Deploying P-300 EEG Based Signals for Mobile Robots

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Abstract:- **Electroencephalogram (EEG) is a test that identifies electrical movement in human brain employing tiny, metal discs mounted on the human scalp. This study designs and implements electroencephalogram (EEG) controlled four-wheeled robotic car for brain-computer interface applications. The proposed system changes direction according to variations brain electrical activities in terms of meditation, attention, and blink signals. The hardware and software experimental results demonstrate that the proposed robotic module performs well under various test conductions.**

Keywords:- *BCI, Invasive, Non-invasive, Partially- invasive, EEG.*

I. INTRODUCTION

For decades, there has been an escalating significance in the control of computer systems using brain signals. This technology play key roles in diverse field ranging from neuroprosthetics, gaming and many health care applications. This non-invasive approach of BCI has a unique advantage of low cost in comparison to other brain signal recording techniques [1-4]. Extensively used brain-computer interfacing systems normally incorporates P300-speller abilities. One key benefit of P300-based BCI control devices is that they need no user's training but physical features of the human's response. However, one of the main problem associated with P-300 based BCI control-based devices is that their performances can be affected by a various human condition like attention level, fatigue, and motivation. Moreover, low information transfer rate (ITR) is another typical problem connected with BCI control devices. This problem restricts the usage of BCI systems for adoption locked-in humans, as they cannot maintain interactions with other humans or BCI interfaces. Therefore, this paper proposes a new BCI model that can facilitate both high adaptively to changes in brain electrical activities and high information transfer rate.

II. PROPOSED METHODOLOGY

The proposed system BCI model uses motor imagery inputs such as blinks, meditation, and attention signals from neurosky headset to navigate in in forward, reverse, left, and right directions. As depicted in figure 1 above, the neurosky mind wave headset transmits the generated brain wave signals using Bluetooth. It integrates Bluetooth mechanisms for reception of the transmitted brain waves at the receiving end. It also incorporates a power switch, flexible ear clip, sensor Tip/Arm and has an adjustable headband. It has sensors, which detect the brain signals in a noninvasive wave without a direct contact with the brain, which may result in scar tissue or weaker signal acquisition when the body reacts with external objects. When powered a red LED glows and when connected, a blue LED glows indicating it has been paired.

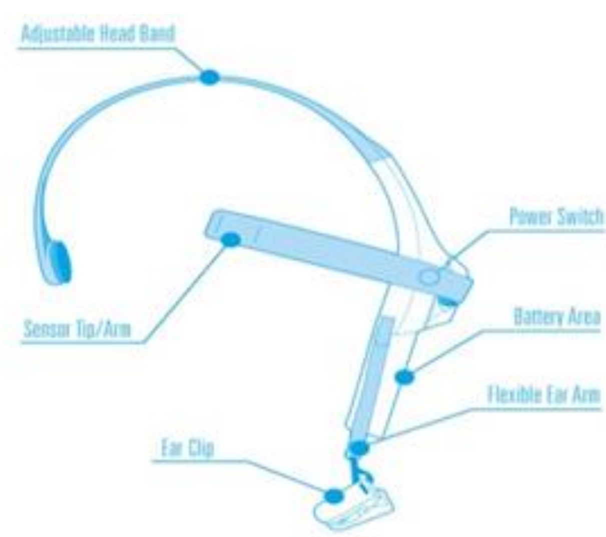

Fig 1:- Neurosky Mind wave Headset

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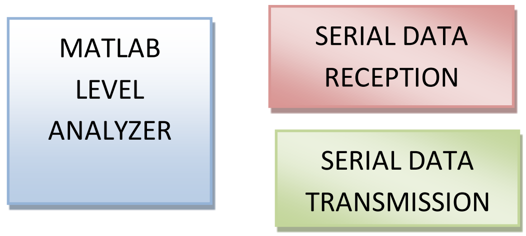

