Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

Neuro-Robotic Car Control using LabVIEW

Seban James
PG Scholar:
Department of Mechanical Engineering
St. Joseph's College of Engineering and Technology
Palai, India

***Abstract*—All of the billion neurons which make up human brain are constantly exchanging information using chemical processes resulting in bio-electricity production which is measurable in active region of brain directly over the scalp surface using a Neuroheadset. High bandwidth transfer of information between machines and brain is possible using Electroencephalography(EEG) Neurosky Mindwave headset with its single electrode process and amplify brain signals to get real time cognition data which can be used for actuating any Neuro–Robotic hardware. Human -machine interfaces promise motor and sensory function restoration and treatment of disorders related to neurological illnesses. Cognitive neuroscience and improvement in imaging of brain showed that neural electrical action in the motor cortex provoked all physical action. Brain–Computer Interface (BCI) supports differently abled or aged people with neuromuscular disorders to use devices using only cerebral or mental commands, could be considered a boon.**

Main purpose of robot car is to investigate the feasibility of BCI technology to control a robotic car, as this work will demonstrate. This project focuses on the scope of using BCI within the field of transportation and driving for disabled people using neurofeedback. A robot car is designed and controlled remotely using Neuroheadset that leverages EEG encoded in human cortical brain signals to synthesize communication between user's brain signals and the robot car. HC-05 Bluetooth module is used for data transfer, while Arduino execute programmed instructions stored for movement using driver motors connected with drive wheels. Finally we use LabVIEW software, for data acquisition, processing and analysis.

Keywords*— *Arduino IC; Neurosky Mobile; ThinkGear; Electroencephalograph(EEG); Neuroheadset; LabVIEW.

I. INTRODUCTION

Imagine driving your car by using only thoughts. A grand revolutionary change could be witnessed if this was a possibility where demarcation between the disabled people and abler vanishes in our society. Electrophysiological driver monitoring could reflect all the different mental commands accurately which if recorded in Real-time used to drive Intelligent Transportation Systems. Electroencephalography technology is used to record brain electrical activity. If used for the control a car can produce remarkable changes in the field of transportation. The possibility to drive the robot car using electroencephalography will inspire the disabled people to have confidence to drive. The low cost of the robot car makes it accessible for creation of various practical applications. High success rate in advanced automation engineering field is best understood evaluating automation level of laser operations. Electroencephalogram, technique is used for brain mapping which works by recording electric pulses which are generated inside the brain, tracking the state of mind is possible by extracting the various Bio-Signals, for example meditation, attention etc. The state of mind can be decoded using different brain frequencies from people who are differently abled using an electroencephalogram neuroheadset, which is used for robot car wheel movement control implemented by recognition user's thoughts making brain control a reality.

Brain–Computer Interface can help to make a controlled by user's intension which operates like a direct channel linking user's brain and computer system, neuroprosthesis control of a wheelchair by people with damaged physical system will help activity recovery, using a robot [1]. Second, healthy people, an additional interface with machine, can drastically increase the efficiency and productivity in tasks requiring high-throughput.

The classification of BCIs are 1. Non-Invasive BCIs 2. Partially Invasive BCIs and 3. Invasive BCIs. Electroencephalography (EEG) non-invasive techniques for measurement of brain electrophysiological oscillation signals is used commercially with excellent results, enabling real time link using Brain Computer Interface [2].

Electroencephalography method of monitoring biosignals can be used to record all the brain electrical activity occurring on the brain surface by using electrodes placed on brain scalp. Electroencephalography electrical signals measurement from brain shows fluctuation of voltage occurring within neurons inside the brain. Connecting brain implanted electrodes to a computer screen, in turn, gives waveforms with amplitude variation as digital or voltage values.

Classification of EEG waveforms is according to their frequency, shape, amplitude and the scalp site electrical signals, frequency waveforms like alpha, theta, beta and delta. Diagnosing stoke and epilepsy which cause irregular electroencephalography readings are among the various uses of electroencephalography. It can also be used for diagnosing sleep disorders, brain death, encephalopathies, and coma. Primary method used for diagnosis of epilepsy, tumor, brain disorders and stroke is EEG [3].

