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# Design & Implementation of a Mind Controlled Home Automation System

Mohammed Saifuddin Munna[1], Juliana Shetara[2], Shantanu Bhattacharjee[3], Md. Zahed Hossain Bhuiyan[4]
Dept of Electrical & Electronic Engineering
Chittagong University of Engineering & Technology[1&2], Premier University, Bangladesh [3&4]
munna.puc@gmail.com[1], julianashetara@yahoo.com[2], shan71625@gmail.com[3], mdzahedpu@gmail.com[4]

*Abstract*— **this paper represents mind controlled home automation system, which is based on Brain-computer, interfaces (BCI). Today people have become physically disable for stroke and traumatic brain injury cause long-term. BCIs are systems that can bypass conventional channels of communication to provide direct communication and control between the human brain and physical devices. Proposed system worked by translating different patterns of brain activity into commands in real time. The brain wave sensor will sense brain signals and it will convert the data into packets and transmit through Bluetooth. Then the control command will transmitted to the relay circuit. With these entire steps, system can control any home appliances through brain signals, which connected to the relay circuit.**

**Keywords— Brain-computer interfaces (BCI), Bluetooth, Traumatic, Brain signal.**

## I. INTRODUCTION

Our brain is composed of neurons, glial cells, and blood vessels. The number of neurons is approximately 100 billion [1]. These number of neurons are interconnected each other via trillions of synapses. Neurons communicate using electrical signals and chemical messengers called neurotransmitters that either stimulate or inhibit the activity of a responding neuron [2]. These electrical signals are possible to record using a monitoring method, which is Electroencephalography (EEG).

Today, the consequence developments in the neurosciences and computer technology, it has become possible to create a communication between a human brain and a computer. This process is known as Brain Computer Interface. This idea of interfacing minds with a computer has long captured the human imagination and recent advances in neuroscience and engineering are making this idea a reality.
By using BCI (Brain Computer Interface), we developed a system, which can help to control different appliance and security for disable.

## II. METHODOLOGY

Our brain has some biological signal. The signals are generated by differences in electric potential carried by ions on the membrane of each neuron. These small signals intensity is quite and measured in microvolt's (μV). Depending on the frequencies of the human brain waves, EEG signals are divided into four categories. They are Alpha, Beta, Gamma, and Delta. In fig. 1 different types of EEG signals are shown [3].

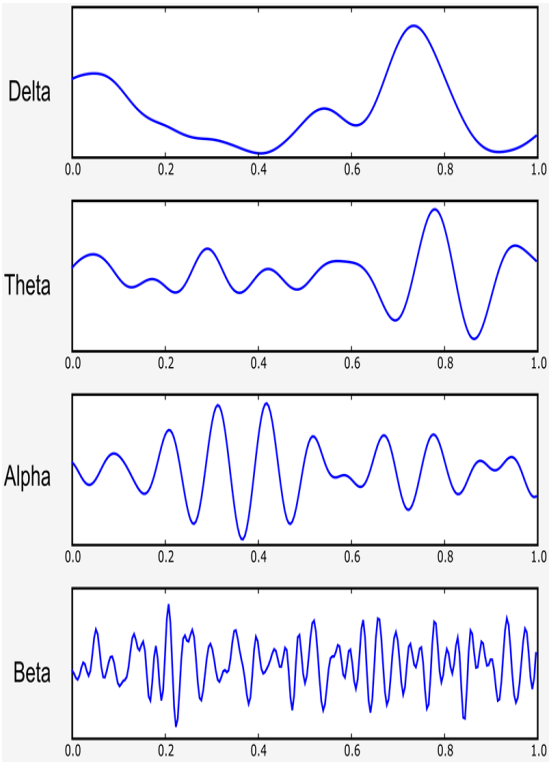


Fig 1: Different types of EEG Signals

To analyze the EEG signals, we use a device is named as Neurosky Mind Wave mobile. It has two dry sensors which help to detect and filter the EEG signals. one sensor is placed on the forehead which is FP1 in fig. 2. This sensor picks up ambient noise which is generated by human muscle,

computers, light bulbs, electrical sockets and other electrical devices. The second sensor, ear clip which is used ground and reference. This sensor allows the thinker chip to filter the electrical noise. This is recorded electrical activities of brain and transmitted through Bluetooth.

