

Brain Computer Interface Based HomeAutomation System

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Abstract: Home automation is being developed with the aid of Internet of Things (IoT) technology to control any devices by connecting them to the internet. All home appliances are able to operated with the help of IoT technology. But for someone with physical limitations, using the appliances without assistance is still a difficult undertaking. The BCI (brain controlled interface) technique enables people with physical disabilities to interact with household equipment. A brain and a machine can work together to create a formof brain-computer interface (BCI) that allows signals through the brain to operate an outside action, like moving a cursor or adjusting a prosthetic limb. It is possible to control an object directly from the brain thanks to the interface. The technology will translate thebrain's messages into actions by interpreting them. Withthe aid of a Bluetooth module, these electrical signals aretransformed into their original waveform and handled inthe direction of an Arduino controller. The chip in the Arduino will continue to process the data that was received before utilizing a relay to control the appliances.The system that is suggested will be easier to build and more cost-effective.

Keywords: Brain sense, Arduino, Home automation, Home appliances and Brain Computer Interface.

1. Introduction

The growth of smart cities has been revolutionised by smart houses, and the automation of home appliances is still a crucial requirement for smart homes. Automated tasks, such as checking the temperature, turning on and off motors, separating goods, lifting large loads, etc., are initially more important in industrial environments. [1].

The development of a smarhome infrastructure depends on the automation of household appliances. A smart home is built with automatic light, fan, lamp, and other appliance ON/OFF switches. [2,3].

This automation was made possible by Internet of Things (IoT) technology, which uses a network to transport data and manage devices. By controlling and operating gadgets in homes and companies, IoT can enhance people's lives. For a variety of uses, IoT-based applications are being applied in smart homes, including home irrigation and offering ways to conduct business from home. [4-6].

Smart home systems operate the equipment utilising internet-enabled mobile applications of automated household appliances that are designed to support people with physical disabilities and are run by voice-activated devices. These gadgets will capture disabled people's spoken instructions and control home electrical appliances to turn on and off. Despite being applicable

for the disabled, this method cannot be used to operate the devices by unintelligent people. This represented a drawback of the voice-activated system. [7].

Home appliances could be operated through the Internet of Things, according to a design put out by M. H. AbdWahab. The household appliances are operated wirelessly using a cell phone and a Cytron Blue Bee Bluetooth module. The device must be used with a mobile phone and a mobile application installed in order for it to function. However, people who are illiterate cannot utilise mobile devices, and operating mobile applications is challenging. [8].

A new approach that uses hand gestures to control home appliances has been put out by S. Khirsagar et al. A new glove has been created that can recognise movements and control home appliances automatically. This design has the restriction that it cannot be used by people who are unable to move their hands [9]. For those who are unable to speak with those around them or use mobile devices, home automation can be helpful. These individuals can control the equipment with the help of brain impulses. [10- 17].

As a controller, Arduino can process the data received to run the appliances [18–21]. The suggested solution is simple to design and economical. The technology is set up so that people with disabilities and paralysis can operate the appliances on their own. Section II illustrates the creation of a home automation system that makes use of BCI technology and an Arduino controller. The findings and conclusion in Section IV are illustrated in Section III.

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2. Bci Technology Implementation with Home Automation System Using

ARDUINO

A. MODEL OVERVIEW:

Through the use of electrodes, BCI technology will gather brain impulses and use those signals to control the appropriate gadget. Electroencephalograms (EEGs), which track voltage changes in the brain's cells, are capable of recording brain signals. Electrodes placed all over the head are used to measure these electrical signals. Brain impulses are collected, analysed, and then converted into commands for end devices using BCI technology. The block diagram of a home automation system is designed around a brain computer interfacing as shown in fig 1. The system includes signal acquisition, transmission, and identification, as specified.

B. MODULES

1. Mind wave mobile

The Brainwave Starter Kit or MindWave Mobile is an EEG headset that allows you to watch your brainwaves alter in real time. Monitor your levels of concentration and relaxation, and see how your brain reacts to your favourite music. YOGA Meditation | Focus Practise | Visualising Brain Waves (EEG).

2. Brainsense

It is a device that operates on the BCI - Brain-Computer Interface principle, which involves analysing the brain

with EEG - Electroencephalography, studying the electrical activity of brain neurons, and designing brain-actuated applications utilising this technology.

