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Interaction of Human with Robotic Arm

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ABSTRACT: Electro Encephalo Gram based Brain-Computer Interface prosthetic arm helps as a powerful support for severely disabled people in their regular activities, especially to aid the disabled people to move their arm voluntarily. This paper proposes and implements a brain signal (mind) controlled prosthetic arm to yield different movements in prosthetic arm. The key lies in the mapping of the EEG signal to the prosthetic arm to achieve the objective. In this project we are developing a cost effective BCI prosthetic arm that will help the physically challenged people to lead an independent life with the help of their brain signals using non-invasive techniques.

KEYWORDS: Brain Computer Interface (BCI), Brainwaves, EEG sensor, Neurosky Mindwave Headset, Prosthetic arm.

I. INTRODUCTION

In India, there are many disabled people. For disabledpeople with severe neuromuscular disorders such as brainstem stroke, cerebral palsy, multiple sclerosis or amyotrophic lateral sclerosis (ALS), the project must provide basic interaction capabilities in order to give them the possibleresponse to express themselves. The solution developed for this problem is Brain Computer Interface (BCI) systems. A BCI is a non-muscular communication channel that enables a person to send messages or specific pattern to an automated system such as prosthesis, bymeans of his brain signal. One of the most important features in a BCI system is acquisition. The most spread acquisition technique is EEG, and it represents cost efficient and transferable solution for acquisition. The electrical waves from the brain will be sensed by the EEG sensor tip and it will convert the data into packets and transmit through Bluetooth medium. Laptop will receive the brain wave raw data, it will extract and process the signal using Arduino IDE. Then the control commands will be transmitted to the prosthetic arm to process and perform the actions.

II. HISTORY OF PROSTHETIC ARM

An effective prosthesis delivers desired functionality and is cosmetically pleasing, but it also serves the wearer's sense of wholeness. A prosthesis, is not only a medical device but alsoprovides emotional comfort, and so the history of prosthetic arm and leg is not only a scientific history, but the story of human beings since the dawn of civilization who by birth,accident, or wound were left with something missing. The first example of a prosthesis ever discovered is not a arm, leg, or even a fake eye, it's a toe.Worn nearly 3,000 years ago, this toe is a representation of the history of prosthetics.

The famous Ancient Roman in the history of prosthetics is General Marcus Sergius, who is the first documented wearer of a prosthetic arm. In the second Punic War, Sergius lost his right arm and was given prosthesis, fashioned by iron, which enabled him to hold his shield and continue fighting.In the early sixteenth century, Doctor Ambroise Pare made significant changes and advances in both amputation surgery, and the development of prosthetic limbs. He was the first one to introduce a hinged prosthetic hand, and a leg with a locking knee joint. In the 1970's, the inventor M. Martinez made a huge impact on the history of prosthetics when he developed a lower-limb prosthesis that, instead of trying to recreate the motion of a natural limb, focused on improving gait and reducing friction. By relieving pressure and making arm movement more comfortable, Martinez improved the lives of many future patients.

The prosthetic arm was designed using acrylic sheets. The thickness of acrylic sheet is 3mm. Acrylic sheet is less weight, low cost and easy to cut, so acrylic sheet was used for the construction of prosthetic arm. The first step is to design the cad file (refer figure 2 & 3).The prosthetic arm was designed using acrylic sheets. The thickness of acrylic

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III. DESIGN OF PROSTHETIC ARM