The device measures the raw signal, power spectrum (alpha, beta, gamma, theta), on head detection, attention level, mediation level and blink detection [5]. Neurosky Mind Wave mobile has pre-built algorithms which are attention, meditation, Blink Detection etc.

In this paper, we used attention level and on head detection. The attention level indicates the intensity of mental "focus" or "attention." Its value ranges from 0 to 100. The attention level increases when a user focuses on a single thought or an external object, and decreases when distracted [6].

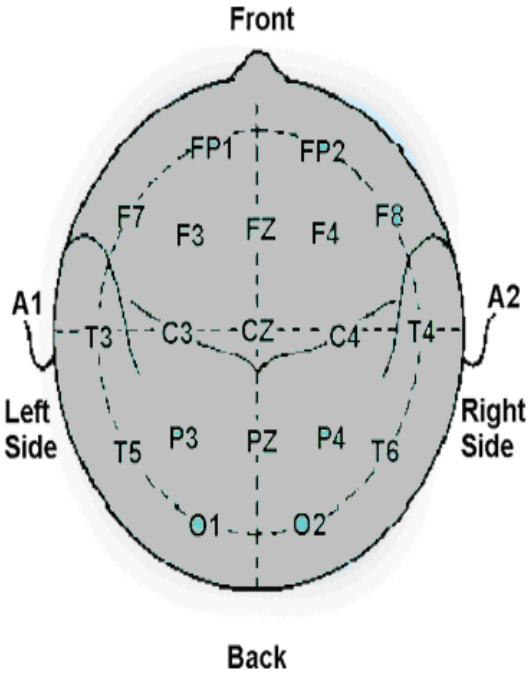


Fig-2: FP1 position of scalp

A brain computer interface (BCI) is a direct communication pathway between the brain and an external device. It is also called mind-machine interface (MMI), direct neural interface (DNI), or brainmachine interface(BMI). It is a communication system for controlling a device, e.g. computer, wheelchair or a neuro-prosthesis, by human intensions, which does not depend on the brain's normal output pathways of peripheral nerves and muscles but relies on the detectable signals representing responsive or intentional brain activities[8].In this flow of brain computer interface is shown in fig-3.

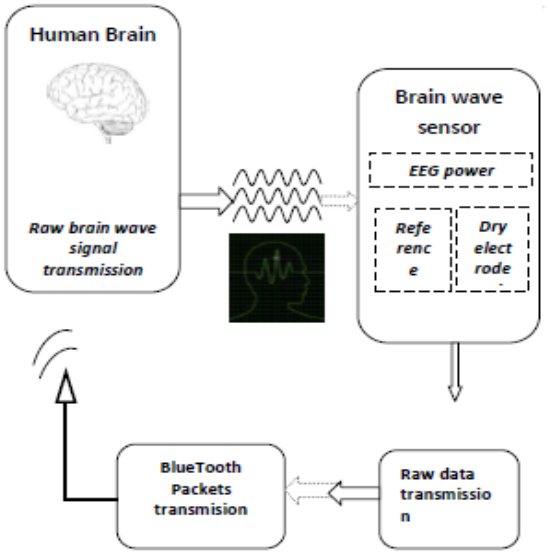


Fig-3: BCI (Brain Computer Interface)

The BCI interface and its control is explained by "J. Williamson in „Interaction design for brain computer interfaces [7].

## III. PROPOSED SYSTEM

a) Working Procedure

First, the turning on the Neurosky mind wave, its LED light is blinking. After a few seconds, it creates communication with the Bluetooth receiver, which previously configured. The block diagram of transmission Section of proposed system is given in Fig. 4.

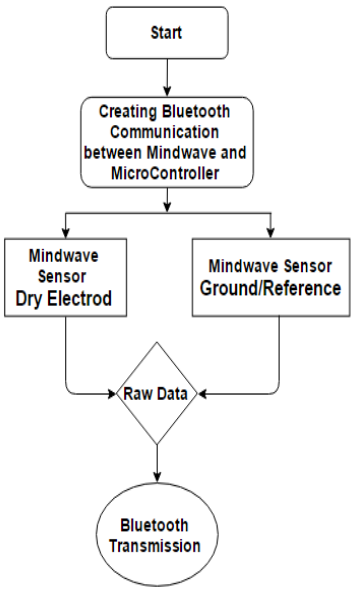


Fig-4: Transmission Section of proposed system

Neurosky mind wave simultaneously sends data to the microcontroller. In fig 5, Microcontroller analyzes the raw data to determine user attention level and On-head detection.