Every sector in this generation is attempting to create AI bots that are more clever than humans and may pose a threat to humans. On the other side, certain sectors are embracing BCI technology to improve the human condition. Industries such as Elon Musk's Neuralink are developing smaller electrodes that may be planted around the skull and used to monitor brain activity.

The Brainsense is another BCI device that uses non-invasive electrodes, which can simply be implanted on the head.

3. Arduino uno

Arduino.cc created an open-source, Arduino Uno microcontroller board. Input/output (I/O) pins on the board, both digital and analogue, can be utilised to link to different connections or board expansions. The circuit board includes 6 analog pins, 14 digital connectors, and a kind of B Ethernet connector for programming with an Arduino IDE .

Which will operate with voltages ranges between 7 & 20 volts, where fueled a ethernet cable or an external 9-volt battery. Which is similar when Arduino Nano and Leonardo. You can operate your board by giving its microcontroller a set of instructions. To do this, you need the Software IDE, which is Processed, and Wiring-based programming language.

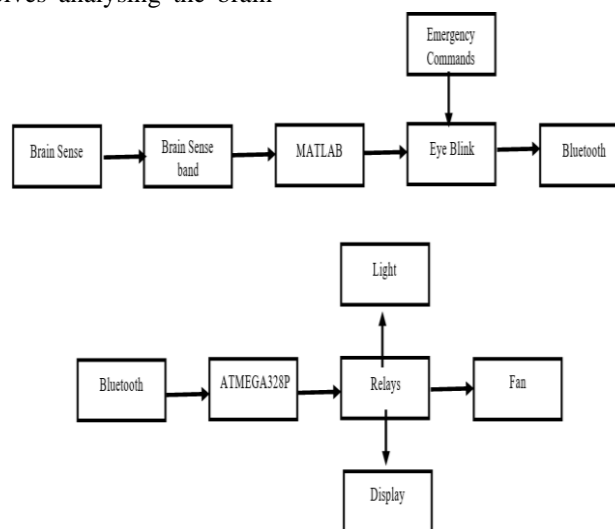


Fig 1.1 Block Diagram

4. Bluetooth HC – 05

A LED on the module shows that whether the Bluetooth on or off. Which is being connected to the module, this LED blinks continually and irregularly. It blinks for only 2 secs and it is connected to any other Bluetooth module. At 3.3 Volt, the module is operational. The module includes a 5 to 3.3 Volt ranges, that may also attach a

5Volt power.

Since this Bluetooth module by default has a 3.3 volt voltage level at RX/TX since the microcontroller itself is able to identify 3.3 V values, then there's not a requirement to change the transmitting level. But you need to change the signal that is sent voltage that flows from the processor into the RX device.

Types of BCI INVASIVE BCI

The goal of invasive studies on BCI had been to provide new capabilities for paralysed people and to repair damaged vision. By putting chips in opposition to the brain that have numerous pins that extend from their ends to pierce the layer of cortex, researchers may read the activity of several of cells in the neural network. Each pin is no wider than a single strand of hair in thickness. The computer interpreter uses specialised algorithms for decoding the brain's electrical language after receiving the meaning of neurons firings. It is subsequently transmitted to another a laptop, which receives the converted information and gives the device instructions.

C. Partial-invasive are implanted into the head, they don't cease inside grey and white matter of brain ; instead, they cease outside brain. In comparison to non-invasive BCIs, which cause signals to be deflected and deformed by the bone tissue of the skull, they provide signals with higher resolution and are less likely to cause the brain to develop scar tissue.

D. Electrooculography (ECoG) uses electrodes placed inserted and to detect in the brain. since it is a increase to the recorded the use of EEG this method has greater resolution in space, a wider frequency range, with lower requirements for training.

E. DETECTION

I. The brain detecting headset, which includes a Bluetooth module with an electrodes, can detect signals from brain. Neurons in human brain activate when a person thinks, feels, senses, or recalls something. Electrodes positioned all over the scalp gather electrical signals from these neurons. The electroencephalogram (EEG) waveform detects these voltage variations. The Brain Sense device covers the scalp with non-invasive electrodes. Neurons activate during eye blinking, producing an analogue EEG waveform that MATLAB then transforms into a blinking signal.

