International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 09 | Dec-2015 www.irjet.net p-ISSN: 2395-0072

EEG BASED BRAIN COMPUTER INTERFACE FOR CONTROLLING HOME APPLIANCES

B. SUJATHA[1], G. AMBICA[2]

[1] *Associate Professor, Department of ECE, LINGAYA'S INSTITUTE OF MANAGEMENT & TECHNOLOGY, INDIA*

[2] *M.Tech, Department of ECE LINGAYA'S INSTITUTE OF MANAGEMENT & TECHNOLOGY/INDIA*

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ABSTRACT: *This project discussed about a brain controlled home appliances based on Brain–computer interfaces (BCI). BCIs are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a home appliances can be controlled. Here, we are analyzing the brain wave signals. Human brain consists of millions of interconnected neurons. The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using Mat lab platform. Then the instructions will be sending to the home section to operate the modules (bulb, fan). The project operated with human brain assumption and the on off condition of home appliance is based on changing the muscle movement with blinking.*

KEY WORDS – *BCI, Neurons, brain wave sensor, brain wave raw, data Level analyzer unit (LAU).*

I. INTRODUCTION

In this present world many people are coming across many problems, one of those problems is physically handicapped and aged people depending on others to complete their tasks. Technology can be used to reduce this problem to maximum extant using BCI (Brain-computer interface)[1].Brain-computer interface is nothing but the interaction between the human neural system and machines; it is a control system which enables the people to communicate and control a device by mere thinking.

Different brain states are the result of different patterns of neural interaction. These patterns lead to waves characterized by different amplitudes and frequencies. This neural interaction is done with multiple neurons. Every interaction between neurons creates a minuscule electrical discharge. This project dealing with the signals from brain. Different brain states are the result of different patterns of neural interaction. These patterns lead to waves characterized by different amplitudes and frequencies. The signals are recorded by electroencephalogram (EEG) [2]. The signal generated by brain was received by the brain sensor and it will divide into packets and the packet data transmitted to wireless medium (blue tooth)[3].the wave measuring unit will receive the brain wave raw data and it will convert into signal using MATLAB gui platform. Then the instructions will be sending to the home section to operate the modules (bulb, fan). The project operated with human brain assumption and the on off condition of home appliance is based on changing the muscle movement with blinking. The basic idea of BCI is to translate user produced patterns of brain activity into corresponding commands. A typical BCI is composed of signal acquisition and signal processing (including preprocessing, feature extraction and classification) [4]. Although some BCI systems do not include all components and others group two or three components into one

Algorithm, most systems can be conceptually divided into signal acquisition, preprocessing,

Feature extraction, and classification.

II. DESIGN AND IMPLEMENTATION

This project work consists of a Processor using ARM7core, brain wave sensor and alert unit obstacle detection unit as hardware parts and an effective brain signal system using Mat lab platform. In this project initially the person's attention level or else the blinking level should be found out by the brain wave sensor.

Fig 1: Brainwave Headset provided by NeuroSky

The signals from our brain are taken by using the brain sensor shown in fig;1. EEG Sensor to Sense the Human brain, and it will be sensed by using the Brainwave Headset which is provided by NeuroSky i.e Dry electrode [5]. Technologies and those signals will be transferred by using Bluetooth which is there in the Brainwave headset, for this Brainwave headset we need to give power using a AAA battery .The Brainwave headset comes with Power switch, a sensor tip, flexible ear arm and a ground connection Ear clip. In this Headset we use Non-invasive sensor that won't cause any pain to the User who were the headset. After inserting 3 AAA batteries switch on the Brainwave headset automatically the LED indicator will blink in GREEN colour which shows the sensor is on.

Coding Platform:

In this project a brain computer interface system is used which will do the key role in the entire operation. For the BCI system, we are using the MATLAB and for brain wave sensor and Processor communication neurosky is used. The BCI will process in the following way.

For calculating the blinking levels we need to use a brain wave sensor support a neuro sky product which is called mindo3 initially we have to take the data from the brain by using neurons position and should store in the brain wave sensor. The supportable sensor in the MATLAB is given in the form of the following data function

