International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-8S, June 2019

Enhancing Physical Activity based on BCI for Physically Disabled

P.Kingston Stanley, P.Vijay Daniel, J.Samson Isaac, A.Sanjeevi Gandhi

Abstract: ***Elderly and disabled people needs proper care at a right time in order to improve their quality of their life. It is appropriate for them to use a mechanical wheel chair but difficult to use by these people. To provide an easy movement, the designing of intelligent wheel chair is required. Using Brain Computer Interface(BCI), brain wave control wheel chair is controlled directly by the brain. The direct communication between brain and wheel chair is enabled by Brain Computer Interface (BCI). The mobility of these persons can be enhanced by using the Electroencephalogram (EEG) signal based movement of the wheel chair. Mindflex P2369 headset is used for capturing the EEG signal. EEG signal is transmitted by headset wirelessly via Bluetooth. Based on the EEG concentration, the direction of wheel chair can be determined using signal processing techniques. Atmega 328 microcontroller is programmed to act as BCI controller. Depending on the brain concentration values, the control commands will be transmitted and based on the human thoughts, the wheel chair will be moved.***

Keywords: ***Electroencephalogram (EEG), Brain computer interface (BCI), Bluetooth, Lab VIEW and Microcontroller.***

I. INTRODUCTION

Millions of interconnected neurons are present in the human brain. Thoughts and emotional states are denoted by the pattern of interaction between these neurons. Different electrical waves are produced by the change of pattern that vary according to the human thoughts. The brain wave sensor senses all these electrical waves and converts the data into packets and transfer through Bluetooth. A brain controlled wheel chair is one of the steps towards prime utilization of robot in human life. A healthy person can operate a wheel chair with the help of joystick, keyboard etc. But a person who does not have control on their muscle are not able to use these. Brain computer interface (BCI) has been established in order to overcome such challenges that by pass all conventional methods of communication and directly interface brain of human beings with the communication devices. Brain directly sends the command to the physical devices in proposed system [8].

The brain computer interface technique acts as a communication system that helps the person to operate the external devices by measuring and analyzing the electrical brain activity (EEG) that is controlled by his or her own thoughts.

Table. 1 The Frequency Band of an EEG Signal [9]

EEG Band	Frequency
Γ	(30-100) Hz
B	(12-30) Hz
A	(8-12) Hz
Θ	(4-7) Hz
Δ	(0.5-4) Hz

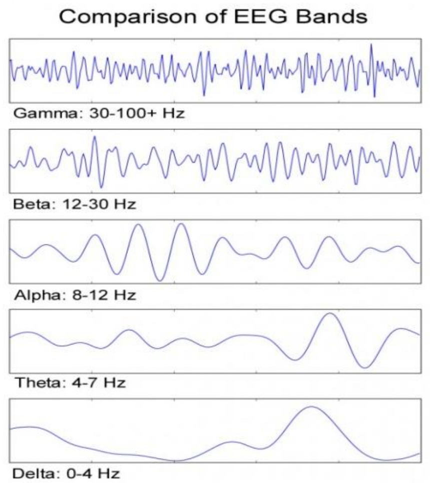

Fig. 1 This Frequency bands of EEG signal [9]

The EEG signal shows the collection of multiple action potentials of single neurons, which is acquired in one electrical wave and are arranged in different frequency bands as in Table(1) and presented graphically in Figure(1). The strength of these brain waves varies all over the day, that is different EEG bands dominates each other based on the brain activity and its degree of awakens. For example, the (β) wave will be the most influential in the EEG signal when the brain is in awake and alert state, while if the brain is in awake and at rest state the (α) wave will be the most influential. The EEG signal will turn to lower frequency bands if the brain is in sleep or near sleep state like (θ) wave. The α waves plays a significant role in the encoding of the limb movements.

Here, the raw EEG signal that is processed and recorded from the Mindflex sensor in the LabVIEW environment is discussed. The control commands are passed to the wheel chair through Bluetooth transmission. These mind wave sensors are useful in Brain control interface (BCI) and neuro feedback but not for clinical purpose.

Revised Manuscript Received on May 22, 2019.

P.Kingston Stanley, Karunya Institute of Technology and Sciences
P.Vijay Daniel, Karunya Institute of Technology and Sciences
J.Samson Isaac, Karunya Institute of Technology and Sciences
A.Sanjeevi Gandhi, Karpagam college of Engineering

This project has an effective brain signal system using LabVIEW platform, Brain wave sensor and Atmega 328 processor. Using the brain wave sensor, the concentration level of the subject should be found initially. The brain wave sensor unit calculates the concentration level and compares it with the minimum concentration level of human whenever the person wants to move forward. In the proposed wheel chair modification of the manual wheel chair is done by mechanically coupling motors to rear wheels there by making it an electric wheel chair. The active rear wheels are rotated by motors to the orientation and the current driving directions are similar to each other.