From the level of user attention, microcontroller gives a signal to relay circuit. After receiving signal from the microcontroller, the relay circuit controls its connected equipment.

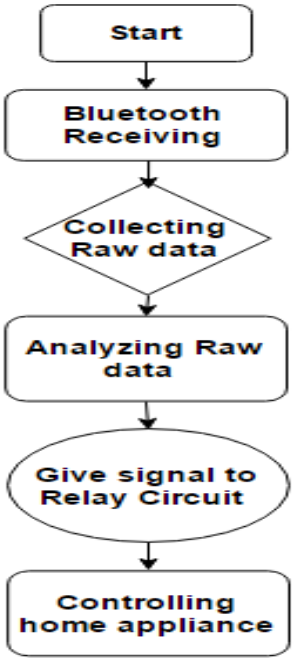


Fig-5: Receiver Section of proposed system

*b) b. Neurosky Mind Wave Headset*

The Neurosky Mind Wave is a device, which is used for monitoring electrical signals generated by neural activity in the brain. [9] For measuring the EEG signal of brain, this device is worn on the head and consists of a headband, an ear-clip, and a sensor arm containing EEG electrode which rests on the forehead above the eye. Neurosky Mind Wave has a Bluetooth communication system. So, it can send its raw data to another Bluetooth controlled device.

The measurement of the Mind Wave is raw signal, EEG power spectrum, meters for Attention and Meditation, Blink Detection & On-head detection.

Here EEG power spectrum which provides information on a user's brainwave like Delta, Theta, Alpha, Beta and Gamma and meters for Attention and Meditation which determines how effectively the user is engaging Attention or Meditation. We get this value by decoding the electrical signal and applying algorithms to provide readings on a scale of 0 to 100. Table.1 contains the values of those brain signals.

Fig 6. Neurosky Mind Wave Headset

Table 1- Descriptions of meter values

| Value | Description |
|---|---|
| 1-20 | 'Strongly lowered' levels |
| 20-40 | 'Reduced' levels |
| 40-60 | 'Neutral'/'Baseline' levels |
| 60-80 | 'Slightly elevated' / higher than normal |
| 80-100 | 'Elevated' / heightened levels |

The Attention meter which indicates the intensity of a user's level of mental 'focus' or 'attention' to determine levels of concentration and the meditation meter which intensity of a user's level of mental 'calmness' or 'relaxation'. However, Distractions, wandering thoughts, lack of focus, or anxiety may lower the Attention meter level and anxiety, agitation, and sensory stimuli may lower the Meditation meter levels. In this project, we use attention meter and On-head detection.

*c) HC Serial Bluetooth*

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle [10].

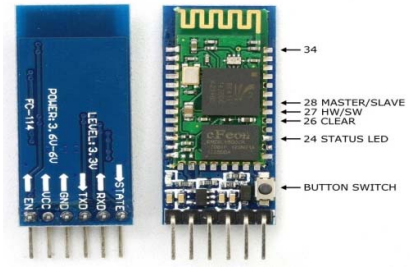


Fig 7: *HC Serial Bluetooth*

*d) Arduino UNO R3*

The Arduino Uno R3 is a microcontroller board based on the ATmega328p, which can coordinate the work of each module and process the relevant data [11]. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The ATmega328 has 32 KB flash memory (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library). The Uno differs from all other preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 programmed as a USB-to-serial converter. The ATmega328 also provides UART TTL serial communication, which is available on digital pins 0 (RXD) and pins 1 (TXD).

Fig 8. Ardiuno Uno

*e) Relay Circuits*

A relay is an electromagnetic switch. It is operated by a relatively small electric current that can turn on or off a much larger electric current. To control high volt circuit, we use relay circuit. This circuit helps to create communication between Arduino and high voltage equipment without damaging any device. Arduino UNO r3 gives signal that is approximately 5v. In this project, we use 5v-220v relay.

