Brain Wave Controlled Robotic Arm

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Abstract
Paralysis is one amongst the major neural disorder that causes loss of motion of one or more muscles of the body, where in depending on the cause, it may affect a specific muscle group or region of the body or a larger area may be involved. In pursuit of rehabilitation, the eye can be regarded as one of the organs that can help a paralyzed person to communicate suitably. The Brain Signals of such patients can be used to help them communicate to others and also to perform various tasks by providing necessary infrastructure and training. This project describes the acquisition and analysis of Brain signals for operating a robot having a robotic arm mounted on top of it. The proposed method here uses a minimum number of electrodes for obtaining the brain signals using EEG Headsets available in the market and then control a robot based on the levels of these brain signals which can be varied by varying the states of mind. The EEG Headset detects the signals and generates a discrete value. This value is then sent over Bluetooth to a PC/Laptop for further processing and plotting using MATLAB. After processing the actions to be performed are sent over ZIGBee to the ARM Microcontroller that controls the robot as well as the robotic arm mounted on the robot.

Keywords
EEG, BCI, Prosthetic

I. Introduction
The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium [1]. Level LAU will receive the brain wave raw data and it will extract and process the signal using Mat lab platform. Then the control commands will be transmitted to the robotic module to process. With this entire system, we can move a robot according to the human thoughts and it can be turned by blink muscle contraction.
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) [2]. Although some BCI systems do not include all components and others group two or three components into one algorithm, most systems can be conceptually divided into signal acquisition, pre-processing, feature extraction, and classification The brain signals that are widely used to develop EEG-based BCIs include P300 potentials, which are a positive potential deflection on the on-going brain activity at a latency of roughly 300ms after the random occurrence of a desired target stimulus from non-target stimuli the stimuli can be in visual, auditory, [3] or tactile modality SSVEP, which are visually evoked by a stimulus modulated at a fixed frequency and occur as an increase in EEG activity at the stimulus frequency and the ERD and ERS, which are induced by performing mental tasks, such as motor imagery, mental arithmetic or mental rotation [4].
Although many researchers have developed various brain-controlled mobile robots, to the best of our knowledge, none of the existing brain-controlled mobile robots is brought out of a controlled laboratory environment. The main reason for this is that the BCI is not stable due to the non-stationary nature of the EEG signals. Thus, to make these mobile robots usable in real-world situations, stable BCI systems need to be explored.
If a BCI system is not stable, other techniques should be further developed to improve the overall driving performance. Rebsamen et al., Iturrate et al. also combined a P300 BCI and an autonomous navigation system to develop a robotic wheelchair. The main difference between them is that the latter allows a wheelchair to move in an unknown environment. In addition, the user is able to control the wheelchair to turn left or right at any time by focusing his/her attention on the "turn left" or "turn right" icons at the lower section of the visual display to elicit a corresponding P300.

II. System Design
We divide brain-controlled mobile robots into two categories according to their operational modes. One category is called, "direct control by the BCI," which means that the BCI translates EEG signals into motion commands to control robots directly who first developed a brain-controlled robotic wheelchair whose left or right turning movements are directly controlled by corresponding motion commands translated from user brain signals while imagining left or right limb movements.
The robotic platform is illustrated also used a BCI based on motor imagery to build a brain-controlled mobile robot, as illustrated which can perform three motion commands including turning left and right and going forward and validated this robot in a real world.