A differential drive uses two motors on either side of the wheelchair and a castor wheel on the front. When both the Left and Right Motors are forward biased, the wheelchair moves forward. For turning the wheelchair right, the Right Motor is given forward bias and the Left Motor is given reverse bias. Forward bias on the Left Motor and reverse bias on the Right Motor turns the wheelchair left. The duration and hence the degree of turn is controlled by the mind wave signals from the user. The most important features of this system over the other conventional systems is that they are of low cost which uses Bluetooth interface between the arduino and the Mindflex headset. This is also greatly helpful for the disabled people as it wipes out the demarcation between the able and disable.

II. EXPERIMENTAL SETUP

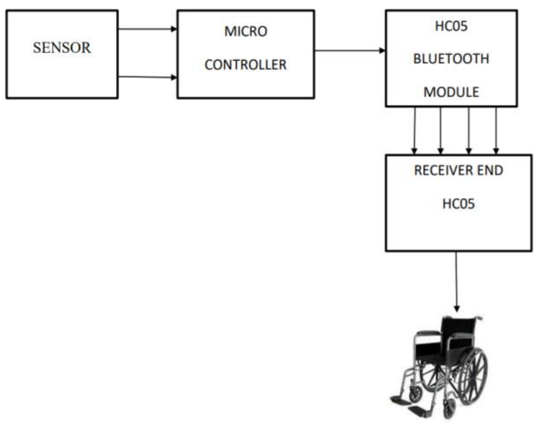

Fig. 2 Block Diagram of the proposed system

In this proposed system, Mindflex p2639 brain wave sensor is used which has a built in Neurosky EEG processor to analyze the EEG signals.

The specifications of this are mentioned in Table II. This proposed EEG sensor are 2.79cm x 1.52cm x 0.25cm.

Table. 2 Specifications of The Sensor

SL No	Type of electrode	Dry electrode
1.	No. of. Channels	One with three contacts EEG,REF and GND
2.	Location	Frontal

The simple dry electrode gives an excellent signal quality. No preparation is required with a sampling frequency-512 bits per second and a frequency range of 3-100Hz. The EEG electrode is placed above the left or right eye on the forehead. The Ground and reference electrodes located behind the ear or at the earlobe. It measures,

- Raw brainwave signal
- Processing and output of EEG power spectrums (Alpha, Beta, etc.)
- Eyeblink detection

The brain wave raw data will be received by the Microcontroller (Atmega 328) and is transmitted to the receiving end via Bluetooth module HC05. The receiver end has another Bluetooth module which is connected to the wheel chair and initiates the movement based on the concentration of the subject.

Wheel chair control mechanism:

The output of the sensor need to develop is a wheel chair this includes 5volt DC gear motor that are driven by motor driven IC as they require hand some amount of current, which the microcontroller is unable to provide so external source is needed to supply the current. For making the wheel chair totally wireless the system need to put that external source on the chassis and the microcontroller is to be supplied from the same supply source. Thus it can drive the two motors in forward and reverse direction from the concentration of the subject via the IC.

III. RESULT AND DISCUSSION

In this section, the testing results ensure the reliability of the dry sensor and the circuits for acquiring EEG signals in daily life. Brain signals control the physical devices by the desired results obtained. The brain wave sensor senses the EEG signals and it is checked using the EEG lab software. When the procedure is completed for moving the wheel chair, run command is given in the LabVIEW. As shown in Fig. 2.

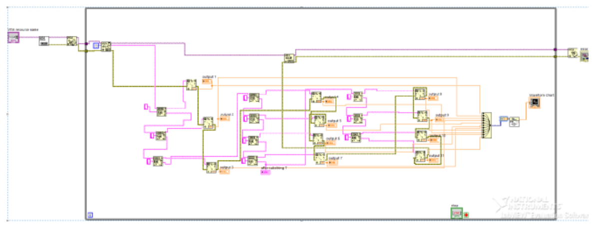

Fig. 3 Lab VIEW Program for signal acquisition

As the result of the command given the signals obtained from the sensor through the subject was observed to be an output comprising 11 channels as shown in Fig.3. Various types of filters are available in LabVIEW to filter the biomedical signals basically IIR and FIR filters.IIR filters re designed to provide the nonlinear phase response and FIR filters are designed to provide the linear phase response.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

An FIR filter is used here to have a flat frequency response and used to extract the different frequency bands such as Delta, Theta, Gamma, Beta and Alpha in a single wave form as shown in Fig.4.

