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EEG Based Brain Controlled Wheelchair for Physically Challenged People

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ABSTRACT: Independent mobility is a necessity to live everyday life for human beings. A person with physical challenges has restricted mobility. For these people, Brain Computer Interface (BCI) provides a promising solution. Using Electroencephalogram (EEG) signals for movement of wheelchair the mobility of these persons can be improved. The proposed system is based on Artificial Neural Network (ANN) algorithm. This article presents Mu rhythm signals that provide commands to wheelchair. Using wireless link between head gear and computer, commands to control the wheelchair can be issued.

KEYWORDS: Brain Computer Interface (BCI); Electroencephalogram (EEG); Wheelchair, Brainwave Sensor;

I. INTRODUCTION

Now a day's robot becomes an essential thing in industrial as well as in human life. These robots can provide a support to disable people in their day today life. A brain controlled wheelchair is one of the steps toward prime utilization of robot in human life. A healthy person can operate wheelchair with the help of joystick, keyboard etc. But with a person who does not have control on their muscle are unable to use these. For this reason some special technique has been proposed like eye tracking and many others. But it has some limitations. To overcome such challenges Brain Computer Interface (BCI) system has been developed which bypass all conventional methods of communication and directly interface brain of human being with communication devices. In proposed system brain send command directly to physical devices. Basically there are two types of Brain Computer Interface techniques, invasive and noninvasive technique. In invasive technique the brain signals are recorded by an implanting electrode directly into cortex of brain. In noninvasive technique electrode placed on scalp of brain. Electroencephalography (EEG) is an example of noninvasive technique of detecting brain activity. [1]

EEG is a technique of recording a electrical activity along the scalp produced by firing of neurons within the brain. EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time as recorded from multiple electrodes placed on the scalp. EEG is generating due to neuron. Potential generated by neurons travels down, result into neurotransmitter. This neurotransmitter activates receptor in dendrite. By combination of receptor and neurotransmitter electric signal is generate which can measure at scalp. [17] This voltage is ranges from 1uV to 100uV.

TABLE 2: Frequency Classifications

Waves	Frequency	Location	Use
Delta	< 4 Hz	Everywhere	During sleep, coma
Theta	4-7Hz	Temporal and parietal	During emotional stress
Alpha	8-12 Hz	Occipital and parietal	Reduce amplitude during mental imagery
Mu	9-11 Hz	Frontal	Reduces amplitudes with intention of movement
Beta	12-36 Hz	Parietal and frontal	Increase amplitude during intense mental activity

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This generating voltage is called EEG signal. This may vary according to brain activities of human being. The EEG signals which are generate classified into different types according to their frequency range. Delta, Theta, Alpha, Mu and Beta wave are the types of EEG waves. Occurrence of these waves depends upon different activities performed by brain. For this proposed system Mu rhythm is use. These Mu waves find in frontal position of brain.

II. RELATED WORK

EEG technique has been used by many of researchers for wheelchair control. Kazno Tanaka developed recursive training algorithm for generation of recognition pattern from EEG signal. He control left and right direction of chair.[3] Junichi Miyata proposed a system based on υ-ϕ coordinates. Straight and corner movement of wheelchair are performed by it.[4] Brice Rebasamen developed a wheelchair based on P300 BCI system. In this system user select a destination amongst a list of predefine locations.[5] Naisan Yazdani used optimal electrode position for his proposed system. He has implemented 3D virtual environment for training evaluations.[6] EEG signals was captured by using eight electrodes and Wavelet Packet Transform(WPT) was used for feature extraction of relevant frequency band from EEG signals. This system achieved left, right, forward and backward movement.[7] Tom Carlson et al., 2012 proposed a wheelchair based on asynchronous protocols, mutual learning and shared control principles. He have undertaking trail with patients.[8] In et al., 2013 he showed four healthy subjects were able to control wheelchair using asynchronous motor imagery based BCI protocol.[9] Rajesh Singhla developed a wheelchair based on steady state visual evoked principle in which he find Support Vector Machine(SVM) shows better accuracy than Artificial Neural Network(ANN).[10] In et al., 2014 Tabias Kaufmann proposed system which is based on tactually evoked event related potentials for controlling wheelchair.[12] Murali Krishnan used emotiv EPOC signal acquisition unit for EEG signal acquisition. ANN and SVM were used for EEG classification.[14] Choi and coworkers, also used a BCI based on motor imagery to build a brain-controlled mobile robot.[15]

III. PROPOSED SYSTEM

Proposed system is mainly depends upon EEG waveforms. Brainwave sensor, Matlab and ARM Controller are the key parameters of system. Figure 1 illustrates conceptual diagram of it.

