

# Automated System for Physically Disabled Patient using EEG Sensor and Brain Controlled Interface

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**Abstract:-** The system is executed with fully functional product with the use of BCI (Brain Controlled Devices). This provides the easiness in operations and also helpful to elder and disabled people. This is useful for people who cannot operate the peripheral devices using our normal muscular body parts. 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 be transmitted to the Arduino Controller. With these entire steps, system can control any home appliances through brain signals, a wheelchair movement which is connected to the circuit also Emergency Commands will be provided with the help of Brain Waves. With the help of Matlab Interface it is designed where a main control panel will help to navigate through the following modules. Each module provides different functions. For example: The wheelchair module will provide a complete control over movement of the wheelchair. The Home Automation module will provide control of Basic Electrical Home Appliances such as Lights and fans. The Command module will provide an interface which the user can use in case of an emergency.

**Keywords:-** BCI (Brain Controlled Interface), EEG (Electroencephalography), Arduino, Matlab, Interface, Bluetooth.

## I. INTRODUCTION

The proposed work is to develop an automotive machine that will be assisted by brain waves. Different patterns of neural interaction results in different states of brain. These patterns lead to waves characterized by different amplitudes and frequencies. The human brainwave signals are measured by using the brainwave sensor product i.e. MindWave device headset. Headset uses Electroencephalography (EEG) technique. BCI is a method of communication with a computer using the electroencephalogram (EEG) signals obtained from the

user's brain activity. Considering EEG signals are independent of the normal pathways of the nerves and muscles [1]. They are made by integrating brain signals to arrange brain potentials in a way so that no muscle arbitration is required [8]. The intrusive approach of placing electrodes inside the scalp is called as the invasive method which is comparatively less appealing as compared to the non-invasive approach in which electrodes are placed on the scalp, which is used in many BCI based restorative applications for a couple of crippled clients [4]. Analysis of brain signals is done by the proposed system which uses only single electrode headset based on EEG sensors which will monitor the Eye-Blink, Attention and Meditation Mode. The signal generated will be received by the brain sensor and it will divide into packets and transmitted to wireless medium (Bluetooth). The wave measuring unit will receive the brain wave raw data and it will convert into signal by use of MatLab Library in MATLAB GUI platform. Then the commands will interact with the main section to operate the modules (Home Appliances, Wheel-Chair). The working of each module i.e. Home Appliances, Wheel-Chair will be categorized separately such that no functionality could violate the other. To properly bifurcate the modules these module will be worked independently but will be clubbed in one single instance of the system. The Eye-blinking pulse reading will be responsible for the change in module. Where fixed number of eye blinks will categorize the module. Inter-module action will be further distributed to the readings of other modes i.e. Attention, Meditation Mode.

## II. SYSTEM AND FUNCTIONAL DESCRIPTION

### A. System Requirements Hardware

1. Arduino UNO Microcontroller
2. Neurosky Mindwave Mobile 2 EEG Sensor
3. HC-05 Bluetooth Module
4. 5V Relay
5. DC Motors
6. Robotic Chassis