A. Problem Statement

Disability caused by epilepsy, stroke, brain injury, muscle injury and back bone injury are directly affecting millions all around the world. About 900,000 people reported various severe problems related to muscle function, produces noticeable improvement after 4 months by conventional therapy post injury [4]. Losing function of hand causes a decrease in quality of life for disabled people. BCIs promise hope for new treatment, so existing problem can be solved by

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

developing Brain-Computer Interface system with an easily usable graphical user interface [5].

B. Motivation

All the feelings and emotions are almost unconscious and to describe them generally is hard. Electroencephalography research has identified a lot of regions in the human brain sensitive to emotional stimulations and feelings; these are precisely measurable the electric brain signals in micro volts range. A new emerging field for BCI is EEG. Recently more detailed understanding of areas of the brain which are active during stimuli recognition, when the body prepare for movement execution, paves the way for robust EEG devices controlled using activity of the brain. For example, this technology can assist paralyzed people in movement of a cursor or to mentally control their wheelchairs, an exoskeleton for military purpose can be fabricated using BCI technology permits soldiers provided with an electroencephalography cap to move, lift, and carry heavy items based on activity of the brain. Elimination of conventional biological communication between limbic system and motor cortex provides direct human brain and external machine connection.

C. Applications

- Provide movement restoration, communication, and environment control for differently abled people.
- Provide differently abled individuals with control of wheelchairs, assistance robots, or vehicles.
- Provide additional Bionics/Cybernetics control for differently abled individuals with damage in neural pathways of motor cortex.
- Monitor long-distance driving, consciousness of aircraft pilots and issue warning in case of lowered attention levels.
- Provide direct brain robot control of inhospitable or dangerous situations for example controlling underwater Neuro–Robotics.
- Long-standing commercial demand for “intelligent and self-conscious” robotics.
- BCI research of spatial memory capture, upload or download perceptual processes.

II. SYSTEM REQUIREMENTS

A. Hardware Requirements

- Arduino Microcontroller
- Neuroheadset EEG Sensor
- Bluetooth Module HC-05
- Robotic chassis
- DC motors and Wheels
- Battery and Relay

B. Software Requirements

- LabVIEW software
- Embedded C programming
- Arduino 1.8.1
- Flash magic software
- KEIL µversion3

III. METHODOLOGY

A. The Proposed Structure

The user brain activity is detected by the Electro Encephalograph Neurosky Mindwave Neuroheadset. It has a dry electrode which is situated in forehead position of the scalp. The control of Neuro–Robotic car is by using, EEG brain signals and Eye-Blinking signal. The corresponding brain signal values from the brain are analyzed by the dry electrode by detection of the brain electrical activity at 514 SPS (sample per second) rate. The recorded values are transmitted using Bluetooth module. LabVIEWsoftware is used for examination of the EEG signals. Neural information from Neurosky Mindwave Neuroheadset can be conditioned to acquire different brain waves signal like alpha, theta, beta and delta. Brain signal analysis is performed using LabVIEW. Depending on levels of attention, meditation and blink an appropriate classification algorithm distinguish the commands which needs to be send to Neuro–Robotic car. Bluetooth is used for shifting microcontroller interface signal. The microcontroller recognizes the various commands and then creates relating signal for control, and sends to the motors control.

B. Basic Block diagram

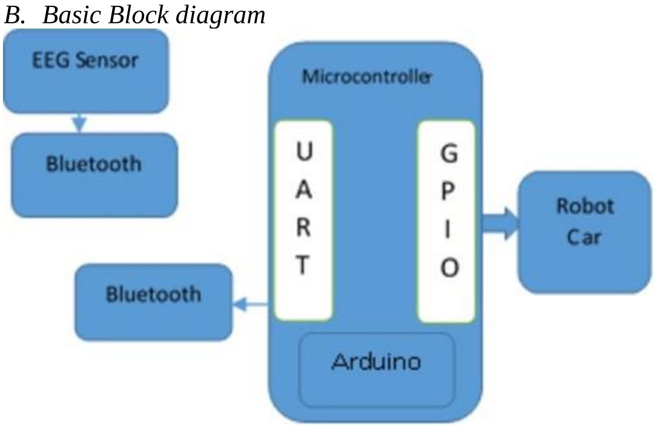

Fig. 1. Block diagram used for the robotic car

In Fig.1, the overall framework used for EEGs signal processing by using Bluetooth interface is given. Employment of BCI technology synchronizes the computer and EEG sensor. EEG securing was used to extract The EEG signals. In signal receiving end, a Bluetooth wireless module paired to a computer with LabVIEW software interface classifies various raw EEG signals. The control of electric Neuro–Robotic is accomplished using raw EEG signals which are converted to electrical voltage.