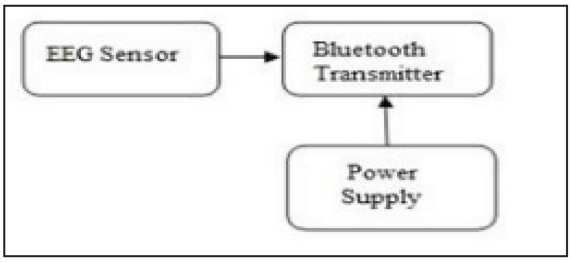

Fig. 1: Brain Secret Card Section

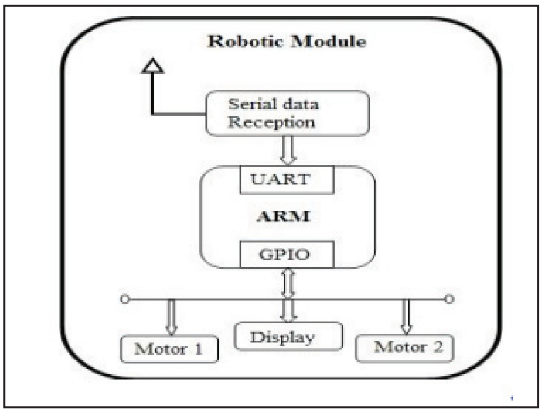

Fig. 2: Brainwave Headset Provided by NeuroSky

As shown in fig. 1 the Brain secret card section contains EEG Sensor to Sense the Human brain, and it will be sensed by using the Brainwave Headset which is provided by NeuroSky. Technologies and those signals will be transferred by using Bluetooth which is there in the Brainwave headset, for this Brainwave headset we need to give power using a AAA battery which is shown in figure 1.The Brainwave headset comes with Power switch, a sensor tip, flexible ear arm and a ground connection Ear clip. In this Headset we use Non-invasive sensor that won't cause any pain to the User who were the headset. After inserting an AAA battery switch on the Brainwave headset using the power switch the LED indicator will blink and if the Red colour light not blinking the headset is powered on but not connected to with the computer's Bluetooth.

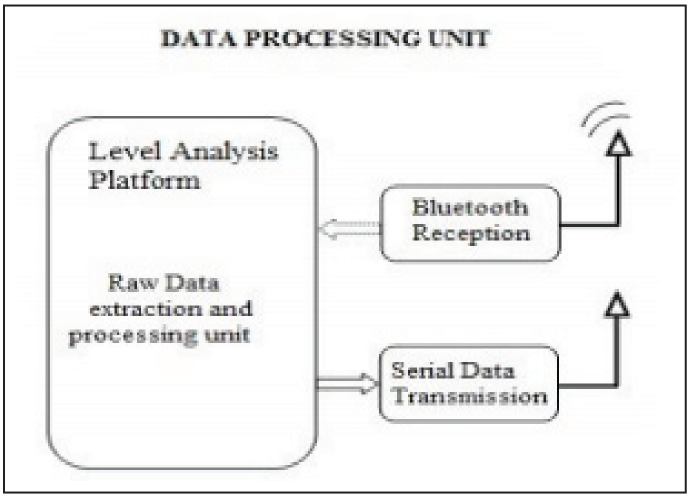

Fig. 3: Data Processing Unit

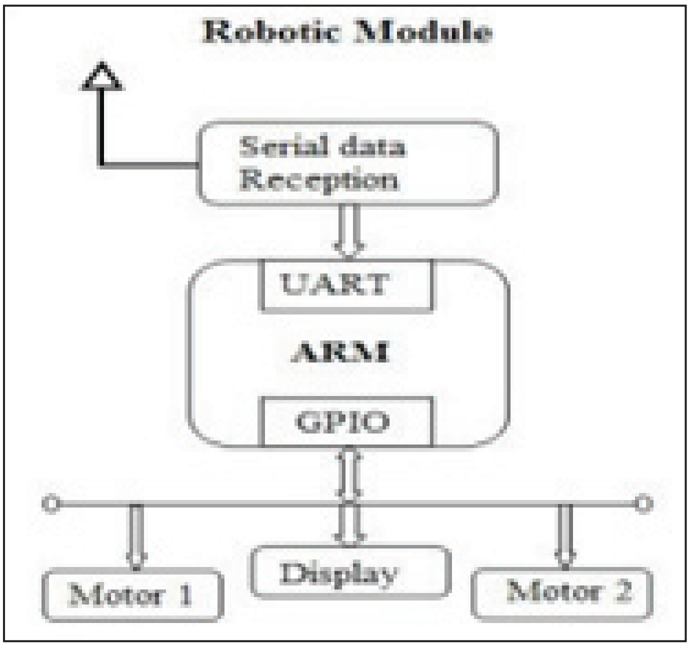

Fig. 4: Robotic Module

As shown in fig. 3 the Data transmitted by the Brainwave headset will be received by the Computer's Bluetooth receiver. And then all these data will be analyzed by the Level Analysis platform. The Level Analysis platform will extract the raw data using the MATLAB. After the analysis of this data, this data will be sent to the robot module using serial data transmission i.e. using XBee.

As shown in fig. 4, in the robot module there will be an XBee receiver will receive the data which is transmitted by the XBee transmitter. According to the data received by the XBee the ARM processor will give the directions to the motors and the robot is self-controlled robot with ultrasonic sensor and connected with a relay and a driver circuit. And all this information will be displayed on the LCD display.