- 7. Jumper Cables
- 8. LEDs

*B. Software*

- 1. MATLAB
- 2. Mindwave connector

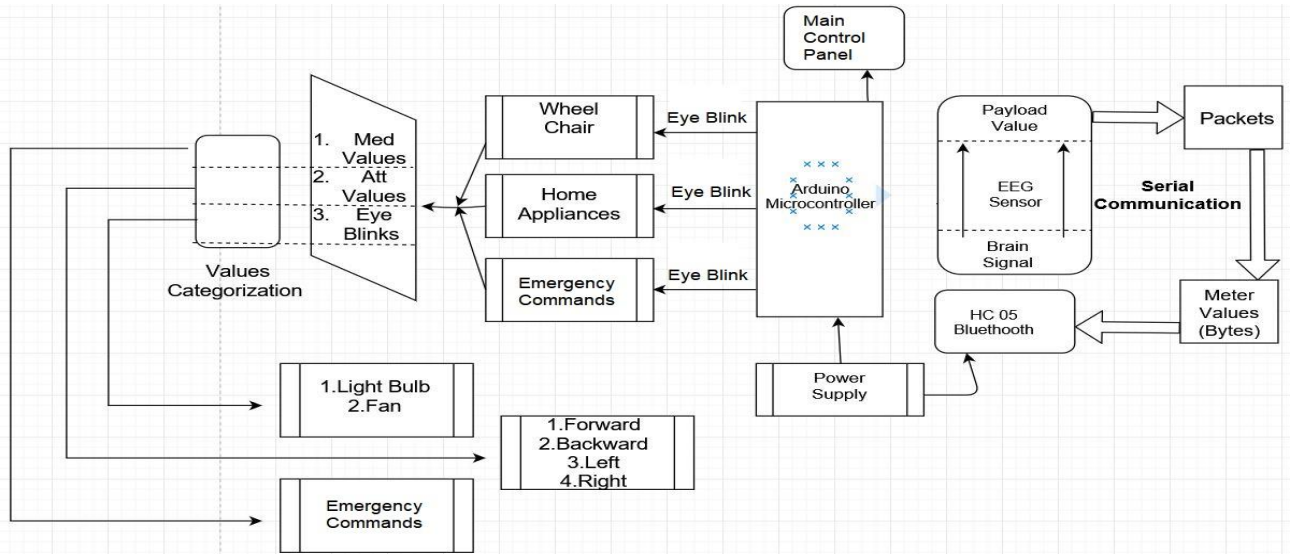


Fig 1:- System Architecture

*C. Arduino:*

The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The proposed system have two Arduino Uno, where one microcontroller is used in Home Automation and the second Arduino is used in Wheelchair. Each microcontroller is attached with a Bluetooth where it generates a connection between processing unit where the Brain signals are converted into the raw data and are transferred with the module.

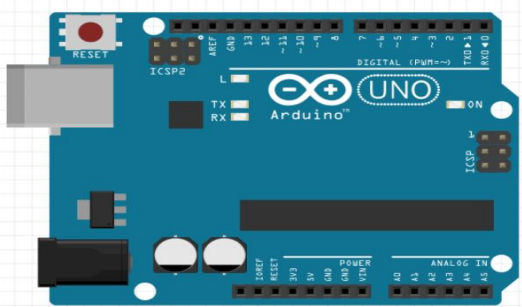


Fig 2:- Arduino UNO

➤ *Connections:*

- HC-05 Vcc to 5V
- HC-05 GND to common GND
- HC-05 RX to Arduino pin D3 (TX) via a voltage divider
- HC-05 TX to Arduino pin D2 (RX) connect directly

➤ *Assignment of Bluetooth:*

The default settings for new modules are

- Baud rate in AT/Command mode = 38400
- Name = HomeAutomation
- Password = 1234
- Baud rate in communication mode = 9600\*

The default settings for new modules are

- Baud rate in AT/Command mode = 38400
- Name = Wheelchair
- Password = 4321
- Baud rate in communication mode = 9600\*
- Baud rate in AT/Command mode = 38400

*D. HC-05:*

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for wireless serial connection setup. This Bluetooth module works like a master/slave device that automatically pairs with Mindwave Mobile EEG headset It has 6 pins . Here is the zs-040 version of the popular HC-05. The HC-05 is based on the EGBT-045MS Bluetooth module. It can operate as either a slave device or a master device. As a slave it can only accept connections. As a master it can initiate a connection.

HC-05 BASIC SET UP

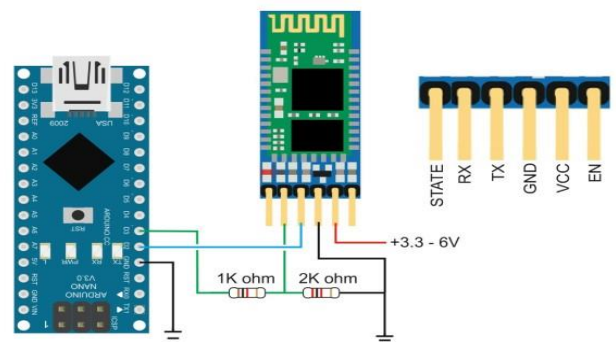


Fig 3: HC-05 Bluetooth Connection

**E. Neuro-Sky Mindwave sensor:**

The MindWave Mobile 2 safely measures and outputs the EEG power spectrums (alpha waves, beta waves, etc), NeuroSky eSense meters (attention and meditation) and eye blinks. The device consists of a headset, an ear-clip, and a sensor arm. The headset's reference and ground electrodes are on the ear clip and the EEG electrode is on the sensor arm, resting on the forehead above the eye (FP1 position).

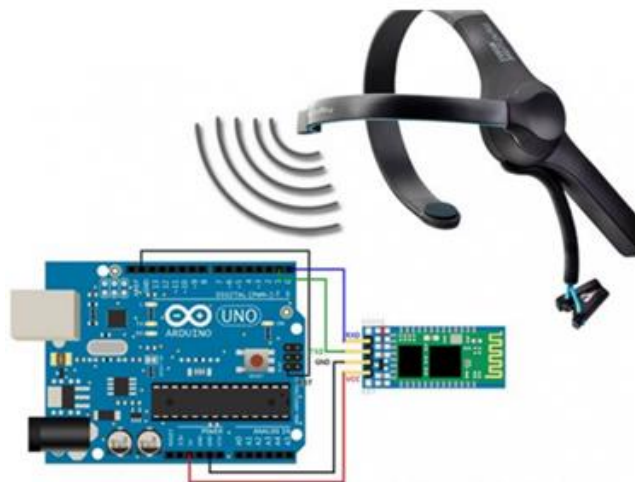


Fig 4: Mind Wave Neuro-Sky Mobile 2

**F. Algorithms**

➤ **Think-Gear:**

ThinkGear allows the measurement, amplification, filtering, and analysis of EEG signals and brainwaves. Combined with NeuroSky's proprietary eSense algorithms, this allows a headset to be able to measure the wearer's state of mind, and makes this information available to applications so that the applications can respond to your mental activity.