Fig 2:- RFID Processing Unit

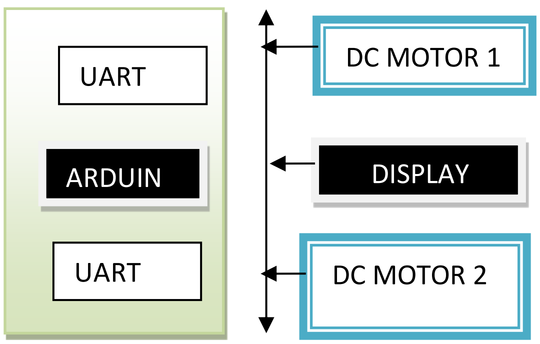

Fig 3:- System Block Diagram

When the mind wave headset is paired with the Bluetooth dongle, the generated brainwave signals are received at the level analyzer unit. Meanwhile, at the analyzer, various frequencies of the brain signals is applied to the movement of the robot in various directions. The signal is transmitted from the level analyzer unit to the robot via Zigbee transceiver module. The electrical activities in the human brain changes, depending on the specific activity carried out by the person. Normally, a specific brainwave will be dominant depending on the person's mental state.

Brainwaves	Frequency(HZ)	Amplitude(Micro Volts)
Alpha	8-13	20-200
Beta	13-30	5-10
Delta	1-5	20-200
Theta	4-8	10
Gamma	40-70	0.5-2

Table 1:- Five Types of Brain Waves

A. Positioning of Electrodes

The position of the electrode is named corresponding to the area of the brain beneath the scalp area, namely; parietal, sulcus, frontal, occipital and temporal. The electroencephalogram signal is acquired from scalp electrode pair in bipolar area. The electrode pairs read the potential difference above the brain, while the third electrode is positioned on the ear lobe as a reference ground.

B. P300-Based Event

After stimuli, the P300 wave occurs at an interval of 250-800millisecond.A user's preferred choice user evokes an immense P300. The existence, timing and topography, of this signal are often deployed as metrics in the process of decision making.

III. HARDWARE IMPLEMENTATION

For implementation of the hardware, an Arduino UNO microcontroller based on the Atmega 328p is used. Its functionality is based on the downloaded sketch writing in the integrated development environment. For the system prototype two 12V, 1000rpm DC motors are incorporated driven by LD293D driver IC, each having the capabilities of driving each of the DC motors in both clockwise and anti-clockwise directions simultaneously. A wireless Zigbee transceiver is interfaced for transmission of the generated output from the level analyzer unit (LAU) and reception by the robot for its movements in various directions. The robot can be controlled in the range of 100 meters outdoor and 30 meters India at a standard frequency of 2.4GHHZ.

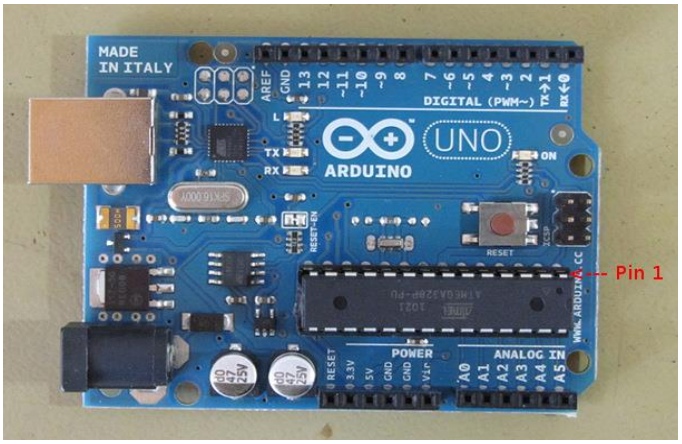

Fig 4:- Arduino Microcontroller

IV. SOFTWARE IMPLEMENTATION

Here, the software Implementation of the system is carriedd out with MATLAB simulation platform i. The movement of the robot in various directions is dependent on the MATLAB output. As shown in table 1, the motion of the robot is dependent on the BCI action.

