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BRAIN COMPUTER INTERFACING FOR CONTROLLING HOME APPLIANCES

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ABSTRACT: **This paper discusses about a brain controlled home appliance system based on Brain–computer interface (BCI). BCIs are systems that provide another communication technique (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different signals of brain activity into commands in real time. With these commands home appliances can be controlled.Human brain consists of many numbers of interconnected neurons. The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern changes which in turn produces different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical signal will be sensed by the EEG sensor and it will convert the data into packets and transmit through Bluetooth or IR transmitter medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using ARDUINO platform. Then the instructions will be sent to the control 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.**

KEYWORDS–
BrainComputerInterface, Electroencephalography, Peripheral Interface Controller, Analog to Digital Converter.

I. INTRODUCTION

Brain-Computer Interface (BCI) technology is a new and fast evolving field that seeks direct interaction between the human neural system and electronic devices, aiming to augment human capabilities by enabling people (especially disabled) to communicate and control devices by using EEG sensor.

Many diseases can severely damage and possibly destroy the neuromuscular pathways which link the brain to muscles.If these link will not used,the brain cannot interact with the external environment .Of these diseases, we mention: amyotrophic lateral sclerosis (ALS), brainstem stroke, brain or spinal cord injury and multiple sclerosis. People that are affected with such diseases may hence lose their moving abilities such as eye movement, arm and leg movement .these patients lose there body control and become locked in their bodies . People with motor disabilities have a few solutions. In case, not all pathways have been destroyed, they can try to make more use of the remaining different pathways. For example, largely paralyzed patients can still use eye movements to answer the simple questions. However, this is only a solution when neural pathway exists to some other voluntary muscle .Evidence to this approach is the case of patients with spinal cord injury that are able to restore movement and control to paralyzed muscles through electromyography (EMG) activity from neighboring muscles . Although the above traditional solutions are very attractive and actually implemented, they are not applicable in the case of locked in patients where all their neuromuscular junctions are destroyed.

Modern brain sensing technologies provides a variety of methods for detecting specific forms of brain activity. Some papers have been written on recognizing brain signal differences during different mental calculations. These papers suggest that different parts of the brain are active during different types of mental calculation, BCI can make use of this if accurate recognition of these separate tasks can be done.

BCI is a system that captures the brain activity in the form of EEG signals Those specific features of the signal that

represent the intent of the user into and operate devices. This technology is developing very rapidly, as it has maximum uses. Assisting the elder In invasive type, an IC is implanted in the brain(internally) by surgeons disabled people and enhancing the life Quality is most significant application people prefer noninvasive BCI because it consist of EEG electrode which externally connected to human brain .

II. LITERATURE REVIEW

There are many environmental control systems were proposed and applied for people with disability to control their surroundings. Radio frequency identification and voice recognition are some of these systems. Such systems will work only for people with motion disability otherwise they will not work for people with voice reorganization. Other systems using human's physiological state were proposed. In this paper BCI system to help disabled people to control home appliances are proposed. The system based on the steady-state visual. Interaction between user's brain andcomputer can be achieved through a number of ways: Visual Evoked Potentials (VEP), Slow Cortical Potentials, P300 potentials, N400 potentials, and Sensory Motor Rhythm (SMR). To this end, VEP refers to the electrical potential recorded from the visual cortex in response to stimulation of light ; P300 is an event related potential (ERP)recorded in response to the occurrence of a discrete event, especially when the subject is actively engaged in the task[1]

Present-day BCIs determine the intent of the user from a variety of different . Electrophysiological signals. Based on this, we can classify current BCIs systems in six different categories.
The first category includes BCI systems that use Visually Evoked Potentials (VEPs). The other groups include respectively, BCI systems that use Slow Cortical Potentials (SCPs), P300 Evoked Potential (EP), mu and beta rhythms, cortical neuronal action potentials, and EEG pattern mapping. They are translated in real-time into commands that operate (Bulb, fan).

In the 1970s, Jacques Vidal developed a system that satisfied the current definition of a dependent BCI, This system used the VEP recorded from the scalp over visual cortex to determine the direction of eye gaze (i.e. the visual fixation point), and thus to determine the direction in which the user wished to move a cursor. Many similar BCIs were later developed, The main disadvantage in such "VEP-based communication systems is that they depend on the user's ability to control gaze direction, and thus they perform the same function as systems that determine gaze direction from the eyes themselves, and can be categorized as dependent BCI systems

Slow Cortical Potentials (SCPs) are slow voltage shifts that occur every 0.5-10 seconds in the cortex and can be recorded on the scalp. SCPs can be either negative or positive. Negative SCPs are usually associated withmovement and activities involving the cortex while positive SCPs are usually associated with reduced cortical activity. humans can learn to control SCPs and thereby control movement of an object on a computer screen. The principal emphasis has been on developing clinical application of this BCI system. It has been tested extensively on people with late-stage ALS and has proved able to supply basic communication capability.