2. Acquisition

The brain sensing headset, which has electrodes as well as a module for Bluetooth, is capable of identifying brain impulses. Human brains include neurons, which fire when a person thinks, feels, senses, or recalls something. Electrodes positioned over the scalp gather electrical signals from these neurons.

The electroencephalogram (EEG) waveform captures these voltage changes. A technology called Brain Sense has non-invasive electrodes all over the scalp. Neurons are triggered when a person blinks their eyes, generating an analogue EEG waveform that is then transformed to a blinking signal using MATLAB.

3. Transmission

The blink wave is separated, and then it is sent via Bluetooth through the Arduino board. The matching appliances will be turned on by the controller attached to Arduino after converting to digital form.

4. Blinkwave Extraction from Raw EEG Brain waves

Signal processing is performed in Matlab to identify the blink waves after the brain's raw EEG waves have been extracted. Among EEG waves, the blink wave often takes the shape of a sinusoidal wave. By measuring its amplitude at both onset and offset, it may be located. A normal eye blink can be distinguished from a deliberate eye blink by the intensity of the blink (for example, a strong eye blink causes the blink wave to have a high amplitude).

5. Steps followed for waveform generation

Step 1: Turn mobile mind-body and brain sense device ON.

Step 2: Enable Bluetooth on your computer or laptop.

Step 3: Open the programme file from MATLAB in step three.

Step 4: It is crucial to alter the program's comm port information before running it. Following laptop-Mindwave mobile connection Navigate to Bluetooth configuration - > Note the COM port number that shows "OUTGOING" as its Direction when using the additional Bluetooth option through COM port. The number of the port in the programme has to be adjusted.

Step 5: Launch the command line to determine "once you BLINK" and check whether the Blink has been recognised or not.

Step 6: At that point, background programming for Open Matlab thinkgear should have been executing.

In step 7, a window for the Controller of appliances at home displays.

Step 8: To begin the process Press START

Step 9: Blinking the eye causes the equipment to work.

Step 10: Look where the "BLINK TO SWITCH" picture is located and blink where it makes sense to select an application.

Step 11: To finish the programme, click STOP.

6. Steps for home appliances

STEP 1: Start the IDE application.

STEP 2: The second step is to upload the programme file to the Arduino.

STEP 3: Connect the Wireless Bluetooth Device and

Uno Board.

STEP 4: Attach the corresponding Uno Pins 2, 8, and 12 to the appropriate Home Automation Relay.

STEP 5: Attach the cables coming from the relay's connection to the appropriate Arduino controller pins.

STEP 6: It is to see the LED inside the Bluetooth Device turn on.

STEP7:Relay is now turned on the bulb, light, and display.

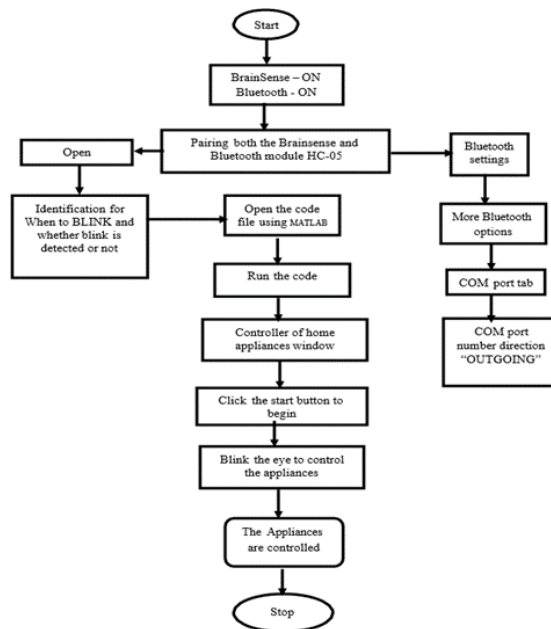


Fig 1.2 Flow chart

3. Results and Discussions

The neuroview software includes a brain-controlled home automation device. The brain wave is viewed using the software Neuroview. The brainsense band and headset must be worn before they can be connected to the system via the brainsense ThinkGear connector.

Wear Brain Sensor on your head in the first step and connect it to the computer using Bluetooth, step 2 as depicted in picture 3. Pairs are formed. Connect the module with Bluetooth (HC-05) to the entire system at the same time. By selecting the additional Bluetooth settings button in figure 4, you can view both the outgoing and incoming port.

