CONTROLLING OF HOME APPLIANCES USING EEG SENSOR

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***Abstract*—World report on disability jointly presented by World Health Organization says that there are 70 million people disabled in the world. Unfortunately, day by day the number of disabled people is increasing due to road accidents as well as diseases like paralysis. It's not easy for elderly and disabled people to control the home appliances. Hence there is need for designing a headset which is used to control the home appliances without any physical movement. In this context, an attempt has been made to propose a thought controlled headset for controlling home appliances. Raw peak attention signals are captured using EEG (Electroencephalogram) sensor. These signals are converted to instructions using Arduino controller and instructions are used to control appliances.**

***Index Terms*— Arduino controller, Bluetooth transmission, EEG sensor, Home appliances.**

I. INTRODUCTION

In this world there are number of people who are physically challenged and there are different technologies that give physically impaired the ability to move around. But there are still people who are fully paralyzed but the mind work properly. With that mind power, so many tasks can be performed. By this technique controlling of home appliances can be done by using brain waves without any physical movement.

A Brain Computer Interface (BCI) is a new communication channel between the human brain and a digital computer. The ambitious goal of BCI is the restoration of movements, communication and environmental control for disabled people. Different brain states are the result of different patterns of neural interaction. Generally, there are different types of levels generated in the human brain. They are Meditation, Attention and Blinking. In Attention level beta waves are generated with frequencies 13Hz – 29.75Hz. In Meditation level alpha waves are generated with frequencies 7.5Hz – 11.75Hz. The peak Attention level is obtained when a person thinks a particular control i.e., ON and OFF for about 8 seconds. Then these waves are characterized by different amplitude and frequencies. The neural interactions are done with multiple neurons. Every interaction between the neurons creates a minuscule electric discharge.

This work deals with the signals from the brain. The signal which is received from brain is recorded using a sensor called brain wave sensor. The brain wave sensor which is used has two electrodes where one electrode is placed over the frontal lobe and other is ground electrode placed behind the ear. It will divide the signals into packets. Each packet is transmitted using the wireless medium (Bluetooth). Then these signals are converted into instructions. These instructions are used to control the appliances.

II. RELATED WORKS

Electro-Encephalography (EEG) devices enable real time monitoring and measurement without specialized equipment. EEG patterns have been used to recognize emotions, providing a more engaging and enriched user experience in games. The team constructed a Virtual Reality (VR) house with the thought–activated virtual devices. The VR environment served as a testing ground for development and provided user with realistic training experience [1].

A non-invasive brain interface uses EEG signals over visual cortex to control an electronic wheelchair. The signal from the brain is recorded using EEG sensor. The data are collected during a session in which four subjects (Forward, backward, left, right) are tested. This data is processed in MATLAB and the control is given to joystick and then the wheelchair is controlled [2].

Another work describes the control of the wheelchair, using brain wave and Eye-Blinking signals through a BCI interface. A simple unipolar electrode is used to record EEG signal from the forehead to construct a Brain-Computer Interface (BCI) that primarily controls electrical wheelchairs through

Bluetooth for the disabled patients. Signals like meditation and attention are taken, in addition to the eye-blinking. Therefore, attention and eye-blinking signals are collected as the management signals. These signals are converted into instructions in PC. Then these instructions are given to ARM controller through a Bluetooth interface in electric chair [3].

III. WORKING PRINCIPLE

The peak attention signals are captured from the brain through the brain wave sensor. Then these signals are transmitted to the RF transmitter using wireless medium. The received signals are then transmitted to Zigbee module then the signals are sent to Arduino controller for processing the signals. Then the signals are converted into instructions.

A. Signal acquisition

In Signal acquisition, the processing techniques and devices acquire and process the ionic electrical signals generated by the neuron signal in the brain.

