Brain Computer Interface based Robot Design for Physically Disabled Person

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Abstract **-**There are number of physically handicapped people. Some of them are using different technologies to move around. The proposed work implements a robot which is controlled using human brain attention.Here brain signals analyzes using electrode sensor that monitors the eye blinks and attention level. Brain wave sensor that detects these EEG signals is transmitting through Bluetooth medium. Level analyzer unit (LAU) i.e. computer system will receive the raw signals and process using MATLAB platform. According to human attention level robot will move. ARM controller is used to design robot.

Keywords – *ARM controller, Brain-computer interface, Electroencephalogram (EEG), robot, Brain wave sensor*

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I. INTRODUCTION

Now a day's robot becomes an essential thing in industries as well as in human life. These robots can provide a support to disable people in their daily life. A brain controlled robot is one of the steps toward prime utilization of robot in human life. Brain Computer Interface (BCI) system has been developed which bypass all conventional methods of communication and directly interfaces brain of human with communication devices. In proposed system, brain sends command directly to physical devices.There is two types of Brain Computer Interface techniques, invasive and non-invasive technique. In invasive technique the brain signals are recorded by an implanting electrode directly into cortex of brain. In non-invasive technique electrode placed on scalp of brain. Electroencephalography (EEG) is an example of non-invasive technique of detecting brain activity.

The robot is designed using ARM processor and connected to a laptop by a Bluetooth or Zigbee connection. According to the human attention level the robot will move forward, backward, left or right.

II. RELATED WORK

EEG technique has been used by many of researchers for robot control.

Rossella Blatt et.al have proposed system in order to meet disabled people's requirements. They have designed the system in such a way that it can be simply modified and adapted to the users 'needs. In particular, the user has the opportunity to choose among several autonomy levels and three different interfaces: a joystick, a touch-screen and a brain-computer interface [1].

Dr.V.Parthasarathy et.al have proposed system which is EEG based Brain-Computer Interface mobile robots can help as powerful support for severely disabled people in their regular activities. They propose and implements a brain signal controlled robot to yield four different directional movements. The schemes use a single electrode pair acquisition scheme, ARM controller and robot module. This author uses three performance metrics to validate the effectiveness of the scheme. It also exhibits good results in generating different navigational directions in accordance with the driving signal [2].

Wei Li et.al develops a BCI based humanoid robot control system. The system consists of an electroencephalograph, a humanoid robot, and a CCD camera. The goal of study is to control humanoid walking behavior through neural signals acquired by the 32 channel EEG. The humanoid robot is equipped with an onboard PC and has 20 degrees of freedom (DOFs). The CCD camera takes video clips of a subject or an instructor hand postures to identify mental activities when the subject is thinking ―turning right,‖ ―turning left,‖ or ―walking forward [3].

Syed M. Saddiqu et.al has proposed system BCI adds a new value to efforts being made under human machine interfaces. BCIs have given a hope where alternative communication channels can be created for the persons having severe motor disabilities. This work is based upon utilizing the brain signals of a human being via scalp Electroencephalography to get the control of a robot's navigation which can be visualized as controlling one's surrounding environment without physical strain [4].

Daniel G¨ohring et.al presenting an approach to control a real car with brain signals. They use a brain computer

interface which is connected to our autonomous car. The car is equipped with a variety of sensors and can be controlled by a computer. They are using four different brain patterns for steering and describe the control interface which is necessary for a smooth, brain controlled driving then decisions for path selection at intersections are made using the BCI. Between these points, the remaining autonomous functions are still active [5].

Katie Crowley et.al evaluating NeuroSky's Mindset headset as a minimally invasive method of measuring the attention and meditation levels of a subject. Two psychologically-based tests were conducted to assess the suitability of the headset to measure and categories a user's level of attention and meditation [6].

Vijay Khare, et.al proposed system in which eight electrodes were to capture EEG from the brain to build a BCI based real time control for wheelchair to help the severely handicapped persons. To achieve this goal Wavelet Packet Transform (WPT) was used for feature extraction of the relevant frequency bands from EEG signals. Radial Basis Function network was used to classify the predefined movements such as rest, forward, backward, left and right of the wheelchair [7].

Krishnaveni Yendrapalli et.al discussed about a brain controlled robot based on 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. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent on others [8].

Anas Fattouh et.al have proposed system where an emotional BCI control system to drive a smart wheelchair is proposed. The proposed BCI control system permits to the user to select one of four commands to drive the wheelchair. Once a command is selected, the control system executes the selected command and, at the same time, monitors the emotional state of the user. While the user is satisfied, the selected command is still executed and when the user becomes unsatisfied, the control system will stop the robot and ask the user to select another command [9].

Win Ching Yang et.al proposed a wireless EEG based BCI and drive circuit for DC motor to control wheelchair through a Bluetooth interface for paralyzed patients. Real time EEG and eye blinking signals can help these patients effectively**.** The proposed BCI system consists of a wireless physiological signal- acquisition module and signal processing unit. Here, physiological signal- acquisition module and signal processing unit were designed for extracting EEG.Advantage of BCI is low power consumption [10].

III. System Design

Before the invention of brainwave sensor controlled robot, people uses SMS or speech based robot. But if the patient is paralyzed, he cannot move easily. Also he/she cannot use sms or speech to move from one place to other. These people can use only eyes and brain to exercise. The development of the project involves 60% of hardware and 40% of software. It reduces efforts of disabled persons. Brain computer interface is best method for such people as shown in fig1.