The port number COM3(BRAINSENSE19'DevB') and The port number COM6(HC-05 'SPPdev') are outgoing.

The port numberCOM4(BRAINSENSE19) and The port number COM7(HC-05) are incoming.

Step3:Using Neuroviewprogramme, examine the signal of brainsense's wave .

To see the unprocessed wave graph. The system and brainsense are linked through Bluetooth, and the neuroview software uses the thinkgear method to show a random output. When this brainsense is linked to a system, Figure 5 depicts the random signal.

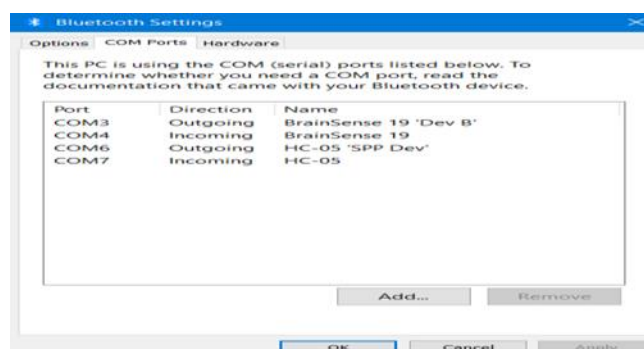


Fig 1.3 Connection between brain sense band and system viablueetooth.

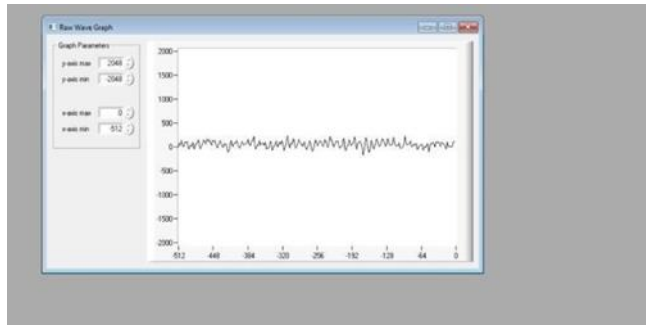


Fig 1.4 Random signal waveform

When there is a blinks, the brain can sense and gathers signal, so that neuroview programme will produce a wave form. The creation of a sinusoidal electrical signal

following an eye blinking in neuroview is shown in Figure 6.

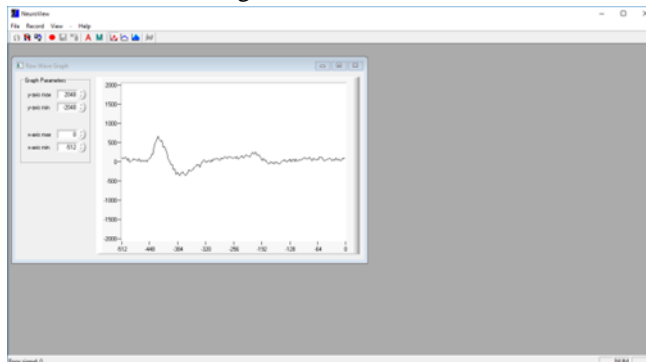


Fig 1.5 Signal generation after a blink.

Step 5: Arduino board source code should beuploaded, and Matlab 2018b should be launched, and type the following commands into the command line to launch

MATLAB. The MATLAB code is shown opening in Figure 6.

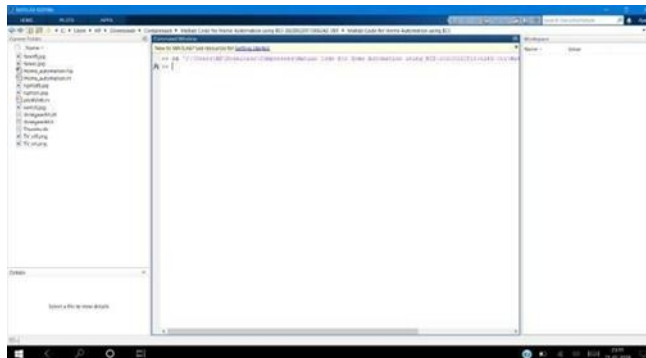


Fig 1.6 Opening MATLAB Code

Step 6: The code displays on the window, when you click "home_automation.m file."