The P300 is a late positive wave that occurs between 250 and 800 milliseconds after the onset of a meaningful stimulus. It was first documented in 1965 by Sutton et al who observed it as a late positive component that occurs in response to task-relevant stimuli related to the subject's reaction to the stimuli rather than the stimuli itself. Later, P300 was studied as a control

device. The first P300 based BCI was that done by Farewell and Don chin in 1988. Since then, many studies were done and P300 proved to be a relatively robust evoked electrical potential, and yet a good possible candidate for an EEG-based computer interface. A P300-based BCI has an apparent advantage in that it requires no initial user training: P300 is a typical, or naive, response to a desired choicesensor is on.

Many people have speculated that electroencephalography or other brain activity measure, might one day lead to a new non-muscular path for the brain to communicate with the external world, which is essentially a brain-computer interface (BCI). Over the past few years however, many productive BCI studies were done, backed-up by the advent of powerful and affordable computing and by a better understanding of the human brain functions. These studies aim at developing some new augmentative communication and control technology for people with severe neuromuscular disabilities such as amyotrophic lateral sclerosis (ALS), brainstem stroke,severe cerebral palsy, and spinal cord injury, and yet BCI technology is promising to be valuable.

With such a broad definition, BCIs currently exist in many different forms. What is meant by 'computer' in brain-computer interface is any mechanical/technological processing computational device. BCIs can be classified in either of the following three ways:

A. CLASSIFICATIONS OF BCIS

1. Dependent BCIs vs. independent BCIs
2. Synchronous BCIs vs. asynchronous BCIs
3. Invasive BCIs vs. non-invasive BCIs

Non-invasive BCIs are on the contrary systems where the electrodes are placed on the user's head. In general, invasive techniques provide more accurate signal translation (very low noise compared to non-invasive techniques). Thus they allow for high speed real time control, more precise information. One example of an invasive BCI is the Neuron Spike based BMI (Brain Machine Interface). Being more expensive and risky especially in clinical applications, invasive techniques are not very popular. Non-invasive techniques seem more promising for therapies. Their disadvantage is that they are time-consuming and need extensive and more accurate signal processing and feature extraction techniques. Much research has been done on improving the accuracy of such techniques especially in terms of eliminating the noise. The most common non-invasive BCIs are EEG-based BCIs, since EEGs as mentioned above provide sufficient spatial and temporal resolution at relatively low cost

III.SYSTEM ARCHITECTURE

Figure show the block diagram for controlling home appliances using brain wave. Normally we use EEG sensor for measuring the different signals of brain. According to these signals we can control the home appliances. Below systems consists of BCI system, EEG sensor, controller unit, transmitter and receiver section and different electronic appliances which we want to control. The BCI system consists of human user with EEG headset. The user brain generates various signals and according to these signals we can control different electronic devices. This paper mainly focuses on home appliance controlling strategy in achieving accurate switching and control.

The BCI unit which is used consists of EEG sensor to track the brain response signal. The signal converted to digital data and send to our processing unit (ARDUINO) through wireless transmission. Controller collects the data and takes decision according to received data. After that processing data will be sent to the general purpose input /output block.

These GPIO control the various devices according to the signal received from the controller. Due to use of this GPIO controlling

and switching action will be easily possible EEG is nothing but electroencephalography, it is the neuron physiologic measurement, via the used of electrode on the human brain The EEG electrode are carefully placed on certain areas of the brain for the purpose of collecting voltages. The resulting traces of the voltage from the brain are called electroencephalogram. Before electrodes are placed on the scalp, conductive gel is used to reduce the impedance. Normally each pair of electrode connects to the input of differential amplifier (TL07). These differential amplifiers are used for amplification of 60-100DB of voltage gain. The output of differential amplifier is passed to the high pass filter which attenuates low frequency component, after that these signal is passed to the low pass filter which are normally set at 1.06 Hz and 23-50 Hz respectively. Electro galvanic signals are filtered out using HPF and electro myography signal are filtered using LPF and the combination of these both, acts as a Band pass filter.

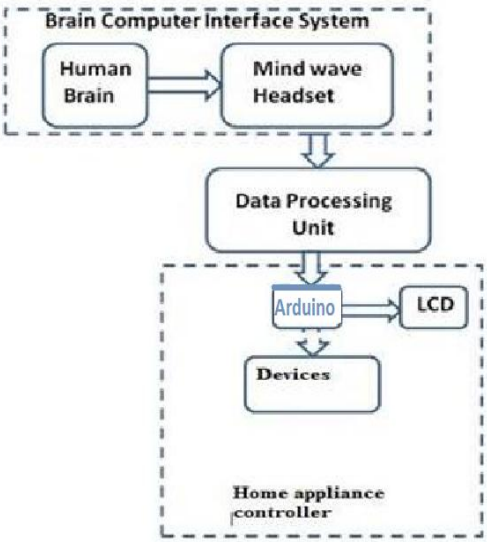

Fig.1 System architecture home appliance controller with EEG-BCI [1]

The final signal is displayed on computer screen or CRO, although it is very powerful method of collecting brain movement. EEG sensor have several limitation, scalp electrode are not sensitive enough to pick up individual action instead they pick up activity of large group of neurons. These are because large group of neurons emit larger voltage rather than the single neuron. Another main disadvantage of EEG sensor is anatomical specificity. EEG is one of the method of directly measured electrical activity. One of the main advantage of EEG is it has high resolution.