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## IV. ALGORITHM

Our total system divided into two sections. One section for user end and another section for controller end. Some special programming code has used to decode the raw signal and smooth control the system. The level analyzer unit (LAU) will receive the brain wave raw data. It makes the system more responsive and faster so that user can easily control the system via mind wave.

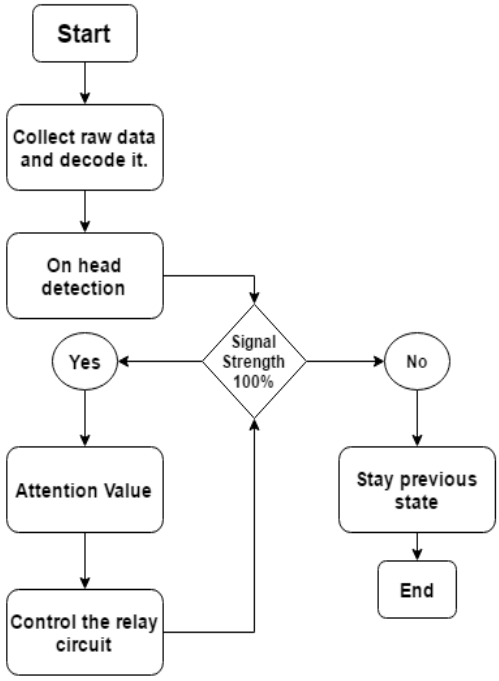


Fig-9: Algorithm of controlling section.

As shown in fig 9 the raw data is collected and decoding is done in micro-controller. Micro-controller check the NeuroSky Mind Wave Mobile headset is worn on the head or not from those data. If the NeuroSky Mind Wave Mobile headset is worn on the head properly, the signal strength is 100%. Then, microcontroller calculates the attention level and gives the signal to relay circuit. The relay circuit turns on or off the different appliance from giving instruction. If the NeuroSky MindWave Mobile headset is not worn on the head properly, the signal strength is below 100%. Then, the appliance stays the previous state.

In the below table 2, along with changing in the attention value, devices are controlled. Different operating conditions are used in here.

Table 2. Commands to Control Device

| COMMANDS | EEG SIGNALS |
|---|---|
| Operate Devices | On-head detection |
| Operate first device | Attention above 80% |
| Operate Second device | Attention above 50% |
| Stop devices | Attention below 20% |

## V. RESULT

The proposed system is implemented and the desired results are obtained in controlling the physical devices using brain signals.

In here, when attention level is greater than 80%, first light turns on and the second light turns off. In addition, attention

level is greater than 50%, first light turned off and the 2nd light turned on.

In fig 10, we plot the attention level and on head detection using MATLAB software, which helps to better understanding about the working principle of this device. We see various data in difference response. When attention value goes to 0%, there is no attention value or no head detection.

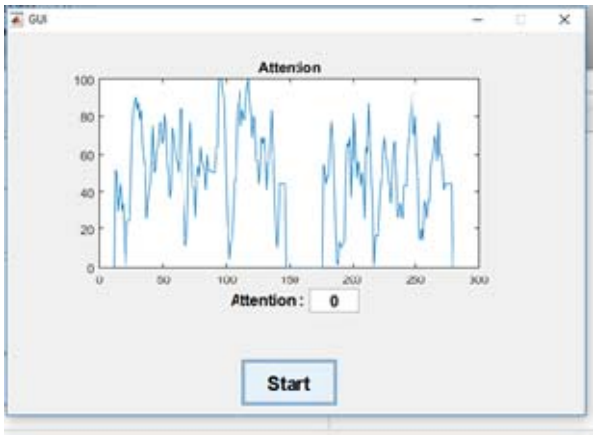


Fig 10: Attention Curve

## VI. Final Design

Fig 11: Mind controlled home automation system

## VII. Conclusion

This paper presents the design and implementation of non-invasive type of Brain-Computer Interface Brain-Computer Interface technique to control the home appliances using EEG based brain signals. This design is cost effective and easy to build. This paper works on the brain signal for controlling the physical devices and the Protective password system. Therefore, the paralyzed and the physically disabled people can independently do their work like switching on and off the lights and fans by their own and the security system can be enriched using this design. In most of the existing systems had to use a computer but in this model use a microcontroller. This design is easily upgradable to multiple loads with same number of processing units. In future, it can be used in Automobile applications, Industrial application, Monitoring device applications and Remote control applications.

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