As a whole there are two types of acquisition techniques:

i) Invasive acquisition

This technique acquires the brain signals through electrodes that are implanted directly in the brain tissue. Surgery is required to implant the electrodes on the cortex. This technique gives excellent quality of signals with very less delay. However, as the electrodes are pieces of wire and metal pins they are not completely reliable when placed inside the brain. Additionally, the invasive acquisition technique may prove to be an ethical controversy [2].

ii) Non-Invasive acquisition

The non-invasive technique on the other hand uses the electrophysiological signals from the scalp and takes measurements [4]. The electroencephalogram is most commonly used due to its simplicity and ease in using other than meeting with the requirements for BCI systems. In this paper, electroencephalogram is used as the signal capturing technology.

B. Types of brain waves

There are different signals that are continuously being captured by many electrodes on the scalp. These waves are classified into following:

i) Alpha waves

Alpha waves range from 8 Hz to 13 Hz. The voltage is very low of about 5 μV to 30 μV. These waves are generated when a person is in an inactive state.

ii) Beta waves

Beta waves ranges from 13 Hz to 30 Hz with the voltage of about 30 μV. These waves are generated when a person's human brain is thinking.

iii) Theta waves

Theta waves ranges from 4 Hz to 7 Hz with the voltage of about 20 μV. These waves are generated when a person is in stress or deep meditation.

iv) Gamma waves

Gamma waves range about 35 Hz or greater. These waves are generated in the human's brain when the user is conscious.

C. Application Interface

i) Connecting EEG headset to BCI:

EEG headset measures the electrical activity of the human brain. EEG measures the voltage fluctuations resulting from ionic current within the neurons of the brain [5]. The user imagines the consequences of the command for 8 seconds. The system records the mental patterns and associates them with the command. Then these signals are transmitted to Zigbee transmitter using wireless medium provided in the headset i.e., Bluetooth. The signal is transmitted from the transmitter to the receiver using USB cable.

ii) Interfacing BCI to Arduino:

The attention signals from the receiver are sent to the Arduino. There signals are processed in the computer and they are converted into instructions by Embedded C language. These instructions are dumped into Arduino Microcontroller. Arduino takes these instructions and sends the command.

iii) Sending instructions from Arduino to appliances:

The instructions which are received by the Arduino, take them as commands then sends them to appliances i.e., light, fan. Then ON and OFF of the appliance is controlled by these commands sent by Arduino Microcontroller.

This working principle is explained in the block diagram below.

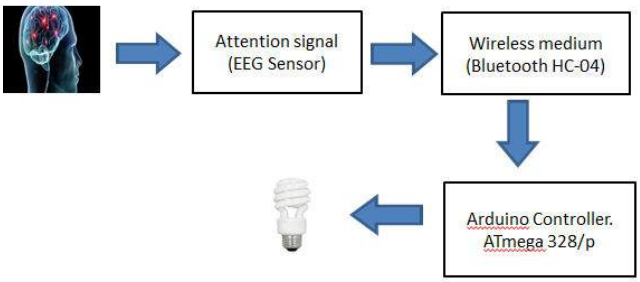

Fig.1 Block diagram

IV. REQUIREMENTS

A. HARDWARE REQUIREMENTS

i) Brain wave sensor (EEG):

An electroencephalogram detects electrical activity of the human brain. EEG sensor measure voltage fluctuation resulting from ionic current within the neurons of the brain [4]. NeuroSky's EEG sensor is used. This sensor digitizes and amplifies raw analog brain signals to deliver concise inputs. There are two electrodes used in this sensor. One is placed over the frontal lobe and other is behind the ear. This sensor has one EEG channel, Reference and Ground. The electrode used is dry electrode.

Dimensions

Size: 2.79 cm × 1.52 cm × 0.25 cm.
Weight: 130 mg

Specifications

Sampling rate: 512 Hz.
Frequency range: 3-100 Hz.
ESD Protection: 4kV contact discharge.
Operating Voltage: 2.97 ~ 3.63 V.
UART (serial): 1200, 9600, 57600 baud.