C. EEG Signal Detection and Acquisition

The Mobile headset by NeuroSky used for EEG signal Acquisition is shown in Fig.2. The neuroheadset consist a dry electrode sensor which will be in direct contact with user’s forehead, the ear clipper junction points has the reference electrode, and an onboard chip operates on all the brain data.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

Fig. 2. Neuro sky-Mindwave Mobile

The eSence algorithm is used by to exercises the various signals directly from the brain and to wirelessly transmit calculated meditation and attention values through the Bluetooth module to HC-05 module at 1Hz rate. The various frequencies and patterns of brain electrical signals is measured by a sensor positioned on front of the scalp. In headset, ThinkGear chip is used to meter the brain electrical signals obtained from EEG sensor and to convert them into usable digital signals; allowing the device user brainwave integration.

IV. EXPERIMENTAL SETUP

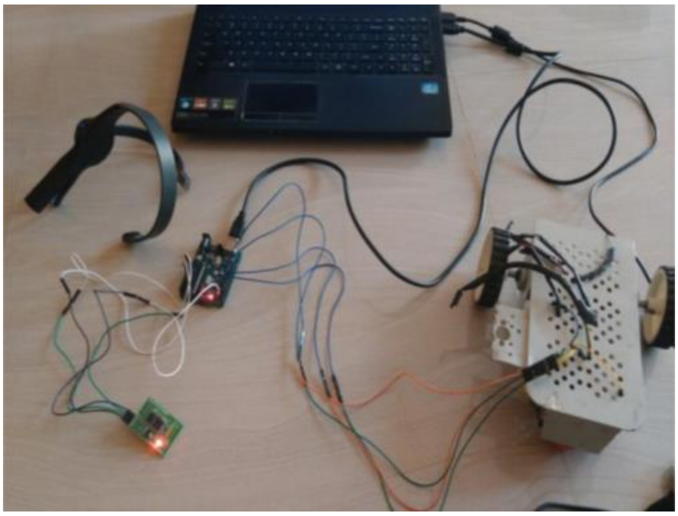

Fig. 3. A photo of the robot car setup

The NeuroSky MindWave Headset when worn start extracting the raw brain biosignal data from the dry electrode sensor above site above of left eyebrow on and transmits brain signal via HC-05 Bluetooth module to Arduino processing unit. After receiving raw brainwave and additional debugging data wirelessly through a virtual communication port (COM port) over by Bluetooth communications protocol. LabVIEW software on computer is programmed for brain data acquisition these raw signals are processed to bring out attention magnitude data and meditation threshold parameters from raw brain EEG Waveform.

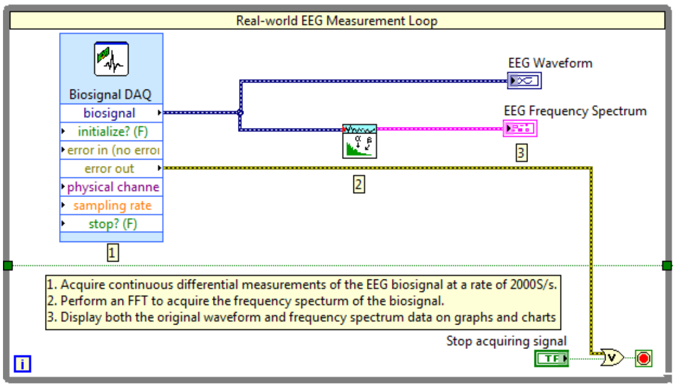

Fig. 4. LabVIEW Program for signal acquisition

In Fig.4, LabVIEW VI used for acquisition and processing biosignal data is shown. IIR and FIR filters which are used in LabVIEW to filter biomedical signals which is basically reprogrammed to provide a linear phase EEG signal output in response to nonlinear phase raw EEG signal input from Neuroheadset. FFT spectrum is used to decipher acquired brain EEG signals and to process various cases of robot motion from LabVIEW platform. LabVIEW Mapping of the Neurofeedback signals from NeuroSky TGCD by raw EEG signal processing finalizes driver control output using brain attention data for final wheel control.