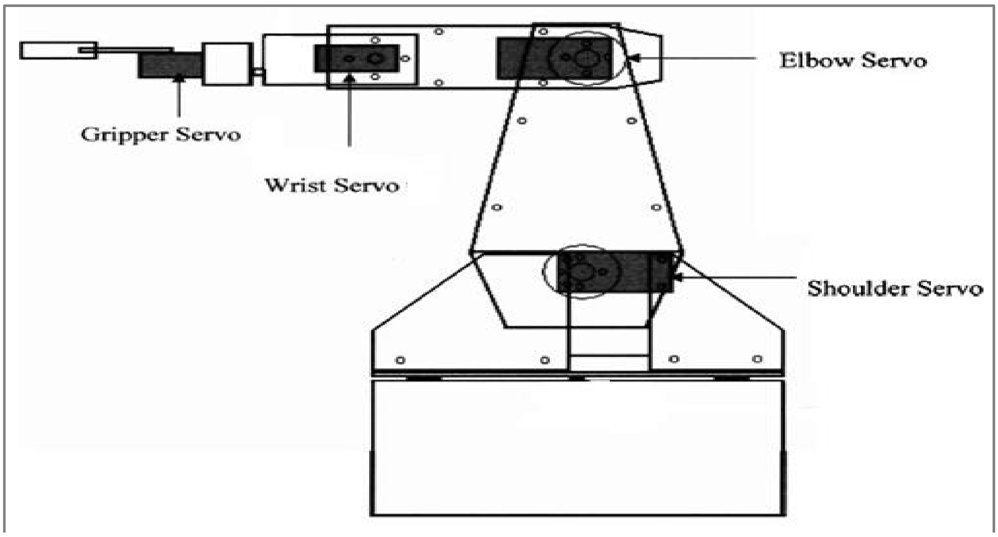

Figure 1: Design Overview of Prosthetic Arm

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.

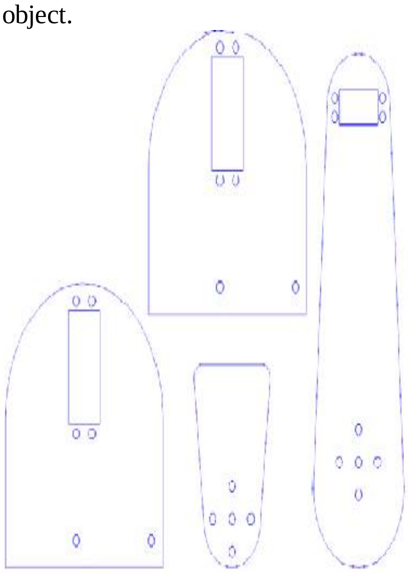

Figure 2: CAD design of Prosthetic arm

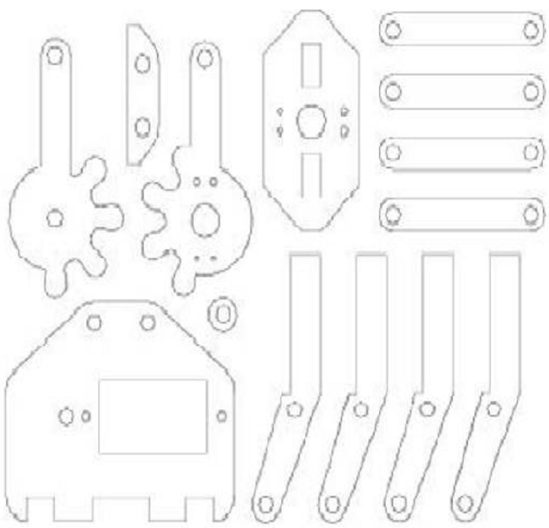

Figure 3: Servo Gripper

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IV. SYSTEM HARDWARE

1. NEUROSKY EEG HEADSET

The Mindwave Mobile headset is a slim, matte black/light blue plastic device that fits comfortably, over the left ear of the person. The primary sensor sits on the person forehead pretty comfortably, although it will take a minute or two to adjust it the first time when the person put it on. The ear clip is likewise pretty comfortable, and the whole apparatus has the advantage of easily allowing the person to wear over-ear headphone at the same time if the person so choose. The Mindwave Mobile device safely and accurately measures and outputs the EEG power spectrums (alpha, beta, etc), NeuroSky eSense meters (attention and meditation levels) and eye blinks. The device is composed of a headset, a sensor arm, and an ear-clip. Theground electrodes and headset's reference are fitted on the ear clip and the EEG electrode is placed on the sensor arm, resting on the forehead above the eye. It uses a single AAA battery with 8-hours of battery life.

