Brain Computer Interface and Arduino Microcontroller Software Interconnection Solution

[1]Ms. Priyanka Nagaral,[2]Ms. Manasa K. M,[3]Prof. Yuvaraj T
Dept. of Electronics and Communication
Alva's Institute of Engineering and Technology

***Abstract*:- Brain Computer Interface is a leading technology in today's world. In simple words, it creates an interface between the brain and the machine, allowing the machine to get input from human brain. This technology has been up in the airs since decades and a lot of work has already been done, but a lot is also remaining. The main use of this technology is in the field of medical science. Works are being done in the field of military and skill improvement domains as well. This technology is growing day by day and is proving to be one of the most important technologies in the current scenario. This project shows how Brain Computer Interfaces (BCI) works and how it can be used in certain applications. Electroencephalography(EEG) was used to read brain waves and then those waves were analyzed to fetch fruitful results which are used in certain applications.**

SECTION1: INTRODUCTION

The project titled '*Brain Computer Interface & its Applications*' is processed and designed under multiple software's, MATLAB and Visual Studio. Core programming languages used Python and C#. The project aims to deal with creating an interface between human brain and a computer using Electroencephalography (EEG) technique, a technique to read brain waves using sensors that read delta, alpha, beta, gamma & theta waves from the brain, amplifies it and gives the output in form of numerical values toss the machine. The users just need to think of movement
in order to drive the system. Several brain scanning techniques like FMRI, PET, or EEG.capable to analyze what you are thinking, dreaming, or seeing.
EEG device that is used to read the brain waves is Neurosky Mind wave Headset (MW001). The field of BCI research and development has thus focused primarily on neuro-prosthetics applications.

The major goal of this project is to develop a system that allows disabled people or ALS (Amyotrophic Laterals Sclerosis) to communicate with other people and thus help them to interact with the external environments. For this purpose, there are invasive and non-invasive types of EEG sensor, known as Neurosky Mindwave Mobile These brain waves are further used to control and actuate a moving robotic gripper. These parameters are parsed using Bluetooth communication. The initial stages of collecting and analyzing the brain waves was done using the a BCI platform known as Open Vibe. The processed data from this platform was further collected in Matlab to reduce the noise. The second stage of the system aims at controlling the above-mentioned application.

Here a Python Interface is established to collect the Sense parameters and transmit it to the microcontroller. This is done by establishing a Telnet communication using the Think Gear socket protocol. The Sense values are thus transmitted to microcontroller. Thus, the different movements of the moving robotic gripper are controlled which aims at picking
and placing an object It comprises of a Wi-Fi dongle and two lobes, frontal lobe for forehead and another lobe that connects to left ear. In all, the device can detect and give three values which can be used to develop mind-controlled applications:

- Raw Values
- Attention Values
- Meditation Values
- Eye Blink Strength

SECTION2: BLOCK DIAGRAM

The platform used to extract real-time data is Python. A connection between Neurosky Headset and python is established using Telnet Communication to collect and parse the data. The collected data undergoes corresponding signal processing, data extraction and feature recognition. The processed data, in real time, is then forwarded to the Teensy microcontroller. Using this, further data extraction is done to drive the corresponding sensors. It is further coded depending on the blink values and the robotic gripper is thus controlled to pick and place objects by the user.

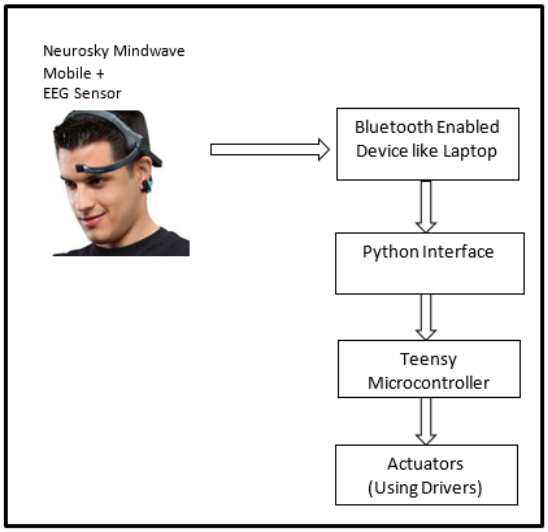

Fig1:Block Diagram of the system

The most fundamental idea of BCI is to convert the brain patterns or the cerebral activity into respective scenarios which can be used for various control applications. In this project, we are using a non-invasive environment to develop a Brainwave Controlled Prosthesis gripper. Neurosky Mindwave Mobile headset is used to detect the brain waves in real time.

The block diagram is as shown in Fig: 2. The headset transfers data using Bluetooth communication. A python interface is created to obtain the values on the Python Shell. This is established using Telnet communication to the headset. A local host (13854) is used to establish connection between python shell and the headset. These values are sent to the Teensy microcontroller through serial communication. An interface with the Dual H-Bridge and the microcontroller is created. Based on the different actuation commands obtained from the microcontroller the moving gripper is controlled.Neurosky headset allows the performance metrics and monitoring of the users emotional states, which allows to modify user interface of computer according to the emotional state of the user. Monitoring of facial expressions allows to give commands to the host computer via different mimic expressions including blink of eye, eyebrows raise, smile, clench of teethes and others. The direction suite reads and interprets a user's conscious thoughts and intent. Via the mental commands the user is able to manipulate virtual or real objects.