LabVIEW Front Panel used for visual communication with the BCI robot car is shown in Fig.5, it is also used to process EEG brain wave data signal sent from Neurosky Neuroheadset and to display processed Neurofeedback signal and command signal on the computer. Here different raw biosignal data from the headset sensor data is processed by software for signal acquisition, processing and analysis. The control data is then sent via HC.05 Bluetooth module to Arduino processing unit connected to motor Drive.

Fig. 5. NeuroFeedback using LabVIEW Front Panel

There is two voltage supply (9V and5V) for motor Drive and Arduino. H type connection of motor drive IC L293D amplifies low bridge current and gives the high current for reverse and forward acceleration of the motors.

We could drive two motors in forward and reverse direction from single L293D IC. Arduino is connected to an external 5V dc current source. This is used to make the robot car wireless.

Neurosky Mindwave Headset forwards beta wave or human attention brainwave signals to the hardware. Mapping brain patterns in real time is used convert brainwaves into appropriate actions. The direction of robot is controlled using interrupt value reception. Each interrupt signal is used to control a function the operation of the robot car. The Arduino microcontroller detects command signal and sends equivalent control signal to the robot car motor circuitry. Thus the robot car is driven by direct actuation of the drive motors from the brain wave signal data of the subject in both forward and direction based on thoughts alone.

V. RESULT AND DISCUSSION

Forward and reverse commands directly from the individuals brain is decoded and executed suitably via the movements of a cheap and less complex arrangement robot car. Suitable training is required to generate the relevant thought patterns to control the robot car movements. At first the speed value of robot car was set at constant low speed for instilling confidence of the subject till the robot control became effortless for various safety reasons.

Table- I: Experimental Data

Experiment	**Threshold value in micro volts(mv)**		
	Attention	***Meditation***	***Robot Movement***
Session #1	70mv	12mv	Forward
Session #2	56mv	30mv	Forward
Session #3	84mv	04mv	Forward
Session #4	49mv	79mv	Backward
Session #5	05mv	74mv	Backward
Session #6	17mv	81mv	Backward

The experiment was conducted for controlling robot movement based on attention threshold value spanning from 50 to 100 micro volts for forward movement of the robot car while threshold value for meditation was10, 20, 30, 40…..50 micro volts. First three experimental Session mainly focused on moving the robot in forward direction and target of the remaining experimental Session was to make robot move in backward direction. Data will show threshold values above 50 micro volts for user's attention drove the robot in forward direction. Threshold value can be changed in the program for testing the robotic car output on whether it will start or not.

As the level of attention differs for each individual, the LabVIEW platform code can be reconfigured for detecting brainwave signal with high precision. The operation Neuro–Robotic car project was with human thoughts or assumption of the condition for movement which resulted in corresponding Neuro–Robotic car motion. The results verify that LabVIEW software could be used for development and debugging Neuro–Robotic hardware with user friendly, responsive graphical interface to assist the differently abled individuals with effortless control over their environment.

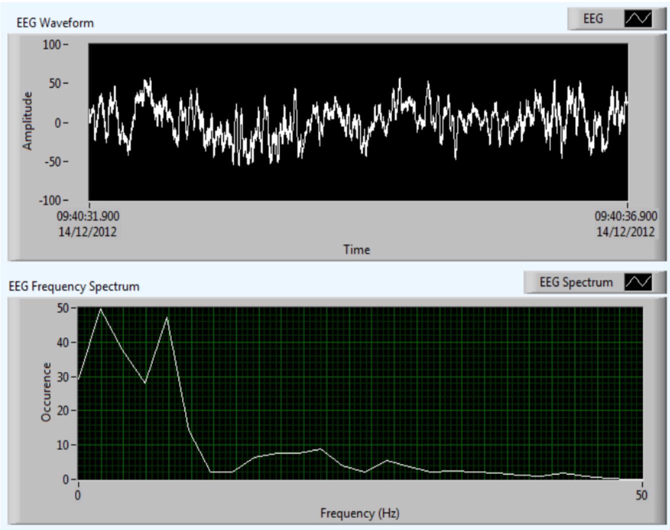

Fig. 6. Session #4 Attention Level Graph

LabVIEW software is used to fashion a responsive brain-machine interface for analysis and processing human brain EEG signals. This software is highly efficient in processing and to identify the input command for equivalent data signal generation to initiate the activity of drive motors connected to the robot car. This system is reconfigurable for using eye blink parameter to control the robot movement in various directions.