2.HC-05

The HC-05 Bluetooth Module has 6 pins- Vcc, GND, TX, RX, Key, and LED. It comes pre-programmed as a slave, so there is no need to connect the Key pin, unless it is changed to Master Mode. The major difference between Master and Slave modes is that, in Slave mode the Bluetooth module cannot initiate a connection, it can however accept incoming connections. After the connection is established the Bluetooth module can transmit and receive data regardless of the mode it is running in. A phone can be connected to the Bluetooth Module in Slave mode. The default data transmission rate is 9600kbps.The range for Bluetooth communication is usually 30m or less. The module has a factory set pin of "1234" which is used while pairing the module to a phone.

3. ARDUINO YUN

Arduino is an open-source physical computing platform based on a simple I/O board and a development environment that implements the Processing/Wiring language. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer. The Arduino Yun is a microcontroller board based on the ATmega32u4 and the Atheros AR9331.The board has built-in Ethernet and Wi-Fi support, a USB-A port, micro-SD card slot, 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analog inputs), a 16 MHz crystal oscillator, a micro USB connection, an ICSP header, and a 3 reset buttons. The Yun distinguishes itself from other Arduino boards in that it can communicate with the Linux distribution onboard, offering a powerful networked computer with the ease of Arduino. In addition to Linux commands like cURL, we can write your own shell and python scripts for robust interactions. The Yun is similar to the Leonardo in that the ATmega32u4 has built-in USB communication, eliminating the need for a secondary processor. This allows the Yun to appear to a connected computer as a mouse and keyboard, in addition to a virtual (CDC) serial / COM port.

4. SERVO MOTOR V0006

Operating Voltage	4.8-6.0Voltage
PWM Input Range	Pulse Cycle 20±2ms, Positive Pulse 1~2ms
STD Direction to 1900µsec	Counter Clockwise / Pulse Traveling 1500
Stall Torque	0.8 kg (11 oz/in) at 4.8V, 1 Kgf.cm(12 oz/in) at 6.0V
Operating Speed	0.16 sec/ 60° at 6.0V at no load ,0.14 sec/ 60° at 4.8V
Weight	9 g (0.2 oz)
Size	22*12.5*20*26.6

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Plug Available	FUT, JR
Special Feature	Economy Servo, Heavy Duty Plastic Gears

5. SERVO MOTOR VTS08A

Operating Voltage	4.8-6.0Voltage
PWM Input Range	Pulse Cycle 20±2ms, Positive Pulse 1~2ms
STD Direction	Counter Clockwise / Pulse Traveling 1500 to1900µsec
Stall Torque	4Kgf.cm(55.6 oz/in) at 4.8V, 5Kgf.cm(69.5 oz/in) at 6V
Operating Speed	0.25sec/ 60° at 4.8V, 0.2sec/ 60° at 6.0V at no load
Weight	43g (1.5 oz)
Size	43 x 23 x 38.2 mm 1.69 x 0.91 x 1.5 in
Plug Available	FUT, JR
Special Feature	Economy Servo, Heavy Duty Plastic Gear

6.SERVO SHIELD

The Simple Lab's Servo Shield is a custom designed Shield to drive Servo Motors. The Shield can drive up to 10 servo motors at a time. The Servo Shield has clear pin mappings and polarity mappings for the Servos. A screw terminal is used for connecting an external power supply for the Servos. Servos require 4.8- 6.0 Volts and consume around 300-500milliamps. The Servo shield requires to be powered from an External Source for it to drive the required servos.

V. EXISTING SYSTEM

Early prostheticarm were simple. They were frequently only small digits that were immovable, or more famously, pegs and hooks. Later technology advances and enabled the movement of the prosthesis, but they looked very different from a human arm. They were claws that would not have looked out of place on industrial robots. As technology advanced, the arm became more natural. However, they still required cables and harnesses to be attached to the working arm to pull them. Myoelectric prosthesis were developed, providing more freedom of movement and more movement in general. However, myoelectric prosthesis are very expensive. In addition, they rely upon the nerves of the arm to be undamaged. Should the nerves be damaged, the myoelectric is useless. By reading the electrical signals and brainwaves directly from the cranium, the major drawback of expensive myoelectric prosthesis can be avoided entirely. However, reading of electrical signals directly from the brain requires multiple electrodes to be placed on or in the brain.

