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Automated wheel-chair on eyebrow movements using brain wave sensor by EEG

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Abstract

This project presents brain controlled applications based on Brain–computer interface (BCI). BCI is becoming increasingly studied as the way users interact with computers because recent technological developments have led to low priced, high precision BCI devices. These systems can bypass conventional channels of communication (i.e., muscles and thoughts) between human brain and physical devices.

The device tested in this paper is called NeuroSky MindWave Mobile, which is an electroencephalograph (EEG) measuring device and enables the measuring of brain activity using 2 strategically placed sensors – 1) A clip on Ear Lobe 2) Electrode on the forehead.

With the help of this, we are analysing the brain wave signals. Human brain have millions of interconnected neurons. The interaction pattern between these neurons is represented as emotional states and thoughts. This pattern will be changing as the human thoughts changes, which in turn produce different electrical waves. Neural bio-recorder used as input which measures and interprets brain activities. The application of a single electrode measures the change in field potential over time arising from synaptic current and forms the basis for EEG.

Readings will be inferred from processing beta and alpha waveform activity. Provides two 100-scale outputs described by the NeuroSky MindWave Mobile chip as “Attention” and “Meditation”. Eye blinking results can be found by observing a peak difference in voltage value of brain wave signals. For a variety of inputs from the users, the number of eye blinks can be recorded and different tasks can be associated with them.electrical waves are sensed by the brain sensor which converts that data into packets and transmitting via a Bluetooth medium to Ardunio due to which automation is achieved.

Keywords: brain computer interface (BCI), neurons, brain wave sensor, EEG

1. Introduction

BCI measures the brain activity of a user and then identifying the thought pattern or desired action using brain waves of the user. BCI have been investigated in many applications like medical and commercial, such as physiotherapy [1, 10] and measuring brain activity of individuals to stimuli [2, 3]. Typical BCI equipment that utilize EEG [4] to measure brain activity is expensive and require expert knowledge to setup and use. The signals generated by brain are received by the brain sensor and they will divide into packets and the packet data transmitted to wireless medium (Bluetooth) [5]. The wave measuring unit will receive the brain wave in raw data format and it will convert into signal using MATLAB GUI platform. Brain-computer interface is nothing but the interaction between the human brain system and machines; it is a control system which enables the people to communicate and control a device by mere thinking. BCI collects the information from the brain and give commands to computer interface at the same time and operate different appliances. This is an electrical activity that records brain waves from scalp of the brain. The use of sensors make it possible to monitor brains neuron process activities that can relate to certain form of thoughts such as how much focused we are in certain objects from an interview to interviewer to get out the thoughts as an analogue value and convert it to digital signals output produced by human brain.

From the past few years, the advancement in Information Technology (IT), cognitive neuroscience and brain signals capturing technologies by external devices both in non/or invasive allow us to interact with human brain directly. For decades, human have been fantasizing to communicate and interact with machines via thoughts itself and moreover expectation was always that the devices will be able to reveal human brains, feelings, meditation as well as attention. NeuroSky Mind Wave [6] logs the wearer’s mental state in the form of NeuroSky’s embedded properties like Attention and Meditation with the help of eSense algorithms not an open source platform. People with cerebral palsy, who have their cognitive function preserved, but are unable to communicate or move, or both, require technological learning aids.

2. Hardware specifications

i) NeuroSky Mind Wave

It is a brainwave sensor which sense the voltage difference between the different waves running in our mind such as alpha, beta, delta which further are responsible to some certain emotion state of mind. It reads the values and passes them to the system for further use in physical action.

ii) Arduino Uno Board.

This is the Micro Controller used for the application performed of wheelchair in which automation is done using Analog and Digital pins which gets their inputs from CPU. Uno board has limited functions and can perform the required task in cheaper rates.

Alternates are Raspberry pie and Arduino Board.

iii) Motors

Two DC motors have been used to control the motion of wheelchair in four different direction by synchronizing the movement individually.

iv) Motor Driver

It is used to control the motors and its uses, which gets its input directly from Microcontroller and performs the actual automation.

v) Flow and Design

After the BrainWave headset is switched ON, it will start sensing the neural signals and via the Bluetooth, it will send the Serial data to interconnected Processor. There the programming language module like MATLAB/Python will check the attention and Eye Blinking Levels.