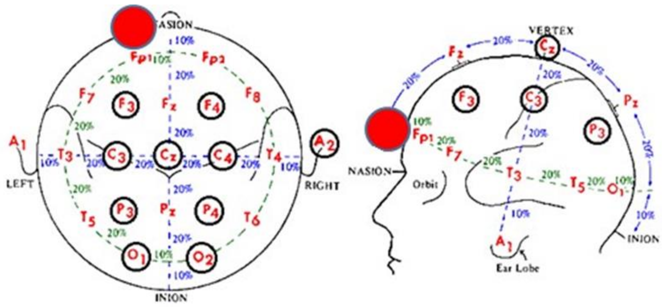

Fig. 7. Fig. 4. Neurosky Electrode Position Chosen In 10-20 system

During the experiment, the Fp1 channel was the one with highest brain wave activity and signified that this area of the brain is responsible for control of robot movements, as shown by red pointer in Fig.7.As a result, we have verified the use of Fp1channel for high accuracy EEG brain waves recording for average users.

VI. CONCLUSION AND FUTURE WORK

In this paper, state-of-the-art control and measurement software LabVIEW was used to develop a user friendly brain-machine interface for analysis and processing EEG signals. In conclusion, further research and development of Neuro–Robot will aid in technological enhancement for industrial applications, automotive applications, home applications, and remote control applications for improving living standard. Human Machine interfaces could facilitate hardware control bionic arms or electronic wheelchairs for paralyzed patients.

In the near future human wishes or direct brain signals will be used to directly control all of our devices without any physical movement required on user's part, the technology employed in the present work is key for realizing that grand vision.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

REFERENCES

[1] Q. Zeng, C.L. Teo, E. Burdet, and B. Rebsamen, “A Collaborative Wheelchair System,” IEEE. Transactions on Neural Systems and Rehabilitation Engineering, 2008, Vol. 2, pp. 18-25.

[2] Andres Ubeda, Jose M. Azor, and Eduardo Lanez, “Wireless and portable EEG Interface to Assist Disabled people,” ASME Transactions on Mechatronics, 2011, Vol. 16, No.5, pp. 870-873.

[3] J. R. Wolpaw, D. McFarland and N.Birbaumer, “Brain-computer interface for communications and control,” Clinical Neurophysiology, 2002, Vol. 113, pp. 767–791.

[4] Inake Ituratte, Javier Minguez and Javier M Antellis, “Noninvasive brain controlled wheelchair based on Neuropsychological protocol with Automated Navigation,” IEEE Trans. Neural Syst. Rehabil., 2009, Vol. 25, pp. 2318-2325.

[5] N. Hashim, A. S. Ja'afar, M. Anuar and A. Jaafar, “Graphical Interface For Wireless Monitoring System By Using Zigbee,” Journal of Engineering & Applied Sciences, 2014, Vol. 9, pp. 1554-1558.

[6] E. Donchin and L. Farwell, "Talking off the top of your head: A mental prosthesis by utilizing human brain potential,” Electroence Neurophysiology, 1988, vol. 70, no.6, pp. 510-523.

[7] Neal Seegmiller and N. Alonzo Kelly, “High-Fidelity Fast Dynamic Model of Mobile Robots,” IEEE transaction on robotics, 2016, Vol. 32, No. 3, pp. 123–135.

[8] B. Obermaier, C. Guger, Pfurtscheller and C.Neuper, “Information transfer in five class brain-computer interface,” IEEE Trans. Neural Syst. Rehabil, 2001,Vol.9, No. 3, pp.283-288.

[9] B. Rebsamen, H. Zhang, C. Guan, E. Burdet C. Wang, and C. Teo, “Brain controlled wheelchairs to navigate in a familiar environment,” IEEE Trans. Neural Syst. Rehabil., 2010,Vol. 18, No.6, pp. 590–598.

[10] Luzheng Bi, Yili Liu and Xin-An Fan, “EEG Based Human Brain Controlled Mobile Robots,” IEEE transaction on human machine systems, 2013, Vol. 43, pp 161-176.