➤ **Algorithm:**

Input: Raw EEG values from Brain.

Output: eSense values.

Step1: START

Step2: Declare the required variables

Begin Serial Monitor at 57600 Baudrate

Step3: while serial monitor available do

Step4: Read serial values and print the same byte

Step5: Look for synchronization bytes:

5a) if ReadOneByte() = 170 then  
 payloadLength = ReadOneByte()  
 else if payloadLength > 169 then  
 return

5b) for each i=0; i<payloadLength; do  
 Store payload into main memory:  
 payloadData[i] = ReadOneByte()  
 generatedChecksum += payloadData[i]  
 end for

Step6: wear the device do check for the values  
 payload of poorQuality, attention and  
 meditation.

Step7: 7a)if Code [0x02]:

Print BadQuality = 200; attention = 0;  
 meditation = 0;

7b)if Code[0x04]:

Print BadQuality = 0; attention = (0-100);  
 meditation = 0;

7c)if Code[0x05]:

Print BadQuality = 0; attention = 0;  
 meditation = (0-100);

Step 8: STOP

**III. INTERFACE**

As the system main aspect is to control various modules under one control panel. The system comprises of three module that is Home Automation, Wheelchair, Emergency Commands. For user only one module can be accessible at one time. At the initial the control panel is shown in matlab GUI in this all the modules images are shown. Here every Module has an indicator where an blink detected will initiate a module. And every hard blink will end the module execution and come on main control panel.

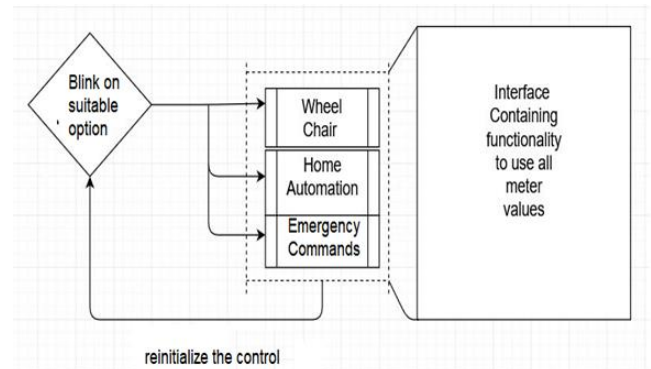


Fig 7:- Module Switching Architecture

**IV. SYSTEM FLOW**

When MatLab is initiated and the system is switched ON the first thing you will get is the main control panel. In the hardware system the Bluetooth of both the module is in the searching phase. The first step of the system will connect the sensor (MindWave mobile 2) with the PC Bluetooth and act as a master mode. After the Connection of the Sensor and the PC is successful the Main Control Panel Process is initiated.

Basically the main Control Panel Has three windows where the indicator indicates the switching control. This indicator blinks on each window so that the user will know which module to start and when to start.

The sensor is continuously sending the brain waves signals to the system where the system parses the signals. If the normal eye blink of strength (50-80) is captured the particular window where the indicator is blinking is initiated.

After the Module Window is opened the Bluetooth Connection is initiated with the master it now acts as per the master slave mode. After the Bluetooth connection is successful the new window now has its own attributes as in

- 1) Home appliances: LIGHT and FAN
- 2) Wheelchairs: Arrows indicating Forward, Backwards, Left and right
- 3) The Emergency Command: Food, Water, Washroom, Entertainment, Not Well, Bath, Medicine, and Outdoor

So As per the Eye blink the particular function is selected as per the indicator is blinking on the window.

For every hard blink (above 80) the particular module will stop its process and come out of the window on the Main control panel. And when the control of the module is changed the Connection with the module is removed and the Bluetooth is set free for new connection.