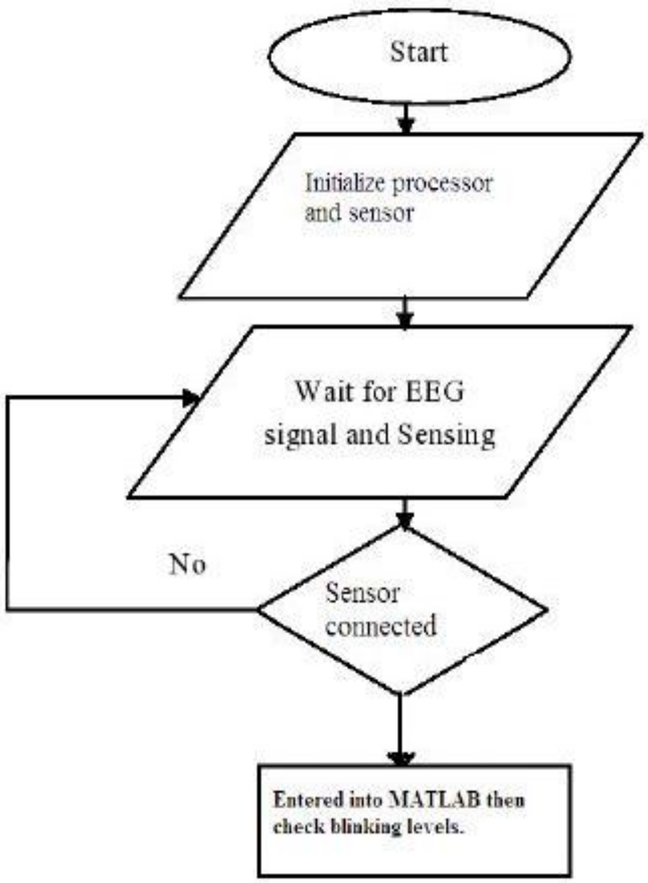

Fig 1: Design Flow

The results obtained with NeuroSky headset doesn't give the 100% accuracy of brainwaves but it is too good for its price and it can give up to 80 % accuracy of brainwaves. After installing all the NeuroSky software's in PC, and connecting the Headset with PC through PC using Bluetooth, we need to wear the headset to the head and then we needed to open the Matlab/Python Code and run the program, after clicking run the program in the command window, it will display the brainwave is connected, blink is detected and after that it will show the attention values and Blink values.

3. Determining Attention

Neural bio-recorder used as input which measures and interprets brain activities. The application of a single electrode measures the change in field potential over time arising from synaptic current and forms the basis for EEG. Readings will be inferred from processing beta and alpha waveform activity. Provides two 100-scale outputs operating at 0.5 Hz described by the NeuroSky MindWave chip as "Attention" and "Meditation".

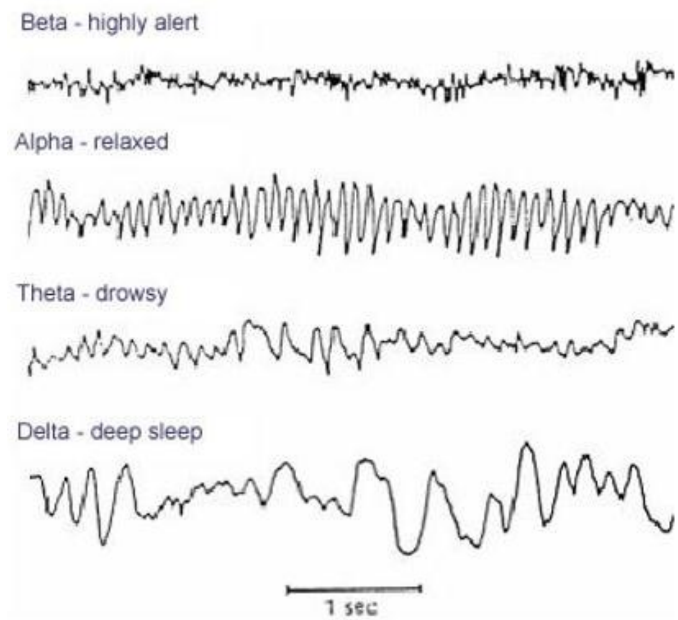

Fig 2: Waveform and its activities

Alpha Rhythm

- 8~13 Hz
- Indication of physical relaxation and relative mental inactivity

Beta Rhythm

- 13~35 Hz
- Indication of mental activity

4. Mathematical Model

The active and reference electrodes in the EEG headset measure electrical potential. Electrical potential is supplied directly to the embedded chipset for filtering as well as separation. The relative power of the alpha and beta waves in relation to the total EEG signal can be used to determine the cognitive state of person.