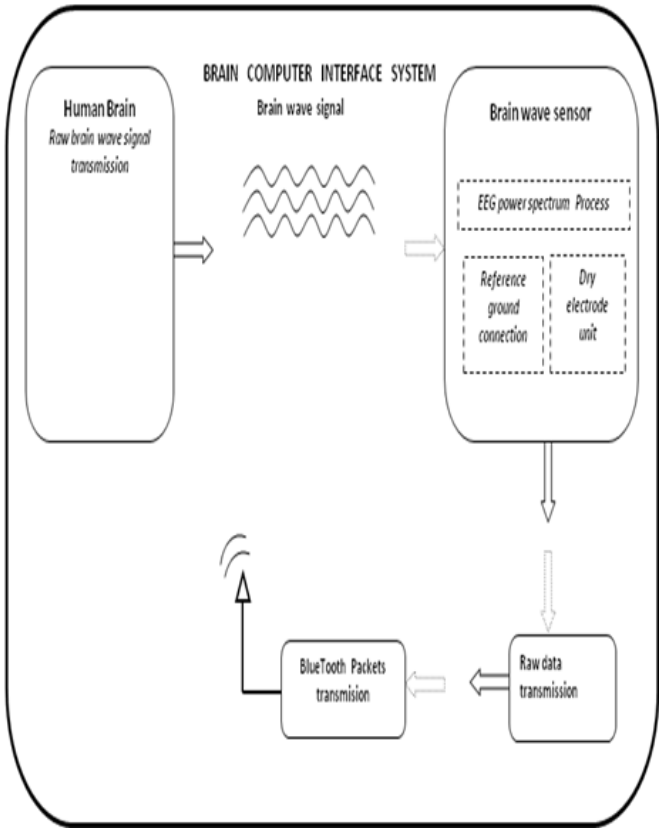

Fig 2: Brain Computer Interface Section

connectionId1 =calllib('Thinkgear','TG_GetNewConnectionId');

Initially we need to check that sensor is connected or not. The mind wave sensor software will provide the information about the sensor connection. If the sensor is connected we are enter into MATLAB section for checking the blinking levels of person.

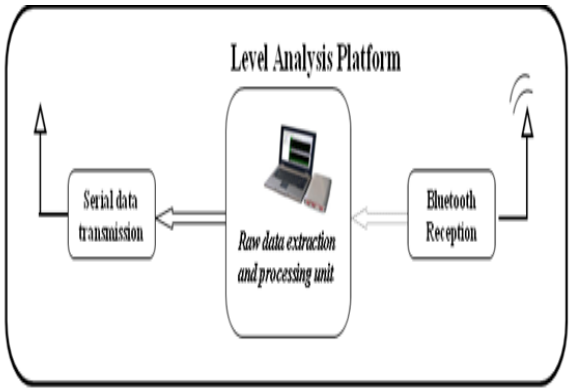

Fig 3: DATA processing unit

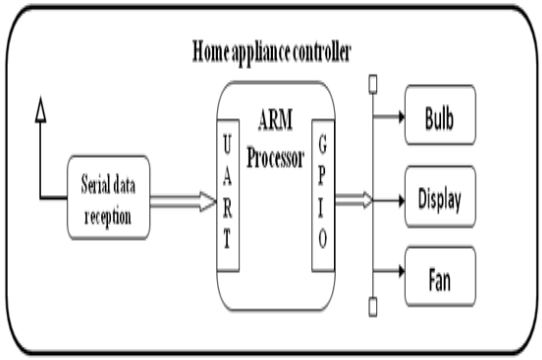

Fig 4: Home section

The Data transmitted by the Brainwave headset will be received by the Computer's Bluetooth receiver. And then all these data will be analyzed by the Level Analysis platform. The Level Analysis platform will extract the raw data using the MATLAB. After the analysis of this data, this data will be sent to the Home appliance controller using serial data transmission i.e. RS232 According to the data received by the RS232 the ARM processor will give the directions to the GPIO to control the home appliances.

III.SYSTEM HARDWARE

3.1 ARM Processor

The ARM processor is 32-bit embedded RISC microprocessor. The ARM7 processor needs very low power, high performance and small size. Here in this paper I'm using ARM7 processor and ARM processor will receive the signals from the Bluetooth receiver and it will process the signals and it will give the signals to the Driver Circuit and according to that signals received from the processor, according to the signals received driver circuit controls the home appliances. Here ARM processor will wait until the signals received from the Brainwave headset and after receiving the signals it will controls the appliances. The driver circuit will connected to the port 1 of the processor

3.2 EEG Signals

EEG signals can be collected with electrodes that are placed on the surface of the scalp. The most widely used electrodes are silver/silver chloride (Ag/AgCl) because they have low cost, low contact impedance, and relatively good stability. Furthermore, there are rather mature commercialized acquisition systems including the amplifier and EEG cap with integrated Ag/AgCl electrodes, which have been successfully applied in scientific research and clinical diagnosis. However, using Ag/AgCl electrodes requires removing outer skin layer and filling gel between electrodes and scalp (and thus, this kind of electrodes is also called "wet" electrodes). These operations take long time and are uncomfortable to users. To address these limitations of "wet" electrodes, some researchers have been exploring "dry" electrodes, which do not need to use gel and skin cleaning. The main disadvantage of existing dry electrodes is that the acquired EEG signals are worse than those acquired with conventional electrodes due to the increase of contact impedance. Some companies (such as Quasar, Emotiv Systems Inc., and NeuroSky Inc.) have been commercializing acquisition systems based on dry electrodes. Here we are using NeuroSky Brainwave headset. However, they are not yet mature, and some researchers have doubts about what physiological signals these systems actually acquire.