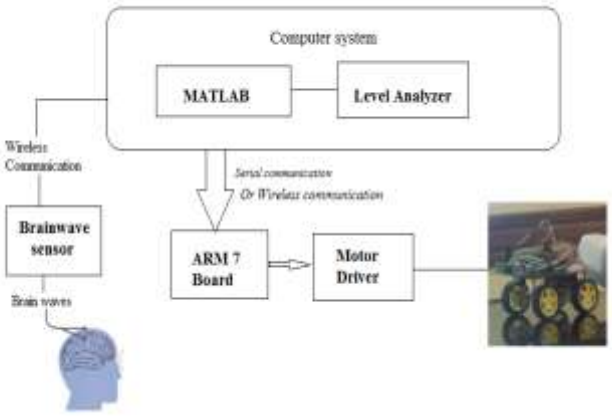

Fig 1: Block Diagram of the system.

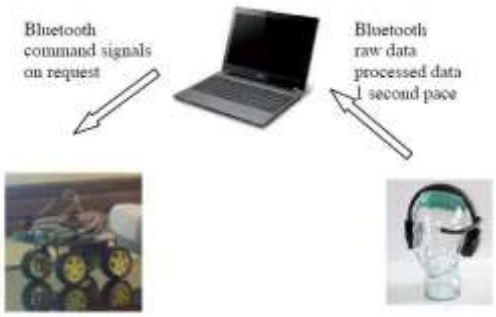

Fig 2: Set up of proposed system

IV. METHODOLOGY

A. *Brain wave sensor*

The NeuroSky MindSet sensor is built with just one inexpensive dry sensor placed on the forehead. With reference point and contacts on the ear pads. The ThinkGear ASIC chip is the digital signal processor (DSP) developed by NeuroSky (Company's primary product are chips) and located in the MindSet device, it amplifies and filters the signal and provides raw signal as well as power frequency bands. One of the main features of this DSP is noise removal, essential when dealing with low frequency low power signals. Noise is caused by

many factors such as muscle activity and electrostatic and electromagnetic noise. All of these are considered, reduced and compensated by the ThinkGear chip and taken into account by the *eSense* algorithms.

Neural interaction of the various part of the brain concur in forming brainwaves, they are primarily classified on a frequency basis. Each type of brain wave has a range of values and is typical of a brain state, for example lower frequency (Alpha waves, 8-12 Hz) is associated with calm while higher frequency (Beta waves, 12-30 Hz) with concentration. Lower frequency waves (0.1-7 Hz) are associated to mental images down to unconsciousness (non- REM sleeps). NeuroSky Mindset can sense frequencies from 0.5 to 50 Hz and transmit data by a Bluetooth connection every second using a proprietary protocol.

B. *Computer System:*
Computer system mainly consists of software based analysis. MATLAB analyzes the data which are getting from sensor. The level of attention is compared with reference level and generates a command for movement.

C. *Robotic Module:*
ARM7 controller receives commands from MALAB and generates respective interrupts signals. These interrupt signals Provide command to robot movement. M1 and M2 motors used for movement which attached to wheels. Motor Driver IC L293d used for monitor the motor rotations.

Applications :

- Automotive Applications
- Industrial Application
- Home applications
- Monitoring device applications
- Remote control applications

Advantages:

Robot control using Human thoughts
Self controlled
To provide real time system
Low cost.

V. EXPERIMENTAL RESULT

This system is implemented to help for the better understanding of how the human brain works in terms of reorganization, learning, memory, attention, thinking, social interaction motivation etc. The module is mainly developed to help the elderly people and the paralyzed patients who can't able to use their hands. After detecting the first 3 eye blinks it will start monitoring other waves that comes out from the forehead.
It has found that when user's attention was for blinking eye (black line) i.e. performing another task then its concentration level is low which is shown in figure 3. When it stops blinking that means try to concentrate with full attention its attention level was increased.

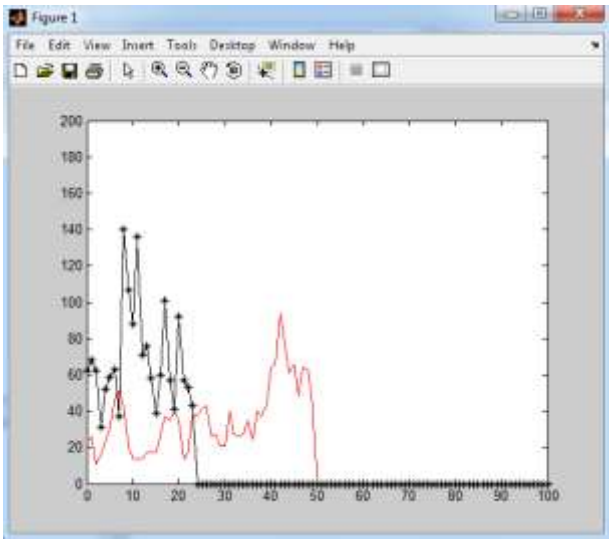

Fig. 3 Combine graph for attention level and eye blinking

When actual experiment was start, initially robot was at stop condition. According to attention level of user robot will move forward, backward, left or right direction. Attention levels are set in the MATLAB code.

VI. CONCLUSION

This proposed system uses a brain wave sensor which can collect EEG based brain signals and it will convert these signals into packets and transmit through Bluetooth medium to check the attention level. After analyzing signal level as per command, robot will move. Here brain controlled robot is used for much application such as assistive device for disabled individuals and a rescue robot in disaster area thereby reducing the cost for designing multiple robots. It is an optimized and customized solution of robots in human life.

VII. FUTURE SCOPE

As we know range of Bluetooth and ZigBee is short. For large distance applications it is not suitable, therefore Global System of Mobile (GSM) instead of ZigBee can make the controlling range of robot i.e. increased from 100 meters to a more accessible distance.

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