Fig.2 Neuro Sky Sensor

ii) Bluetooth

Bluetooth is an open specification that enables low-bandwidth, short–range wireless connection. The appeal of the Bluetooth model lies in its convenience for wirelessly transferring information and small data files between devices. Bluetooth is a standard for a small, cheap radio chip. Bluetooth chip is designed to replace cables.

Bluetooth serial communication module has three work roles. They are Master, Slave and Loopback. A device to computer and device to notebook communication is done using simple Master or Slave Modules.

iii) Arduino UNO

The Atmel AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers a designer to optimize the device for power consumption and processing speed.

B. SOFTWARE REQUIREMENTS

i) Embedded C

Embedded C language is used for analyzing EEG signals. This language is used to convert signals into instructions or commands. Embedded C is a set of language extensions for the C Programming language by the C Standards committee. Embedded C uses most of the syntax and semantics of standard C. C is the most widely used programming language for embedded processor/controllers. Assembly language is also used but mainly to implement those portions of the code where very high timing accuracy, code size efficiency, etc, are prime requirements. Assembly language programs are specific to a processor.

V. SIMULATION CIRCUIT

The simulation is done in Proteus software (8.1). This simulation explains how the Arduino UNO interfaced with EEG sensor is used to control the home appliances.

The simulation circuit is shown below:

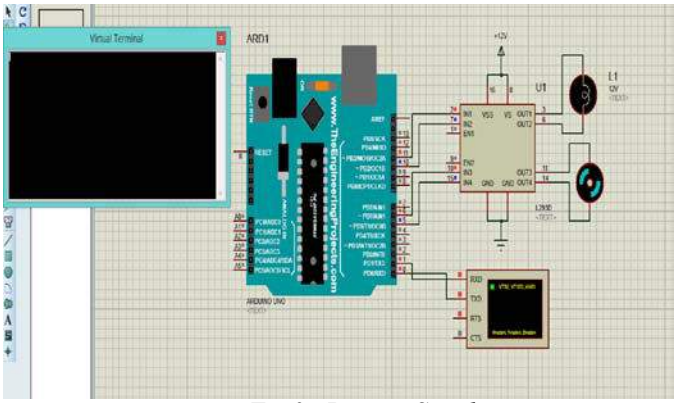

Fig.3 Proteus Simulation

VI. RESULTS AND CONCLUSION

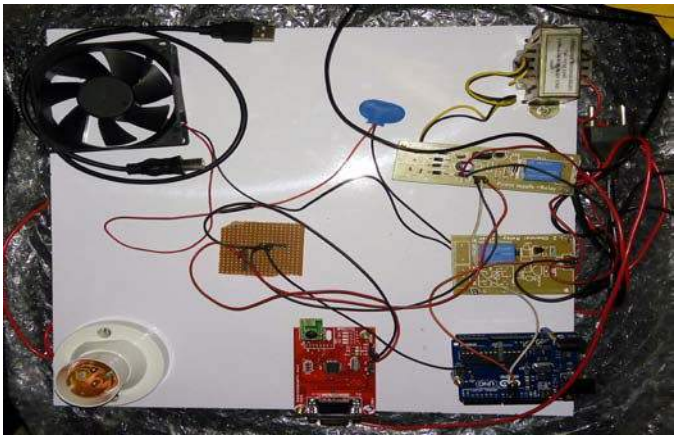

Fig.4 Hardware Implementation

The brain controlled home appliances have not yet been widely adopted. But there are high hopes for future of brain-controlled home appliances. Disabled people will be able to gain some independence through the use of this device. Using the system proposed in this paper the signals are sent from the headset to the Arduino in order to investigate the commands to control the appliances. This system is a step towards brain-controlled movements.

The control of home appliances will be configured to the signals generated by the mind thus negating any physical force required.

VII. FUTURE SCOPE

In this paper controlling of home appliances is done with the help of EEG sensor. This can be implemented further for car automation, door automation and even in aircrafts. Here only attention level of the brain wave is taken for controlling of appliances. In future all the other waves can be used for better results.

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