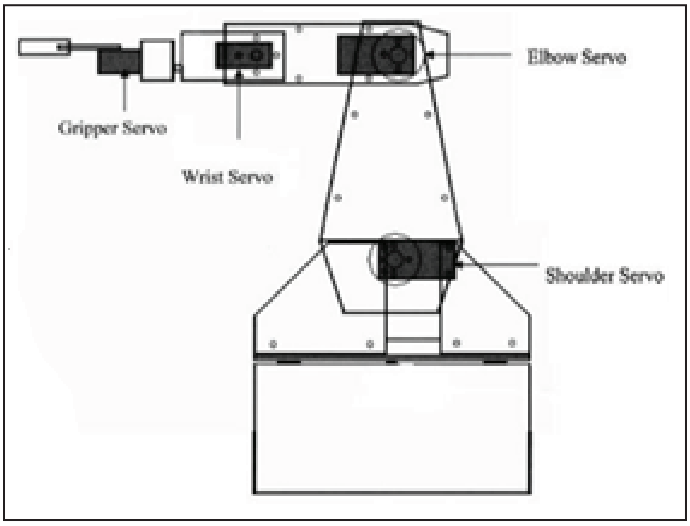

Fig. 5: Design Overview of Prosthetic Arm

Based on the cad file design components are assembled. In gripper design the standard wheels are used to give support to the whole mechanical assembly. One wheel is connected with servo motor shaft and another wheel is dummy. The shaft dummy wheel is automatically rotated. The total system was controlled using three servo motors. Two types of servo motors are used they are SERVO MOTOR V0006 and SERVO MOTOR VTS08A. The maximum angle of the servo motor is 180 degrees. Wooden box (switch box) is used as the base to hold the prosthetic arm. The wrist is prosthetic arm body to move freely up and down the prosthetic arm. The wrist is connected to base and one servo motor. The gripper is used to pick the object (similar to hand fingers). The maximum gripper open is 9.3 cm for 180 degree and close position is 1.0 cm for 0 degree. The gripper is connected with one servo motor and used to pick and place the object.

III. Experimental Study

Mind-Waves are more precisely the ability of the mind to focus and to concentrate to control the prosthetic. This is accomplished by using an inexpensive EEG reader that can be worn on the head. This external device is in contrast to current expensive devices that require an implanted electrode in the arm and requires more training for effective purpose. Also, some of the more expensive prosthetics require myo-electric impulses to control the actuators. The Arduino Prosthesis is an prosthetic arm that uses a microcontroller(Arduino YUN) to measure the brainwaves registered by an EEG headset (Neurosky Mindwave Mobile), and has six servos in the arm(4-v0006 & 2-VTS08A) to control the prosthetic arm. The components are open-sourced and available at low cost compared to other devices.

When the user concentrates hard enough, their brainwaves cause the arm to rotate. The Arduino Prosthesis is a creative innovation because it is less expensive than other prosthesis, and can be expanded beyond its original parameters. If something could happen to it, the microcontroller and servos can be quickly replaced, and the rest of the prosthetic arm can be repaired or restored to its original specifications. This is a prototype that can

ISSN : 2230-7109 (Online) | ISSN : 2230-9543 (Print)

be replaced with high power servo motors to make the arm more functional exactly like a human arm.

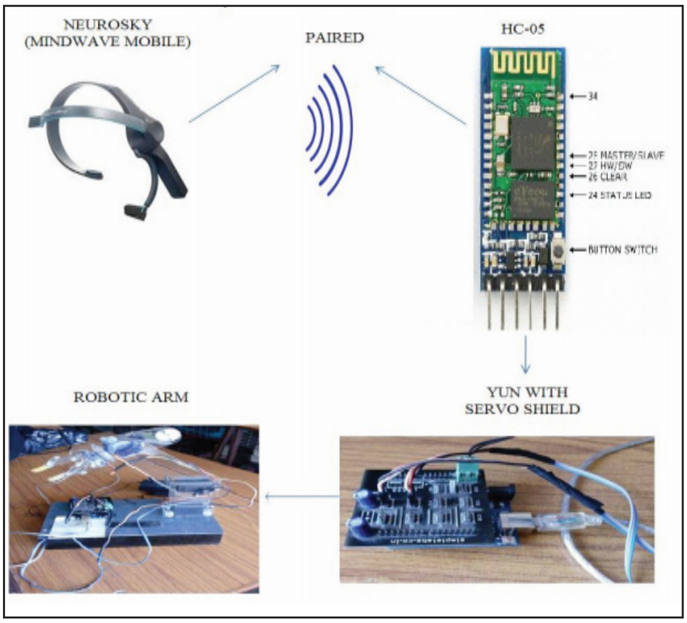

Fig. 6: System Architecture

IV. Methodology

It is basically a Brain Computer Interface (BCI) System. A BCI is a non-muscular communication channel that enables a person to send commands and messages to an automated system such as a robotic arm or prosthetic arm, by means of his/her brain activity.