Fig2: neurosky headset

Arduino is an open-source prototyping platform based on the easy-to-use ecosystem of financially affordable hardware and open source software. Arduino boards are available commercially in ready to use form original vendors or from third parties or it is possible to obtain Arduino boards as the do-it-yourself kits. Designs of the Arduino boards are published under the Creative Commons License. Programming of the Arduino microcontroller “Fig 3.” is possible with the use of the Arduino Software Integrated Development Environment “I.D.E.” that is programmed in Java language and is available for Windows, Macintosh OS X and Linux operating systems. Arduino boards are very popular and there are thousands of amateur, BCI professional, industrial and scientific commercial and open-source projects based on them.

“Fig 3.”. Arduino “U.N.O”

The proposed software solution is not only the Graphical User Interface “G.U.I.” for the purpose of easy configuration of the interconnection between supported facial expressions and the particular inputs of the microcontrollers of Arduino family. The platform used to extract real time data is Matlab The headset transfers data using Bluetooth communication. A python interface is created to obtain the values on the Python Shell. This is established using Telnet communication to the headset. A local host (13854) is used to establish connection between python shell and the headset. These values are sent to the Teensy microcontroller through serial communication. An interface with the Dual H-Bridge and the microcontroller Is created. Based on the different actuation commands obtained from the microcontroller the moving gripper is controlled. The blink strength values range from 0-255. A higher number indicates a strong blink while a smaller number indicates regular/lighter blink. The frequency of blinking is often correlated with nervousness. Based on these values, it is coded to perform the control applications

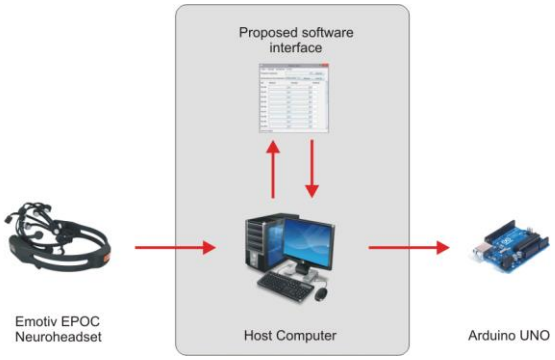

Fig 4. Proposed software interface on the host computer interconnects Emotive EPOC Neuro headset and Arduino microcontroller

SECTION 3: WORKING OF THE DEVICE

The platform used to extract real time information is Python. A connection between neurosky headset and python is centered utilizing talnet conversation to acquire and parse the information. The gathered data undergoes corresponding signal processing knowledge extraction and have recognizance. The processed information in real time is then forwarded to the Teensy microcontroller. utilizing this, additional knowledge extraction is done to force the corresponding sensors. Its further coded relying on the blink values and robotic gripper is thus managed to choose and python objects by using the user.

The most fundamental idea of BCI is to convert the brain patterns or the cerebral activity into respective scenarios which can be used for various control applications. In this project, we are using a non-invasive environment to develop a Brainwave Controlled Prosthesis gripper. Neurosky Mindwave Mobile headset is used to detect the brain waves in real time. The block diagram is as shown in Fig: 2. The headset transfers data using Bluetooth communication. A python interface is created to obtain the values on the Python Shell. This is established using Telnet communication to the headset. A local host (13854) is used to establish connection between python shell and the headset. These values are sent to the Teensy microcontroller through serial communication. An interface with the Dual H-Bridge and the microcontroller iscreated. Based on the different actuation commands obtained from the microcontroller the moving gripper is controlled. The blink strength values range from 0-255. A higher number indicates a strong blink while a smaller number indicates regular/lighter blink. The frequency of blinking is often correlated with nervousness. Based on these values, it is coded to perform the control applications as shown in Table 1.

Action	Range	Actuation
Long Blink	40-60	Forward
Quick Blink	Normal Blink	Backward
Stress Blink	>100	Stop
Blink (twice)	40-70	Move Left
Stress Blink (twice)	90-255	Move Right
Attention 1	40-60	Pick
Attention 2	70-100	Place

Table 1 Blink and Attention status to perform control application

SECTION 4: RELIABILITY AND RESPONSE TIME TEST

Proposed software interface is fully designed, implemented and tested. Tests were realizes on 64-bit version of windows 7 operating system with the use of Arduino "U.N.O." Arduino "U.N.O." is connected to the host computer concurrently and the number of tests were conducted in which commands from the headset were sent to the boards and reliability and response time of the Arduino reactions were monitored. In reliability tests series of facial expressions were performed and it was tested if this expressions is detected and if it causes the adequate response of the Arduino Board. The second column of the Table II summarizes reliability of facial expressions detection by the Neuroheadset within all 120 particular facial expressions performed. Another column comprise

SECTION 5: RESULT

The program allows to attach arduino board to the host computer and to configure interconnection between arduino board and commands which can be generated by way of the neurosky software.

SECTION 6: CONCLUSION

The paper offered BCI as the part of HMI and discussed the possible of it. The neurosky headset as the non invasive solution for monitoring of neural exercise of the CNS and particularly the brain. The application makes it possible for to connect arduino board to the host computer and to configure interconnects between arduino board and instruction which can be generated.

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B. Obermaier was born in 1972. He received the Ph.D. degree in biomedical engineering from the Graz University of Technology, Graz, Austria, in 2001.

G. R. Müller (M'03) received the M.S. degree in biomedical engineering from the Graz University of Technology, Graz, Austria, in 2000. He is currently working toward the Ph.D. degree at the Department of Medical Informatics, Institute of Biomedical Engineering, Graz University of Technology. His research interests include brain-computer communication systems and the human somatosensory system.

G. Pfurtscheller (M'00) is currently a Professor of medical informatics and the Director of the Institute of Biomedical Engineering at the University of Technology, Graz, Austria. He is involved in a number of research programs including the design of a "brain-computer interface " and studies in functional brain topography using event-related resynchronizations.