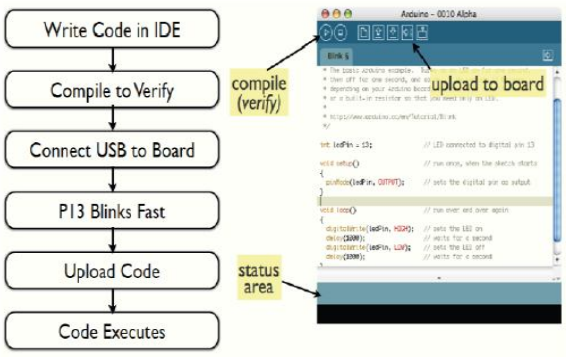

Fig.9: Programming Cycle on a Arduino

III. RESULTS AND DISCUSSIONS

In Arduino we build up a code for controlling the Robot. We have utilized Arduino Mega 2560 as our Robot controller. The Fig.10 demonstrates a piece of our code showing serial correspondence with character "A" for low sharpness.

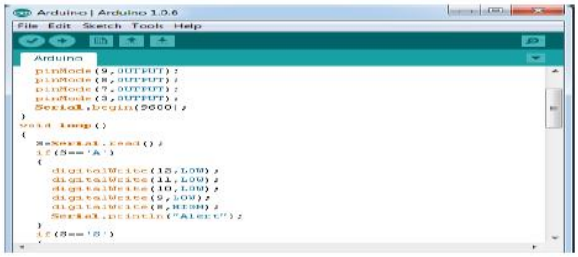

Fig.10: Snapshot of Arduino Code

The main code for reading brain waves, analyzing, classifying and commanding is written in the MATLAB. The Fig.10 shows a part of MATLAB code for reading brain waves of Attention level and Eye blink strength.

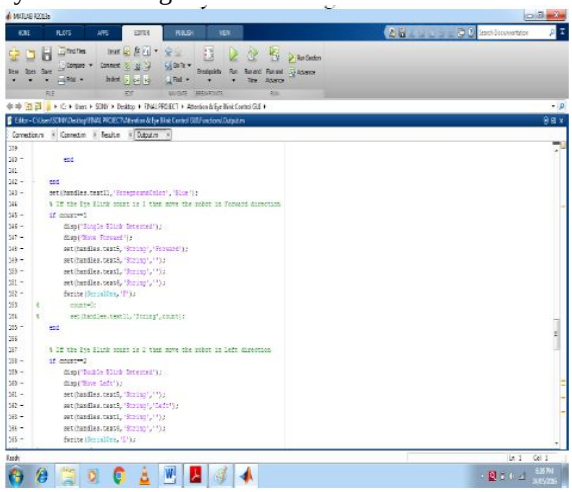

Fig.11: Snapshot of MATLAB code to read Attention and Eye Blink

The Fig.12 shows a prototype model for controlling the Robot by monitoring the brain signals using EEG technology.

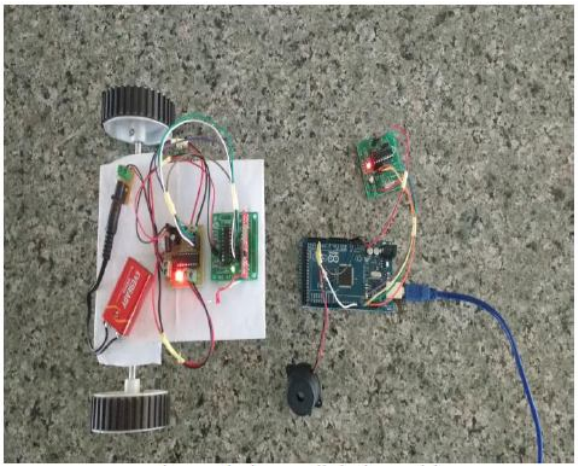

Fig.12: A brain controlled robot model

CONCLUSIONS

The innovative work of Mind-controlled framework have gotten a lot of consideration since they can take portability back to individuals with crushing neuromuscular issue and in this way enhance their personal satisfaction. In this paper, we displayed an extensive of the Mind-controlled System.

This paper utilizes a cerebrum wave sensor which can gather EEG based mind signs of various recurrence and adequacy and it will change over these signs into bundles and transmit through Bluetooth medium into the level splitter segment to check the consideration level and give sound sign to driver. The significant distinction between brain controlled framework and other personality controlled gadgets is that these frameworks require higher security since they are utilized to transport handicapped individuals. Numerous analysts have created different personality controlled framework utilizing distinctive BCI methods and in addition different procedures, for example, insight strategies (in detecting circumstances, limitation, and way arranging) and shared control systems in order to make these framework more secure

FUTURE SCOPE

Research on psyche controlled frameworks has accomplished numerous noteworthy achievements. Further work and achievement of this exploration would prompt the advancement of mechanical frameworks that can be utilized by debilitated clients, and accordingly enhance their versatility, freedom, and personal satisfaction.

In any case, much work remains to be done before cerebrum controlled system can be associated for all intents and purposes, including finding ways to deal with upgrade the execution (especially healthiness) of BCI structures, to improve the general driving execution given the objectives of the BCI system, and to set up standard appraisal methodology to support the inventive work of mind controlled system.

ADVANTAGES AND APPLICATIONS

- Monitor alertness, coma and brain death.
- Locate areas of damage following head injury, stroke, tumor, etc.
- Test afferent pathways (by evoked potentials).
- Monitor cognitive engagement (alpha rhythm).
- Produce biofeedback situations, alpha, etc.
- Control anesthesia depth (“servo anesthesia”).
- Investigate epilepsy and locate seizure origin.
- Test epilepsy drug effects.

- Assist in experimental cortical excision of epileptic focus.
- Monitor human and animal brain development.
- Test drugs for convulsive effects.
- Investigate sleep disorder and physiology.
- Accurate values since it directly measures the brain signals.
- Less time consumption to detect vigilance level compared to the method which detects physical changes.
- EEG has very high temporal resolution, in the order of milliseconds rather than seconds.
- Accident prevention by detecting driver's vigilance.
- May help to alert night duty security guards.
- It may be used to implement in cars for physically handicapped persons.

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