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). One of the most important features in a BCI system is represented by acquisition. The most spread acquisition technique is EEG, and it represents a cheap and portable solution for acquisition. The EEG technique assumes brainwaves recording by electrodes attached to the subject's scalp. EEG signals present low level amplitudes in the order of microvolt and frequency range from 1 Hz up to 100 Hz. Specific features are extracted and associated with different states of patient brain activity, and further with commands for developed applications. Using EEG one more drawback can be eliminated (i.e. dangerous surgery can be avoided for invasive method where electrodes are placed inside of brain called implants).

The EEG Headset or the Brainwave Sensor detects the electrical signals from the brain and sends them in the form of data packets to a PC/Laptop via Bluetooth. This received data is processed in MATLAB and the control commands are then transmitted to the Arm via RF. Based on the data received by the Microcontroller from the PC/Laptop it performs certain predefined actions based on the level of concentration as shown in Table 1 below.

Table 1: Commands of the proposed Robotic Arm

Commands	Extracted Signal
Move Arm in Forward Direction	Attention:20-45
Move Arm Upwards	Attention:45-70
Move Arm Downwards	Attention:70-95
Move Arm towards Right	Meditation:20-45
Move Arm towards Left	Meditation:45-70
Close the Claws of the Arm to hold an object	Meditation:70-95

V. Block Diagram

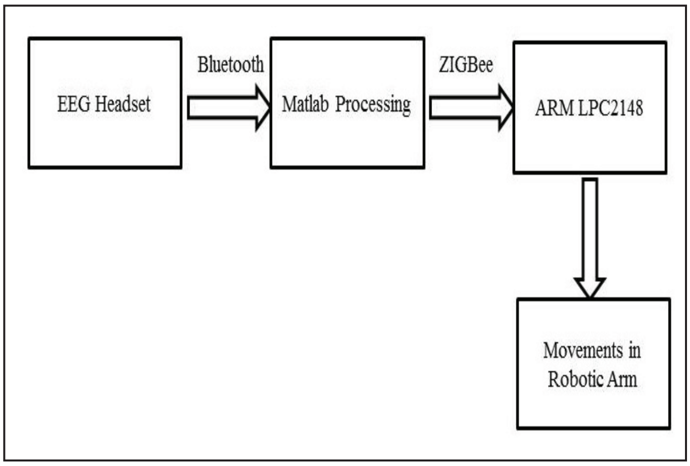

Fig. 7: Block Diagram of Proposed System

V. Application of the Project

It can be used as a Smart Prosthetic for physically challenged persons that can help them to move objects by interpreting the Brainwaves of the user. The same can also be used in Industries and companies to provide employment to physically challenged persons.

VI. Expected Outcome of the Project

The arm must turn out to be an efficient prosthetic aid at a lesser price compared to costlier Myoelectric Prostheses. Must be able to move light weight objects from one place to another as interpreted from the brain waves of the user.

VII. Acknowledgement

We are very much thankful to Prof. T Deepa, HOD, Dept of ECE, BTI, Bangalore for being supportive, technical assistance and for the continuous encouragement and insightful suggestions which helped us to successfully complete this paper. We extend our gratitude thanks to Dr. H S Nanda, Principal, BTI, Bangalore and also teaching staff and management for their moral support and encouragement during this work.

References

[1] Siliveru Ramesh, K. Harikrishna, J. Krishna Chaithanya, "Brainwave Controlled Robot Using Bluetooth", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 8, August 2014.

[2] Arul Prasath, Harihara Ganesh S, Hariharan B, Hariharan, "Interaction of Human with Robotic Arm", International Journal of Innovative research in Computer and Communication Engineering, Vol. 4, Issue 3, 2016.

[3] S.Nasrin Banu, S.Syed Rafiammal,"Controlling of Prosthetic Arms by EEG Signals Using Wavelet CSP Algorithm", 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Vol. 2, 2010.

[4] Howida A. Shedeed, Mohamed F. Issa, Salah M. El-Sayed "Brain EEG signal processing for controlling a robotic arm", November 2013. Computer Engineering & Systems (ICCES), 2013 8th International Conference.

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