VI. PROPOSED SYSTEM

The Arduino Prosthesis is a low cost prosthetic. 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 requiresmore 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. The arm is made up of acrylic sheet with a thickness of 3mm. 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 be replaced with high power servo motors to make the arm more functional exactly like a human arm.

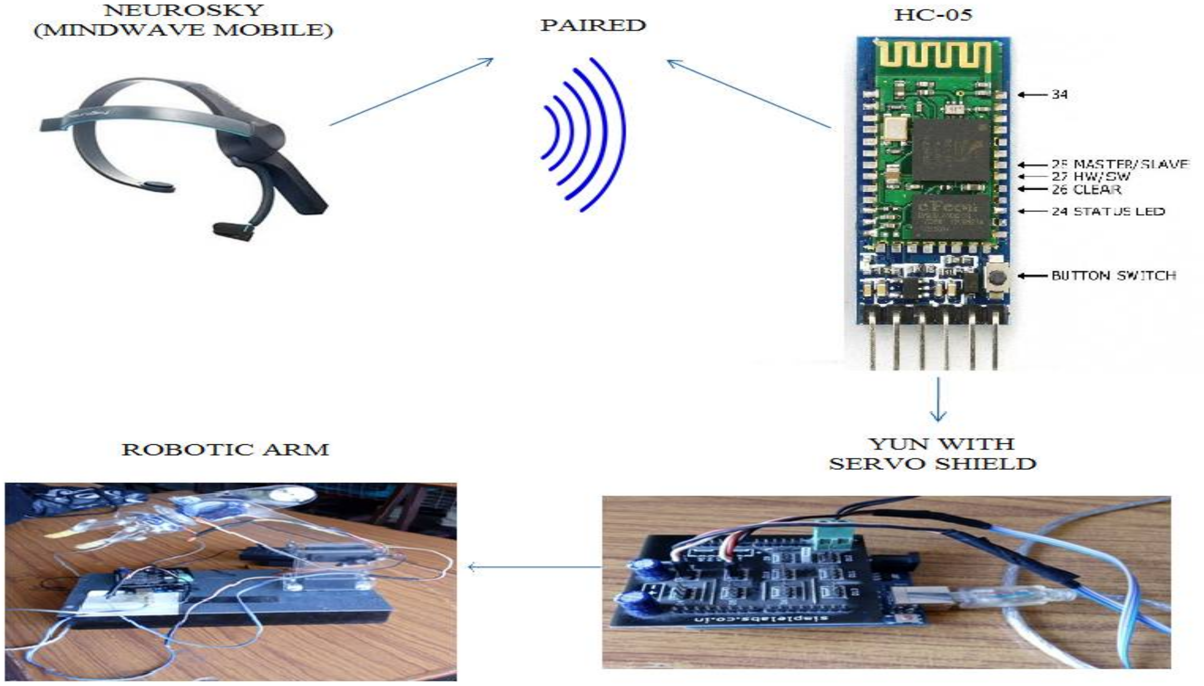

Figure 4: System Architecture

VII.IMPLEMENTATION

1. ANALYSING OF RAW DATA FROM EEG DEVICE

This module consists of many steps. The first step is to determine the mac address of MindWave mobile headset using Computer. The next step is to connect the Arduino YUN and Bluetooth module HC 05 as per the pin diagram. This is followed by Configuration of Bluetooth module HC 05 using AT commands. Configuration can be checked by using the AT command itself.After this setup, HC-05 receives the raw data from Neurosky EEG headset. The raw data is received as packets from the EEG device.HC-05 is connected with Arduino YUN. The received raw data (Signal quality, Attention, Meditation) is displayed on the Arduino IDE. These values are noted for 10 subjects in similar situation (without any noise disturbance). Finally aggregate value is computed using the values obtained from the 10 subjects.