3.3RS232communication

In telecommunications, RS-232 is a standard for serial binary data transmission connection between data terminal equipment and a DCE

(information Circuit-terminating gear). It is more often than not utilized in pc serial port through its serial port, the module can communicate with any logic and voltage compatible UART. The computer will transform the data which is analyzed by using the Level Analyzer unit using MAT lab. The data which is transmitted by the RS232 module from the computer will be received by the ARM processor.

3.4NeuroSky Technology

i. Brainwaves:

The last century of neuroscience research has greatly increased our knowledge about the brain and particularly, the electrical signals emitted by neurons firing in the brain. The patterns and frequencies of these electrical signals can be measured by placing a sensor on the scalp. The Mind Tools line of headset products contain Neurosky Think Gear technology, which quantify the analog electrical signals, commonly referred to as brainwaves, and exercise them into digital signals. The Think Gear technology then makes those computations and signals available to games and applications

ii. eSense

eSense is a NeuroSky's proprietary algorithm for representing mental states. To calculate eSense, the NeuroSky Think Gear technology intensifies the raw brainwave signal and removes the ambient noise and muscle movement. The eSense algorithm is then applied to the remaining signal, resulting in explicated eSense meter values. Please note that eSense meter values do not interpret an exact number, but instead describe ranges of activity. The eSense meters are a way to show how effectively the user is captivating Attention (similar to concentration) or Meditation (similar to relaxation).

(a)Attention eSense:

The eSense Attention meter shows the intensity of a user's level of mental “focus” or “attention”, such as that which occurs during intense concentration and directed (but stable) mental activity. Its value ranges from 0 to 100. Distractions, wandering thoughts, lack of focus, or anxiety may lower the attention meter level.

(b)*Meditation eSense:*

The eSense Meditation meter shows the level of a user's mental “calmness” or “relaxation”. Its value ranges from 0 to 100. Note that Meditation is a measure of a person's mental states, not physical levels, so simply relaxing all the muscles of the body may not instantly result in an intensified effect meditation level. However, for most people in most normal circumstances, relaxing the body often helps the mind to relax as well. Meditation is related to reduce activity by the active mental processes in the brain. It has long been an observed that closing one's eyes turns of the mental activities which process images from the eyes. So closing the eyes is often an effective method for increasing the

Meditation meter level. Distractions, wandering thoughts, anxiety, agitation, and sensory stimuli may lower the Meditation meter levels.

iv. eSense Meter - Technical Description

For each different type of eSense (i.e. Attention, Meditation), the meter value is reported on a relative eSense scale of 1 to 100. On this scale, a value between 40 to 60 at any given moment in time is considered “neutral” and is similar in notion to “baselines” that are established in conventional brainwave measurement techniques (though the method for determining a Think Gear baseline is proprietary and may differ from conventional brainwaves).

IV.DESIGN FLOW

After Switching on the Brainwave headset and the processor will initialize and the headset will starts sensing the neurons signals and after sensing the signals it will transfer them to through the Bluetooth to the system it enter into the Matlab to check the attention and eye Blinking Levels.