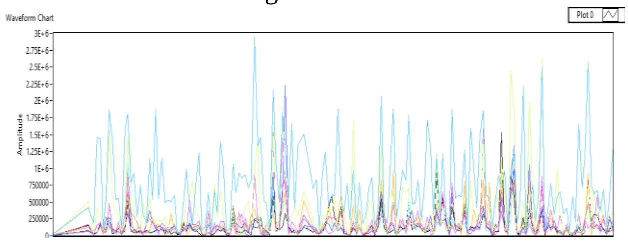

Fig. 4 channel output from the sensor

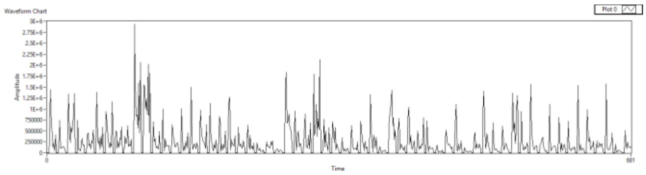

Fig. 5 Filtered signal output

To analyze and measure the raw data from the sensor, the output was taken as a text file and was processed using the EEG lab software and they were plotted as frequency and time As shown in the Fig. 5 and Fig. 6

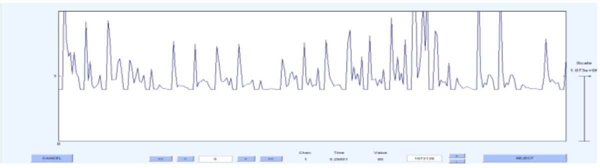

Fig. 6 Time plot

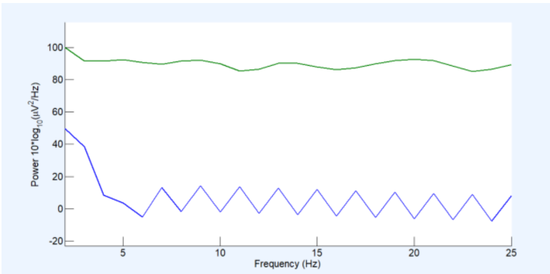

Fig. 7 Frequency Plot

Further analysis of the signals were made depending on the concentration of the subjects. Whenever the subject has a higher concentration with his or her closed the signals obtained had higher frequencies whereas the signals obtained when the subject had lower concentration displayed lower frequency as shown Fig.7 and Fig. 8.

Lower Concentration Output

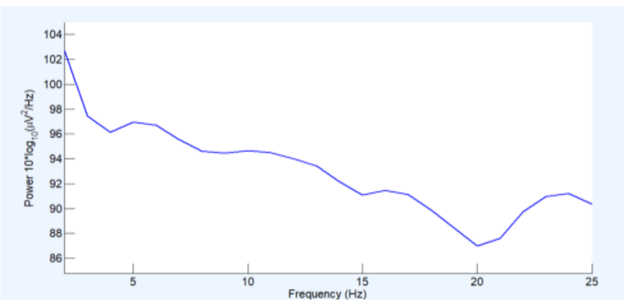

Fig. 8 Lower concentration signal output

Higher Concentration

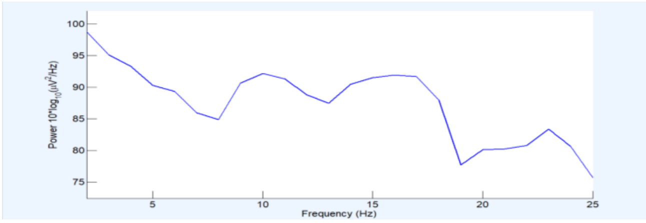

Fig. 9 Higher concentration signal output

When the concentration value is detected i.e., either high or low the direction is selected (forward or reversed) depending on which the wheel chair moves. The plot of the concentration values are obtained with respect to time as well as frequency in EEG lab.

IV. CONCLUSION

This paper demonstrate the design and application of controlling the wheel chair using EEG based signal using non-invasive type of brain computer interface. The usage of gel is not essential as it consist of Mindflex brain wave sensor with a dry electrode and reference ear clip. The idea of using brain signals to control the physical devices helps the paralyzed and physically challenged people to do their work independently. For controlling purpose, remotes was used in existing techniques which were not cost effectives. Further, in industries the whole manual control system and risk environment would be replaced with human mind control technique.