2. CONTROLLING THE PROSTHETIC ARM

In this module, Arduino program is written. This Arduino program receives the raw data as input from the Neurosky EEG headset through HC-05 and compares the received data with the aggregate value which is already computed. If the aggregate value matches, the corresponding action is performed.The person has to spent lot of time in cognitive training, to control the prosthetic arm using the brain signals. Maximize the signal quality strength to control the prosthetic arm with great efficiency.For controlling the prosthetic arm we need to control the servo motor. To control a servo we need to give a pulse once every 20 milliseconds. The duration of this pulse will determine the Servo Angle which we need to achieve.The digital pin on the Arduino board accepts the control signal which is a pulse-width modulation (PWM) signal.This accepts the signal from the controller that tells it what angle to turn.It is just a pulse of varying length. The length of the pulse corresponds to the angle the motor rotates to.Servo shield is used to drive servo

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motors. Servo shield has digital pins. Servo motor is connected with any of these digital pins.When Arduino receives data signals from Neurosky EEG headset to move the prosthetic arm, the received signals are compared with the aggregate value and if it matches with the aggregate value it makes the corresponding servo motor to rotate at desired angle (i.e. it makes the prosthetic arm to move in desired position).

VIII. RESULT

Finally, the prosthetic arm could be controlled using servo motors. The output might appear approximately in Arduino IDE as.