The equations used for analysis are as follows

$$\alpha_i = \sum_{k=1}^{n} P\alpha_k$$

$$\beta_i = 5 \sum_{k=1}^{n} P\beta_k$$

N is the number of electrodes (one in this case), $P\alpha_k$ is the power in the alpha band for signal k and α_i is the total power in alpha band for all N signals at time window i. These variables are same for the beta band. The power of the beta wave is multiplied by five because beta waves are usually smaller than alpha waves by a factor of five.

If $\alpha_i > \beta_i$, then the state is relaxed, otherwise, the state is attentive.

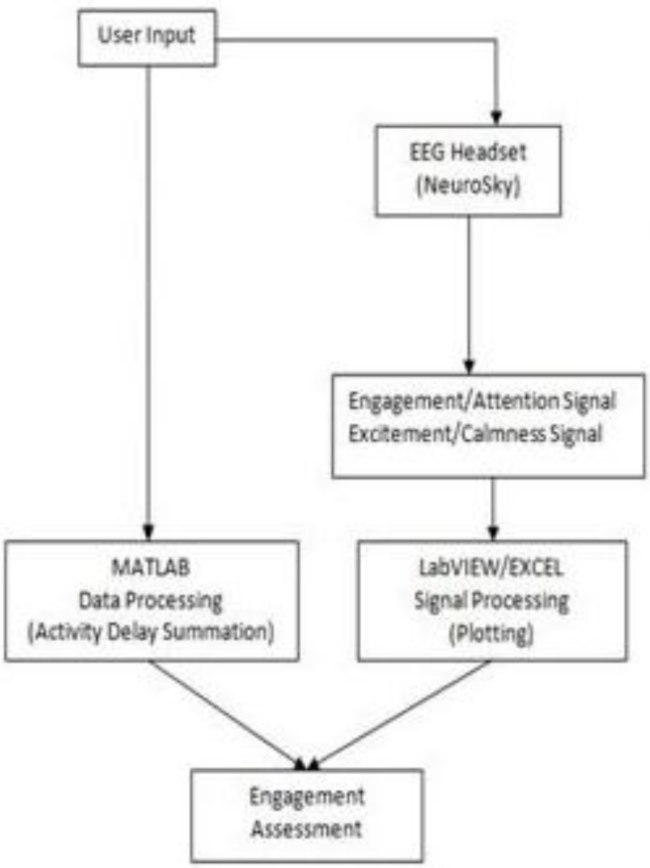

Fig 3: Flow Diagram

5. Procedural Working

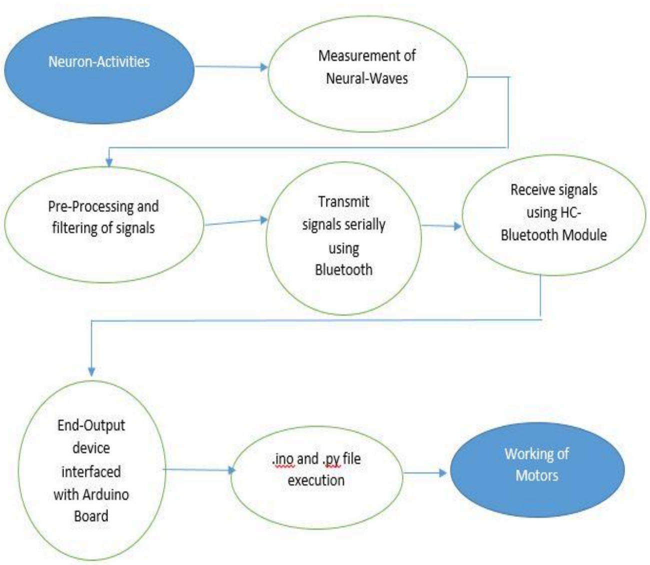

Fig 4

The initial setup states that the patient sitting on the wheel-chair must be wearing the NeuroSky MindWave Headset. In front of the patient, there would be a display screen having options flashing at specific time interval. When the desired option is being flashed on-screen, the eyebrow-movement gesture has to be made by the patient. This will send raw signals to the Arduino board which synchronized with both, the headset and the code.