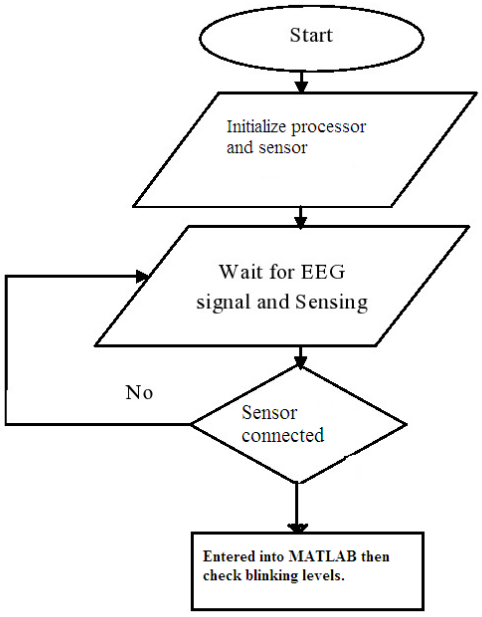

Fig 5: Design Flow

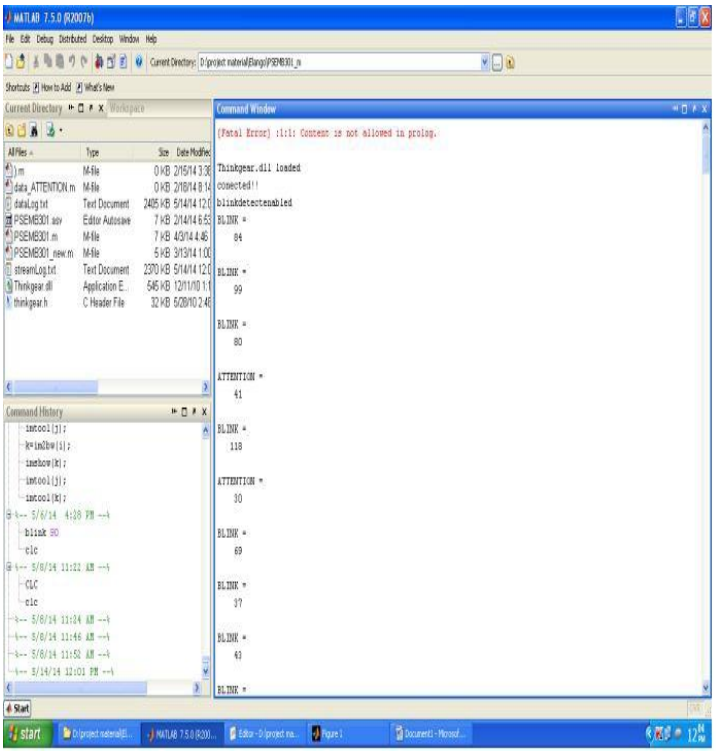

Figure 6: Screenshot of Attention level and Blink level

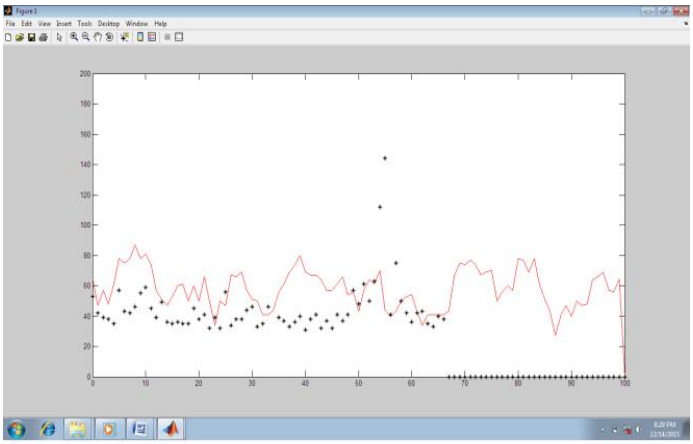

Figure 7: Screenshot of Graph (Black: Blink level, Red: Attention Level)

V. RESULT AND DISCUSSION

The results are chected with NeuroSky headset, the 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, after 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 Mat lab Code and run the program, after clicking run the program in the command window of mat lab it will show the brainwave is connected and blink is detected and after that it will show the attention values and Blink values which is shown in figure 6 After getting these attention and blink values a graph will be generated and In the graph there will be two signals, the Black Signal is Blinking level and the red signal is Attention signal shown in figure 7 . From here these signals will be transferred to the processor, Processor decodes the signals as per Brainwave signals and according to the signals the Processor gives the commands to the home section to control the appliances.

VI.CONCLUSION

The signal generated by brain was received by the brain sensor and it will divide into packets and the packet data transmitted to wireless medium (blue tooth).the wave measuring unit will receive the brain

wave raw data and it will convert into signal using MATLAB gui platform. Then the instructions will be sending to the home section to operate the modules (bulb, fan). The project operated with human brain assumption and the on off condition of home appliance is based on changing the muscle movement with blinking. The Brain Computer Interface has proved to be boon to the disabled persons by providing them independent environment not by manual control but by mere "thinking".

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ACKNOWLEDGEMENT

The authors would like to thank Ms.B.Sujatha for the hardware and software development, useful discussion and data acquisition.

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GADE AMBICA pursuing M.Tech in Lingayas Institute of Management &Technology, Vijayawada in the Stream of Electronics &Communication Engineering was born on 23rdApril 1992.She received graduation with a bachelor degree in Electronics & Communication Engineering Information from Amrita Sai Institute of Science & Technology, Kanchikacherla in 2013.

Sujatha Bethapudi, M.Tech working as an Assoc. Professor in ECE Department at LINGAYAS INSTITUTE OF MANAGEMENT & TECHNOLOGY, Madalavarigudem, Vijayawada. She was born on 10th June, 1979. Since her keen interest in Embedded systems, Communications, Processors and strong support from LIMAT, the author is involved in the development of monitoring, Communication Systems, Processor based applications and other automation applications for industries, Research & Development.