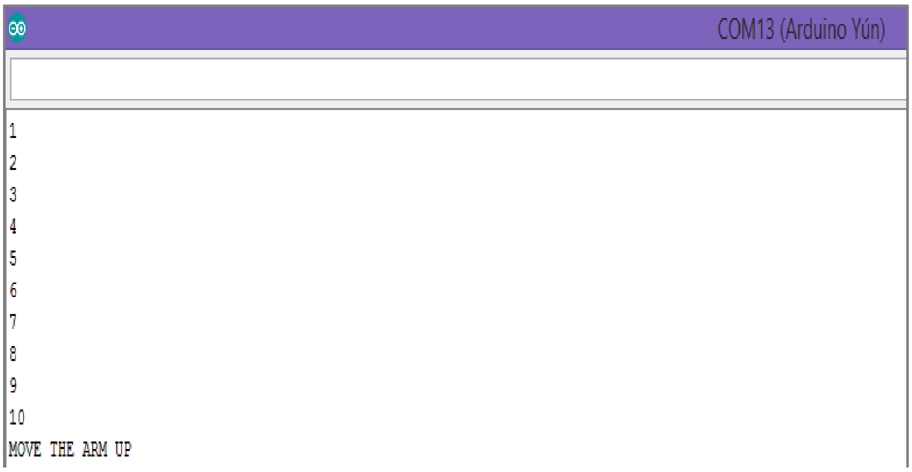

Figure 5: Arm movement up

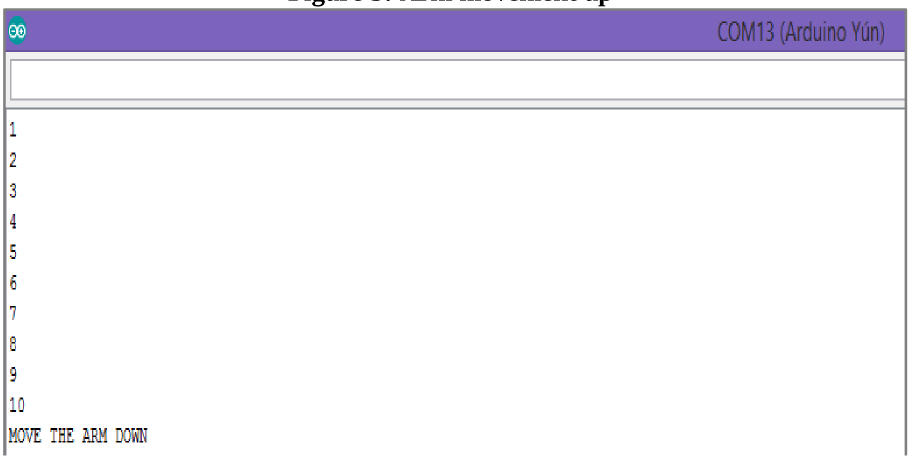

Figure 6: Arm movement down

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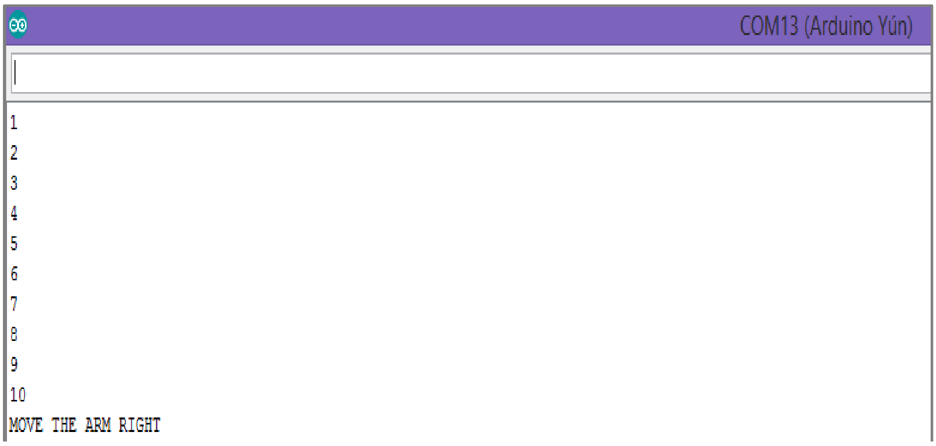

Figure 7: Arm movement right

IX. CONCLUSION

In this work, it has been studied how to control the prosthetic arm using brainwaves with the help of Neurosky EEG device and ArduinoYUN.The systemdeveloped for controlling the robotic arm through electroencephalographic data shows promise.In order to complete the given task, the complexity of the task should be reduced and the effectiveness of the classification system should be improved. This Proposed system could be further improved through gathering more data and instead of using normal servos if high rpm servos are used then it could be able to lift heavier objects.A longer training time for the user would allow the user to easily control the arm move accurately. Also more number of EEG sensors would improvethe accuracy andwould help in classifying it into more ranges.If the accuracy could be increased, then it is believed that the robot arm could be successfully controlled in a real world situation. For future work, the proposed system is to explore these techniquesto increase the accuracy so that it could start running trials on the effectiveness of this control system. The project is further improved by evaluating the use of the system on different people, and in different experimental environments.

REFERENCES

[1]Sridhar Raja .D, "Application of BCI in Mind Controlled Robotic Movements in Intelligent Rehabilitation", InternationalJournalof AdvancedResearchin Electrical,ElectronicsandInstrumentation Engineering,vol.2,pp1231-1238,April2013.

[2] SiliveruRamesh,M.GopiKrishna,MadhuNakirekanti,"Brain Computer Interface SystemforMindControlledRobot", International Journalof Computer Applications,vol. 104,pp 20-23, October2014.

[3] Kale Swapnil T, Mahajan Sadanand P, Rakshe Balu G, Prof. N.K.Bhandari "Robot Navigation control through EEG Based Signals"International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 3 Issue 3 March-2014 Page No. 5105-5108.

[4]Guger, C.,Harkam, W.,Hertnaes, C., Pfurtscheller, G.: Prosthetic ControlbyanEEG-basedBrain-ComputerInterface(BCI).In: Proceedings AAATE5thEuropeanConferencefortheAdvancementof Assistive Technology.Dusseldorf, Germany(1999).

[5] Neurosky, "Mind-set instruction manual", [online]:
available:http://developer.neurosky.com/docs/doku.php?id=mindset_instruction_manual.

[6] Birbaumer, N.: Breaking the silence: Brain-computer interfaces (BCI) for communication and motor control. Psychophysiology 43, 517–532 (2006).

[7] http://developer.neurosky.com/docs/doku.php?id=thinkgear_communications_protocol.

[8] J. del R. Millan, F. Renkens, J. Mourifio,W. Gerstner.Non-invasive brain-actuated control of a mobile robot
by human EEG. IEEE Transactions on Biomedical Engineering, 51: 1026-1033, 2004.

[9] G. Pfurtscheller, D. Flotzinger, J. Kalcher. Braincomputer interfaces – a new communication device
for handicapped person. Journal of Microcomputer Applications 16: 293-299, 1993.