IV. METHODOLOGY

According to the control strategy the navigation and positioning of the system can be done using attention,eye blink and meditation rate. The sensor placed inthe scalp of the head touches the contact in the forehead and the reference point that located in the ear clip. The sensor collects the brain wave signals and process to digital signals in the on-board chip. Attention, meditation and eye blink rate can be calculated by using the mind wave headset. The simulation is performed in Proteus platform.

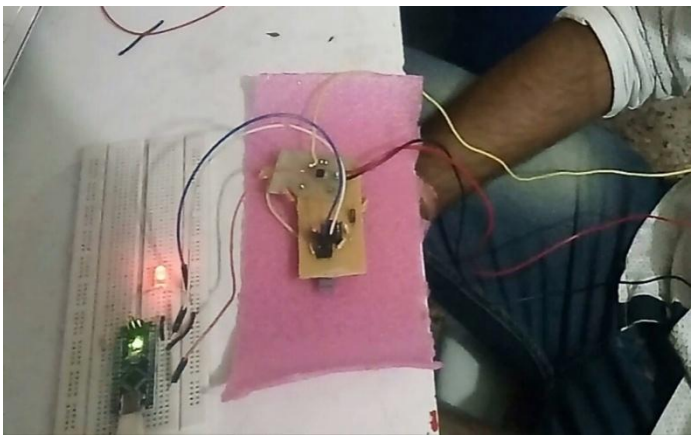

Fig:2 prototype model (Real)

For each person the attention, meditation, eye blinking rate will be different .The below values are of a person. In the proposed system - attention, meditation, eye blinking rates are tracked for operating bulb, buzzer, fan respectively. That is the operation and controlling of the system using BCI can be done in three ways-attention, eye blink and

meditation. In this paper selecting all the above three is done using mind sensing headset.

A graph is plotted which represents the attention and eye blink rate. The figure shown below represents thegraph of eye blinking and attention values at different time instants. In case of attention, the upper cut off value of that person is 80 and the lower cut off value is 40. If the attention signal tracked by the brain is greater than the upper cut off value (80), the bulb will turn on. And if the value of attention is less than lower cut off value(40) bulb will turn off. In case of eye blinking, the upper cut off value of that person is 80 and the lower cut off value is 20. If the value is greater than the upper cut off value(80) fan will turn on at high speed .If value is less than the lower cut off value(40) fan will turn off. There is an intermediate cut off value for the lower speed of fan(60).If the eye blinking rate is less than 60 fan will be at low speed.

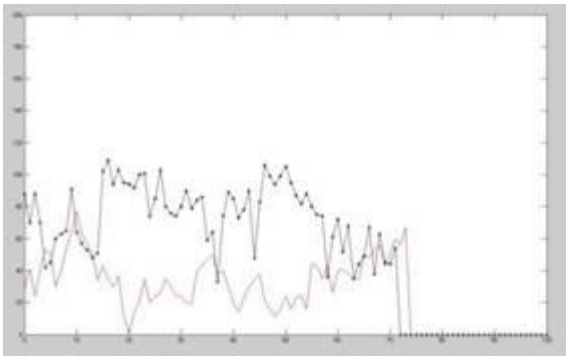

Fig.3Time Vs Amplitude of attention and eye blink

The figure below represents the graph of eye blinking and meditation values at different time instants .Meditation value has been tracked for operating the buzzer .And the eye blinking value has been tracked for operating the fan. In case of meditation, the upper cut off value of that person is 80 and the lower cut off value is 40. If the value is greater than the upper cut off value(80),buzzer will turn on .If the value is less than the lower cut off (40) buzzer will turn off.

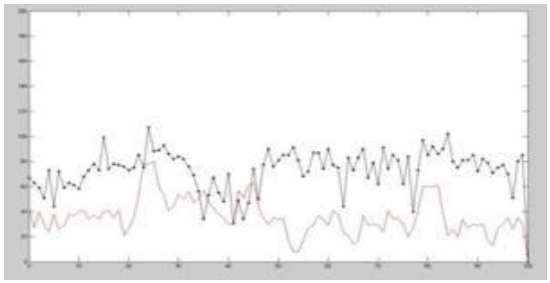

Fig.4 Time Vs Amplitude of meditation and eye blink[1]

V. CONCLUSION

Thus we have observed that the signal produced by brain was received by the EEG sensor and it will divide into data stream and this data stream is transmitted through wireless medium (blue tooth),or IR transmitter. The wave measuring unit will receive the brain wave raw data and it will convert into signal using ARDUINO platform. Then the instructions will be sending to the control section to operate the modules (bulb, fan). The project operated with human brain assumption and the on off condition of home electronic devices is based on changing the muscle movement with blinking. The Brain Computer Interface has proved to be useful for the disabled people by providing them to control home electronic devices without any physical movement.

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