REFERENCES

1. Mehulpatel ,RishikeshBhavsar, *"Design & Implementation Of Brain Controlled Wheelchair"*, Volume: 04 Issue: 3, Mar -2017
2. Saikrishna D, NeethalEphram, ShahasAhamed, Dr.MRajeswari, *"Brain Controlled Car For Disabled Using Eeg"*, Volume 2, Issue 3 ,2017
3. Shakshi, RamavtarJaswal, *"Brain Wave Classification and Feature Extraction of EEG Signal by Using FFT on Lab View"*, Volume: 03 Issue: 07, July-2016
4. SnehaPushpaS ,Chandrashekar N S , *"EEG based Brain-Computer Interface for Controlling Home Appliances"* Vol. 5, Issue 6, June 2016
5. Harish Verlekar ,Hrishikesh Gupta, Kashyap Joshi, *"Using Brain Computer Interface for Home Automation"*, Volume 34 Number 7- April 2016
6. Mrs. V. Jeyaramya A, AslineCeles, A. Durga Devi, *"Mind -Controlled Wheel Chair using an EEG Probes using Microcontroller"*, Volume 2 | Issue 10 | March 2016
7. Daniel Elstob& Emanuele Lindo Secco, *"A Low Cost Eeg Based Bci Prosthetic Using Motor Imagery"*, Vol.6, No.1,February 2016
8. Nikhil R. Folane , R. M. Autee, *"EEG Based Brain Controlled Wheelchair for Physically Challenged People"* , Vol. 4, Issue 1, January 2016
9. Somer M. Nacy* , Sadeem N. Kbah, Hind A. Jafer, Ibraheem Al-Shaalan,*"Controlling a Servo Motor Using EEG Signals from the Primary Motor Cortex"*, 2016
10. SnehaPushpa S1 and Chandrashekar N S2, *"Eeg Based Smart Home Automation Using Non-Invasive Brain-Computer Interface Approach"*, Volume 4, Issue 6, 2016
11. Arjon Turnip, Demi Soetraprawata, Mardi Turnip, EndraJoelianto, *"EEG-Based Brain-Controlled Wheelchair with Four Different Stimuli Frequencies"*, Vol.8/No.1, 2016

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

12. Sim KokSwee,a, Kho Desmond Teck Kiang and Lim Zheng You,*"EEG Controlled Wheelchair"*, 2016
13. Utkarsh Sinha and Kanthi.M,*"Mind Controlled Wheelchair"*, 2016
14. Rishab Shah, Harish N.S, Dr.G.N. Rathna,*"A Smart Home Control And Monitoring System For The Disabled"*, Volume 6, Issue 6, June 2015
15. RohanHundia,*"Brain Computer Interface-Controlling Devices Utilizing The Alpha Brain Waves"*, VOLUME 4, ISSUE 01, JANUARY 2015
16. Abdel Ilah N. Alshbatat, Peter J. Vial, PrashanPremaratne, Le C. Tran,*"EEG-based Brain-computer Interface for Automating Home Appliances"*, VOL. 9, NO. 9, SEPTEMBER 2014
17. S.P.Pande1 ,Prof.Pravin Sen 2, *"Review On: Home Automation System For Disabled People Using Bci"*, 2014
18. Venkatakrishna Bhat K, Nagaraj MahabhaleswaraHegde, VikasN ,Siddarth T C, *"Manojavitvam - LabVIEW Based Thought Controlled Wheel-Chair For Disabled People"*, Volume 6, Number 1 2013
19. Tom Carlson, Robert Leeb, Ricardo Chavarriaga and Jose del R. Mill ´ an, *"The Birth Of The Brain–Controlled Wheelchair Systems"*, October 7-12, 2012.
20. Anupama.H.S ,N.K.Cauvery, Lingaraju.G.M, *"Brain Computer Interface And Its Types - A Study"*, May 2012
21. Interfaces Yu Mike Chi, Yu-Te Wang, Yijun Wang, Christoph Maier, Tzyy-Ping Jung and GertCauwenberghs , *"Dry and Noncontact EEG Sensors for Mobile Brain–Computer"*, VOL. 20, NO. 2, MARCH 2012
22. NunoSérgio Dias a,b, João Paulo Carmoc, Paulo Mateus Mendes c, José HiginoCorreiac, N.S. Dias et al, *"Wireless instrumentation system based on dry electrodes for acquiring EEG signals"*, 2012
23. Chin-Teng Lin Fu-Chang Lin Shi-An Chen Shao-Wei Lu Te-Chi Chen Li-Wei Ko, *"EEG-based Brain-computer Interface for Smart Living Environmental Auto-adjustment"*, 18 june 2010
24. Thomas J. Sullivan, Stephen R. Deiss, Tzyy-Ping Jung, GertCauwenberghs, "*A Brain-Machine Interface using Dry-Contact, Low-Noise EEG Sensors*", 2008
25. M. Teplan, *"Fundamentals Of Eeg Measurement"*, Volume 2, Section 2, 2002
26. V. Rajesh kannan1 ,K.O.Joseph, *"Brain Controlled Mobile Robot Using Brain Wave Sensor"*,