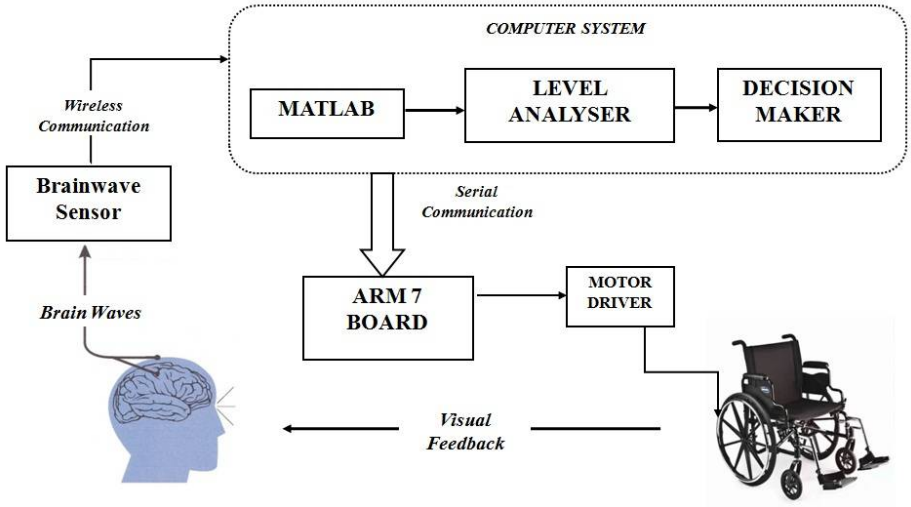

Figure 1: System Overview

A. *Brainwave Sensor:*

It is single node point sensor consists of dry electrodes. Gold-plated dry electrodes were used for system which consist a single channel having three contacts points i.e. EEG, Reference and Ground. Mu signals generated at frontal node (FP1) point detect and transmit data towards computer system. Transmitted data was in packets form.

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B. *Computer System:*
Computer system mainly consists of software based analysis. Matlab analyzed data which are getting from sensor. The level of attention is compare with reference level and generates a command for movement. Artificial Neural Network (ANN) based algorithm is use for decision making purpose. This algorithm gets values from sensor and analyzed it and generates respective command.

C. *Robotic Module:*
ARM7 controller received commands from Matlab and generates respective interrupts signals. These interrupts signals provide command to wheelchair movement. M1 and M2 motors used for movement which attached to wheels. Motor driver IC L293d used for monitor the motor rotations. When M1 get low signal and M2 get high signal then wheelchair get turn to right side. Table 2 shows how other movement achieved with different M1 and M2 combinations.
TABLE 2: Wheelchair Movement

M1	M2	Function
Low	High	Turn Right
High	Low	Turn Left
Low	Low	Stop Moving
High	High	Move Forward

IV. PERFORMANCE ANALYSIS

Before starting execution of system, some concentration level of different users has been taken. It found that concentration levels of users were not being same. It has varied person to person. During experimental setup user were seated with Brainwave sensor connected to their forehead. Waveform shown in fig.3 illustrates concentration level of user at different points. X-axis and Y-axis represents time and concentration level respectively.
It has found that an average concentration of a user was 70%. So it was a reference value for that user. By considering this reference value ANN module performed commanding operation for wheelchair. The reference value may vary person to person.

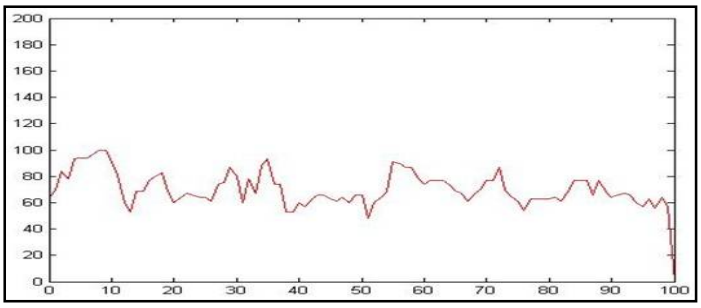

Fig. 3 Concentration level of user

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 4. When it stops blinking that means try to concentrate with full attention its attention level was increased.

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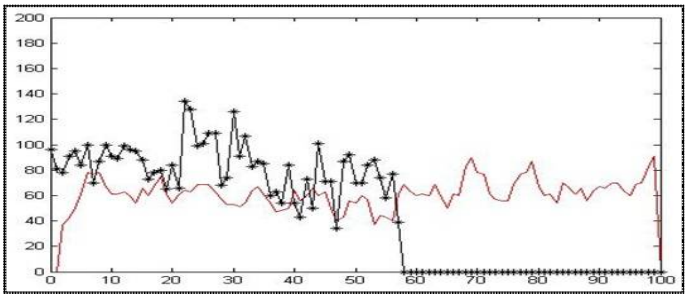

Fig. 4 Combine graph for concentration and eye blinking

When actual experiment was start, initially wheelchair was at stop condition. User starts to think move forward then after some negligible delayed wheelchair moved forward. When it starts to think stop wheelchair it stop immediately.

V. CONCLUSION AND DISCUSSION

Utilization of EEG signals are a significant research area which help physically challenged people. Brain controlled wheelchair is slow but reliable method for physically challenged person. The proposed system uses an ANN to overcome the previous challenges and to achieve higher accuracy. Stability of system depends upon user thoughts so users have to take more training of system.

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