Using Brain Computer Interface for Home Automation

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Abstract- Brain computer interface (BCI) is a communication pathway between the brain and the external peripheral devices like computers. We propose to use this technology for Home automation. Home automation can be totally revolutionized using BCI. Brain produces various types of waves like alpha (9-13Hz), beta (14-30Hz), theta (4- 8Hz), delta (1-3Hz). Using these waves we can control various home appliances. The entire concept consists of 4 main stages detection, amplification, processing, output. First detecting the brain signals using an EEG cap or electrodes. These brain signals are very weak hence in second stage we need to amplify these brain signals to a usable amount and filter these to remove noise. Then thirdly, we will have to convert these signals into digital by using A to D converter and into a type a computer software or a microcontroller can understand. Fourth, taking this decoded signal and sending these signals wirelessly, by using an RF circuit to a distant switch circuit, which will turn on or off the appliance in vicinity. Using this technology the life of people would be further simplified, physical efforts would be considerably reduced and it would also prove as a boon for physically disabled people.

Keywords: BCI (Brain Computer Interface), EEG, Automation

I. INTRODUCTION

Brain Computer Interface (BCI) is a process by which Humans can control the external devices using their brain waves.[1] These interfaces are made using sensors which can record brain data either by invasive plantation or non-invasive plantation. Our Human Brain is highly complex and is made up of 100 billion neurons[1]. There are many types of neurons in our brain such as motor neurons, sensory neurons. These neurons get fired up while generating a response for a particular stimuli and generate an electrical signal which is detected by the electrodes and can be used to control a number of devices.

Home Automation is an area where BCI can be used and our entire house can be controlled simply by our brain[2]. This technology would prove as a great boon for almost all people on the planet. Less energy would be wasted for performing menial tasks such as switching on the lights, ac’s and other electrical appliances[3]. This technology is breathtaking and has the potential to completely revolutionize and change our lives[4].

As an application of BCI we have proposed to interface it with home appliances and automate our homes.

II. System Design

![System Design Diagram]

The System Design consists of two main stages the transmitter stage and the receiver stage. The transmitter circuit consists of the following stages:

A. Electrodes

We will be using dry non-invasive scalp sensors to measure the electrical activity of our brain.[5] Specific electrodes would be placed at the motor cortex area and the rest would be placed in many specific areas of the brain to measure brain activity.

B. Amplitude and filter circuit

These signals along the scalp are very weak i.e., in micro volts and contain noise[6]. Thus, we need to amplify and filter out the frequencies not useful to us, We can use an instrumentation amplifier to amplify the signals we get from electrodes.
One such instrumentation amplifier is AD620, in which we can vary the gain by varying the value or resistor. A High pass filter is designed having cut off frequency 7 Hz and a low pass filter is designed which will have a cut-off frequency at 31 Hz[7]. Hence it will allow only frequencies from 8-31 Hz to pass. The basic noise in all the systems is at 60HZ which is due to power line interference. For, suppression or attenuation of this frequency we can design a notch filter, that will severe reduce gain of this frequency[8]. Also an Analog to Digital converter will be required to feed the data to microcontroller.

**D. Micro-controller**

After the amplification and the filtering process the microcontroller will process the signals and give the output according to the specific algorithm. The microcontroller will do the following operations:

1. Will take the digital signal data from the ADC and process it according to the working specified.
2. The microcontroller will be directly connected to the user interface which will display the data selected, and details such as concentration level.
3. The microcontroller will send the processed data to the wireless transmitter which will transmit it wirelessly.

**E. User-Interface**

The user interface will act as an interface which would let the user know which device is selected. It will basically let the user choose which device it wants to use. Apart from this the user interface will also be having many other details such as concentration level. The user interface will be completely customizable by the user. The user can add and name the devices which he wants to control. The user interface can be designed as a mobile application to make it more user friendly.

**F. Wireless-Transmitter**

The wireless transmitter will transmit the signal which will be received by the receiver end. A Zig-bee Wireless transmitter is used to transmit the signals.

The Receiver circuit consists of the following parts

**Wireless Receiver**

The Receiver will receive the signals and feed it to the O/P Devices. The output devices can be anything lights, TV, fan etc.

**III. Working**

The electrical signals that helps to communicate 2 neurons and that which forms the basis of whatever we do is never fully transferred from one neuron to another but some part of it escapes and reaches the scalp[9]. This electrical neural signal can be observed and captured using right equipment’s such as EEG electrodes. The electrodes will then send the signals to the amplifier and filter circuit wherein the signal is amplified and unwanted noise and signals are filtered out. The analog signals are then converted into digital signals using an ADC converter. The microcontroller process the signals based on the following logic.

1. When the user imagines his right hand the left part of the motor cortex in the brain gets and the signals are detected[10]. Over the motor cortex beta waves are associated with the muscle contractions that happen in isotonic movements and are suppressed prior to and during movement changes[1]. So now the cursor will move in the right hand side of the user interface. The same can be done with the left hand, but the only difference will be is that when the user imagines his left hand the cursor will move to the left hand side.

![Figure 2. Motor cortex area of human brain](image2)

![Figure 3. User Interface](image3)

![Figure 4. Movement of the cursor according to brain signal](image4)
2. Now if the user wants to select a particular device he will have to concentrate his mind. When a user concentrates his mind Beta waves (16-31Hz) are generated, the brain emits more than 18 Hz frequency and the frequency will get locked and that particular device will get selected. It must be noted that when the user moves the cursor to the left or to the right there will be a particular delay after every move by the cursor which the user can set. When a person relaxes alpha (8 – 15 Hz) waves are emitted.

The above logic can also be implemented using machine learning, which will greatly reduce the error of the system.

IV. Conclusion

So by using our brain our homes can be automated using Brain computer interface. A three application based graphical user interface was developed. By interfacing the system with brain using EEG system, we are able to implement home automation system using BCI technology. This will help people with serious illness as they need not depend on others for doing their day to day activities.

REFERENCES