Run the code. Then a window of home device controller with icons for the light, fan, and motor displays. After executing the MATLAB code, the state of the household

appliances is shown in Figure 7. The pane for home appliances includes the brain's raw graphing signal, which is sent to the computer and home appliances through Bluetooth. If the blinking is detected or not, it shows the BLINK STATUS.

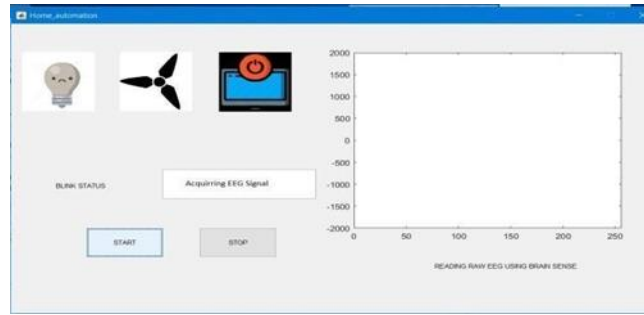


Fig 1.7 Status of HomeAppliances

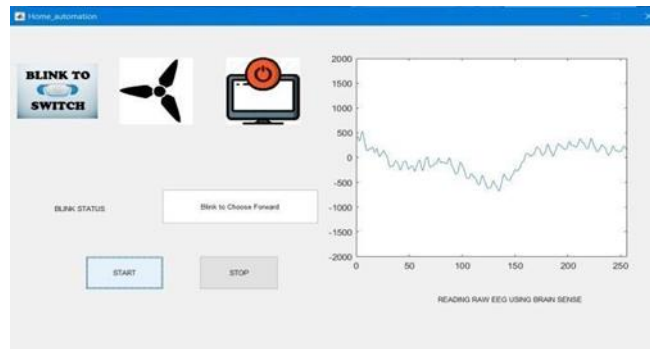


Fig 1.8 Condition of thebulb oncebefore an eyeblink

Step 7: To start the process and cause eye blinking, click START.

Our eye blinks control the lightbulb. Figure 8 depicts the bulb's starting state as being off; following an eyeblink, Figure 9 depicts the bulb's transition into the ON state.



Fig 1.9 BulbturnONaftertheeyeblick

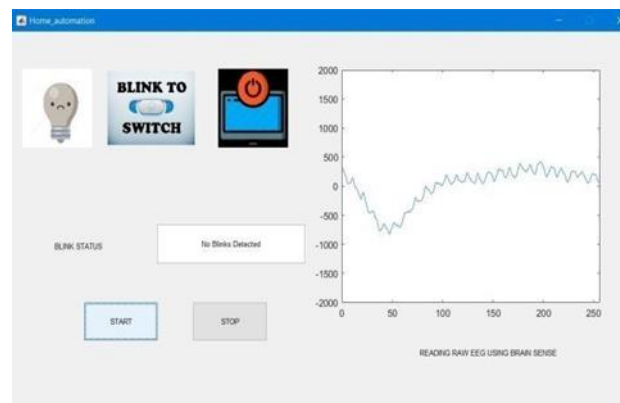


Fig 1.10 Initial condition of the fanbefore an eyeblink

Step 8: Next, the screen changes to the icon of fan (see figure 10), which can be controlled by blinking the eye. Similar to how it was done with the bulb, figure 11's fan goes through the same procedure. The proposed design is intended to assist people with physical disabilities so

they can operate household appliances including lights, fans, wheelchairs, televisions, and many other electrical devices.

Physically disabled people can use these devices, ON

and OFF with their brain impulses, by their own without others help.

4. Conclusions and Future Scope

With the help of this BCI technological advances, disabled people as well as elderly people who have trouble using household equipment can get around the restriction. BCI will use non-invasive electrodes positioned all over the scalp to connect the brain's nerves and electronics. The Neuro vision software is used to connect to and control the Brain sense headsets. The electrodes will gather brain waves, convert them to blink waves, and then turn on the relevant appliances. The proposed home automation with BCI solution aids people with physical disabilities. As stated in this paper, the suggested BCI system is simple to construct and has a cost-effective design. It enables paralysed and crippled people to perform tasks independently and manage appliances in the automotive, industrial, remote control, and other industries.

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