In order to link the MATLAB with the NeuroSky, a special class file is included namely 'ThinkGear.dll'. This contains various methods that are used inside the program to detect levels of emotions and at-last detect eyebrow movements. Once the signals from the Headset reaches the code, the required operation is performed on the wheel chair by specific movements of two motors attached in it. These combination of movements can be seen in following Table 1:

Table 1

Direction of wheel-chair	Motor1	Motor2
Forward	Forward	Forward
Backward	Backward	Backward
Left	Backward	Forward
Right	Forward	Backward

Along with these options on the screen, a 'STOP' operation is added alternate to all other operations. This is because, STOP operations may be used very frequently and in case of emergency, the patient has faster way to stop the wheel-chair.

6. Future Scope

A wheelchair can be made which can be operated by a wireless remote. Output of sensor can be applied to wireless transmitter circuit and can received at wheelchair circuit by receiver circuitry. So, wireless operation can reduce wiring arrangements.

Instead of using acceleration motion (eyebrow Movement) we can use eye retina using optical sensor to move wheelchair in different direction. Using retina movement we would be able to drive a wheelchair. We can use voice command IC to interface our voice signals with microcontroller. So computer interfacing may not be needed. The voice stored in IC could be sufficient to analyze speakers voice Command. Researchers are going on development of handicap wheelchair using nervous system of human. We can use Bluetooth receivers which will remove the half of the wire connections and we can use this wheelchair for long distances with the help of Bluetooth receivers. Range of movement of the wheelchair increases if we use Bluetooth controlled receiver.

As future work a more improved method of classifying intended actions using advanced machine learning techniques is suggested. Furthermore, a BCI system that complements conventional HMI techniques, that may increase the accuracy and responsiveness, will be investigated.

7. Conclusion

The signals generated by brain were received by the brainwave sensing device and divided into packets and the packet data transmitted to wireless medium (Bluetooth). The wave measuring unit received the brain wave raw data and it converted into signal using MATLAB Programming Platform. Then the instructions will be sent to the wheelchair for further operations.

8. References

1. Webb J, Xiao ZG, Aschenbrenner KP *et al.* Towards a portable assistive arm exoskeleton for stroke patient rehabilitation controlled through a brain computer interface. In Proc. of 4th IEEE RAS & EMBS

International Conference on Biomedical Robotics and Biomechatronics (Bio Rob). 2012, 1299-1304.
2. Khushaba RN, Wise C, Kodagoda S, *et al*. Consumer neuroscience: Assessing the brain response to marketing stimuli using electroencephalogram (EEG) and eye tracking," in Expert Systems with Applications, (in printing). 2013.
3. Stopczynski A, Larsen Lyngby JE, Stahlhut C *et al.* A smartphone interface for a wireless EEG headset with real-time 3D reconstruction. In Proc. of International conference on Affective computing and intelligent interaction (ACII'11). 2011, 317-318.
4. Jie Liu, Ping Zhou. Senior Member, IEEE, A Novel Myoelectric Pattern Recognition Strategy for Hand Function Restoration After Incomplete Cervical Spinal Cord Injury ieee transactions on neural systems and rehabilitation engineering. 2013, 21(1).
5. Chiou JC, Ko LW, Lin CT, Hong CT, Jung TP, Liang SF *et al.* Using novel MEMS EEG sensors in detecting drowsiness application, presented at the 2006 IEEE Biomed. Circuits Syst. Conf. (Bio CAS), London, U.K.
6. Neurosky Mindwave. http://neurosky.com/Products/MindWave.aspx, Accessed 10 February, 2013.
7. Wijayasekara D, Manic M. Human Machine Interaction via Brain Activity Monitoring.
8. Emotiv. Website: http://www.emotiv.com/, Accessed 10 February, 2013.
9. Sujatha B, Ambica G. EEG based brain computer interface for controlling home appliances.
10. Palankar M, De Laurentis K, Dubey R. Using biological approaches for the control of a 9-DoF wheelchair-mounted robotic arm system: Initial experiments. In Proc of IEEE International Conference on Robotics and Biomimetics. 2009, 1704-1709.