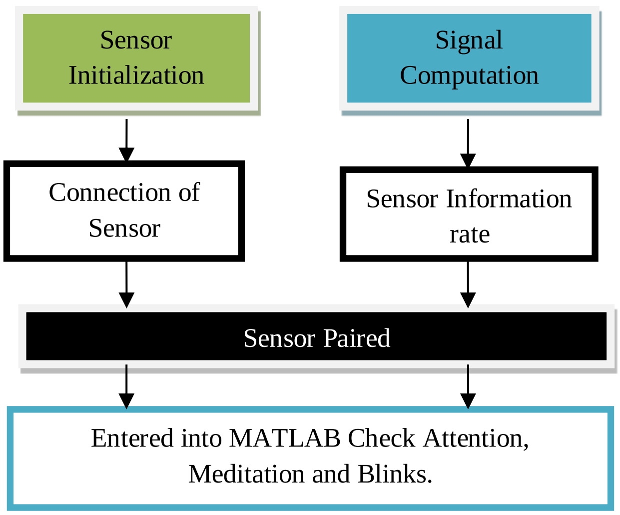

Fig 5:- Flow Diagram of the Design

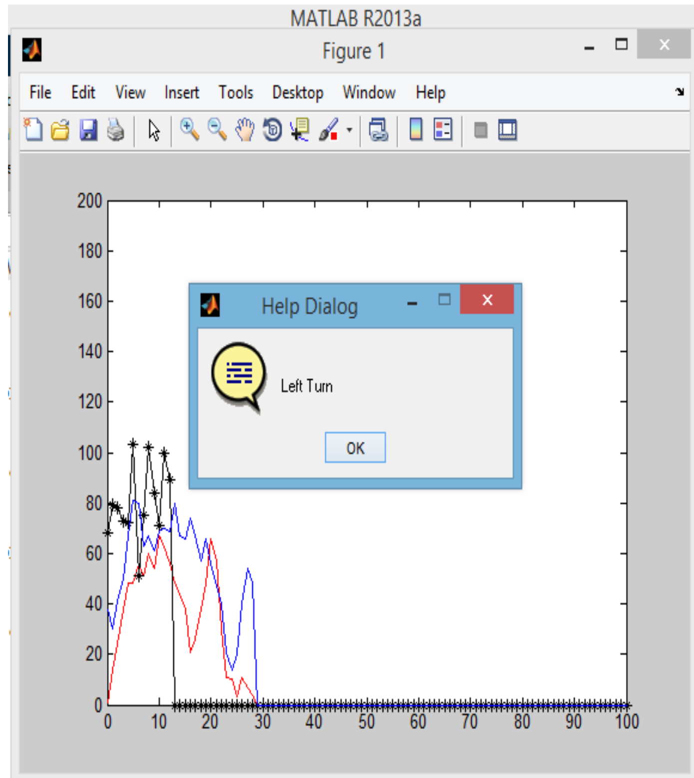

Fig 6:- Robot Left g 5 Movement

V. EXPERIMENTAL RESULTS

A presentation of the results generated is made in this section. The motion of the robot has controlled a person's mental state. The attention and meditation levels increase for higher blinks resulting in increased motion, but prone to increased error rates. By varying the reference level, optimum accuracy can be achieved. As shown in table 2,The motion of the robot ids dependent upon the BCI activities.

Control Outputs	Motion of Robot	BCI Activities
0	Forward Direction	Inactive
1	Right Direction	Right Wink
2	Left Direction	Left Wink
3	Device Control	Blink

Table 2:- Robot Controls and Commands

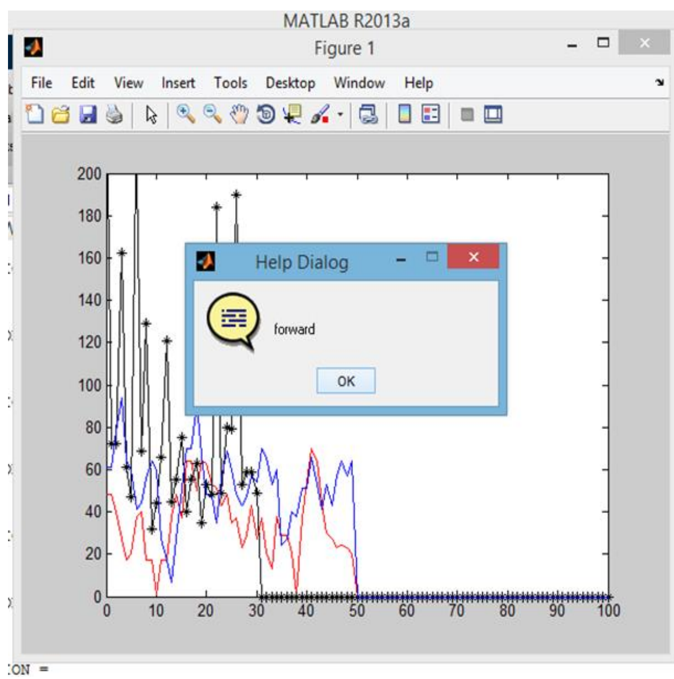

Fig 7:- Robot Forward Movement

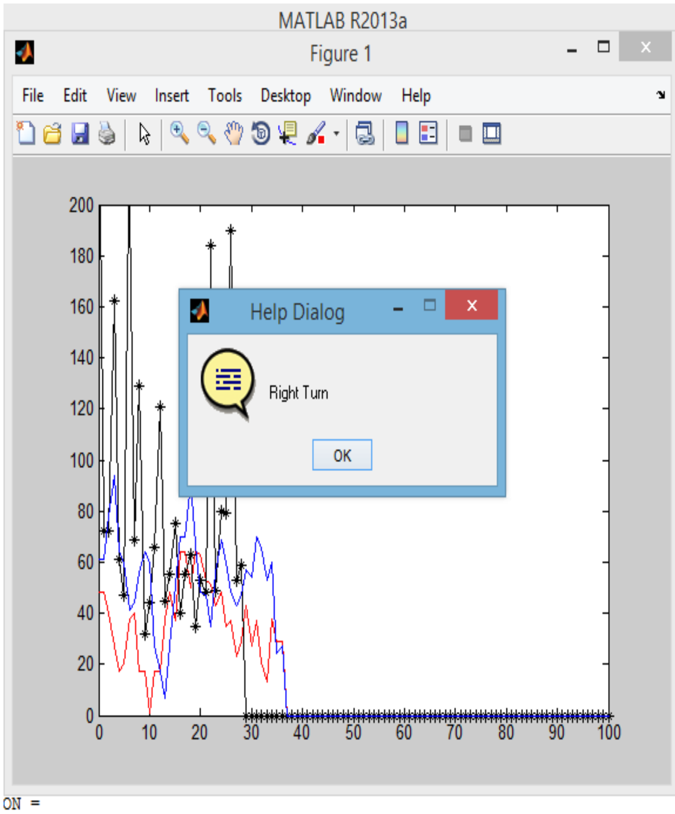

Fig 8:- Robot Right Movement

Fig. 9:- System Prototype

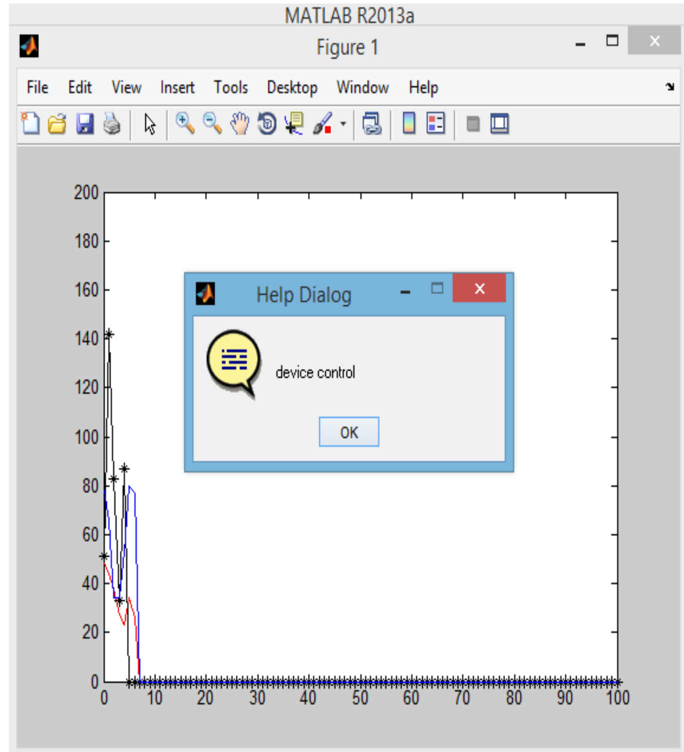

Fig 10:- Device Control

VI. CONCLUSION

In this paper, a non-invasive brain computer interface based on P-300 electroencephalogram was presented and implemented. The excremental results revealed that stronger brain signals can be acquired without incisions or sufferers prone to scar tissues and the generation of weak signals. The generated results can be used for control of other devices including wheelchairs to assist people with disabilities as well as control of cursors on our computer screen. The developed system shall be modified for control of multiple robots.

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