➤ *Main Control Panel:*

The Main Control Panel is the first most page that the user can see. Until now the connections have been established between sensor and the PC .When the system detects a Bluetooth connection the blinker is initiated where the frequency map is in the working mode the parsing of data will start and the blue hoot will start to get the brain wave data which is shown in the graph. As the Blinker is initiate it will rotate on each module with the given time stamp. To select the module user have to give a normal to hard blink according the frequency set. To select the module Hard Blink is given and when the threshold value is satisfied the module opens

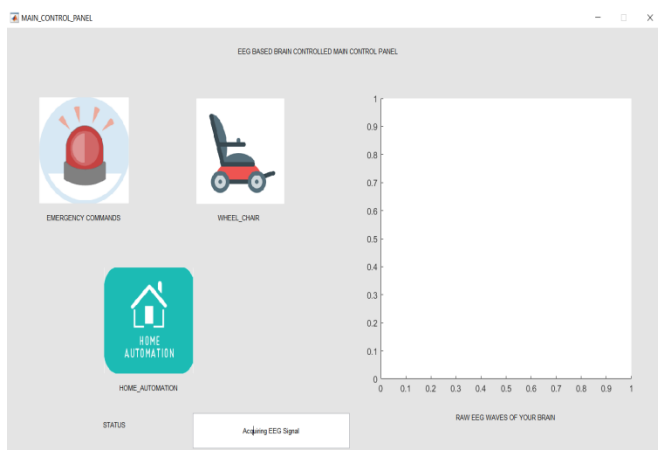


Fig 7:- Main Control Panel

➤ *Module Selection :*

- *Home Automation*

When the home automation module is selected the screen containing the module descriptions with the proper flow control is presented.

After the Module Window is opened the Bluetooth Connection is initiated with the master it now act as a master slave mode. After the Bluetooth connection is successful the new window now has its own attributes as in

1) *Home appliances: LIGHT and FAN*

When the system detects a Bluetooth connection with the module Bluetooth and the PC the blinker or indicator is initiated where the frequency map is in the working mode the parsing of data will start and the Bluetooth will start to get the brain wave data which is shown in the graph. As the Blinker is initiate it will rotate on each function provided in that module with the given time stamp. To select the functionality user have to give a normal to hard blink according the frequency set. The actual hardware movement is then seen by the mechanism provided in the system.

To go back to the main control panel hard blink is given and when the threshold value is satisfied the panel opens.

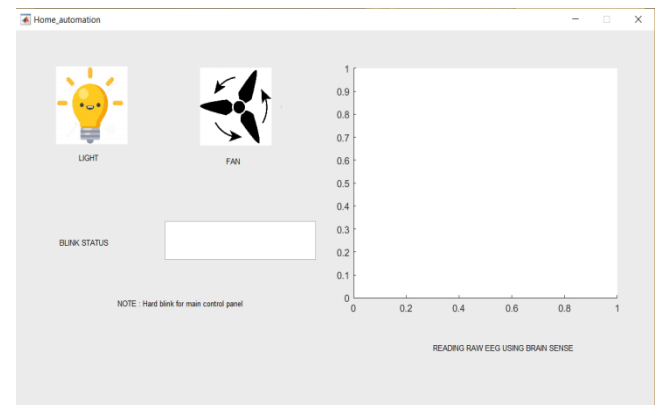


Fig 8:- Home Automation

- *Wheelchair*

When the Wheelchair module is selected the screen containing the module descriptions with the proper flow control is presented on the panel.

After the Module Window is opened the Bluetooth Connection is initiated with the master it now act as a master slave mode. After the Bluetooth connection is successful the new window now has its own attributes as in 1)Movement: Forward, Backward, Right, Left with the connection establish indicator. When the system detects a Bluetooth connection between the module Bluetooth and the PC the blinker or indicator is initiated where the frequency map is in the working mode the parsing of data will start and the Bluetooth will start to get the brain wave data which is shown in the graph. As the Blinker is initiate it will rotate on each function provided in that module with the given time stamp.

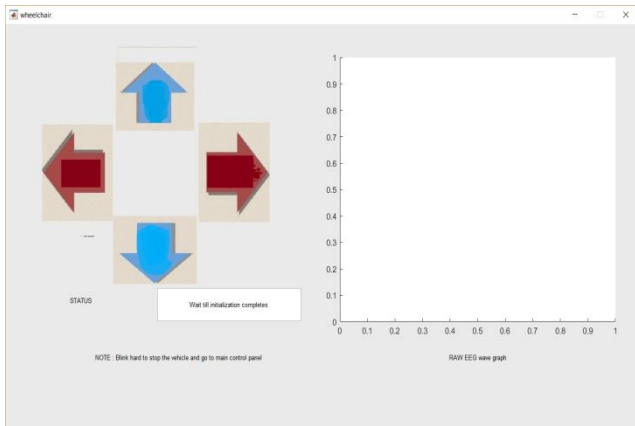


Fig 8:- Wheel Chair

➤ *Commands*

When the command module is selected the screen containing the module descriptions with the proper flow control is presented on the panel.

After the Module Window is opened the Bluetooth Connection is initiated. After the Bluetooth connection is successful the new window now has its own attributes as in 1) The Emergency Command: Food, Water, Washroom, Entertainment, Not Well, Bath, Medicine, and Outdoor So As per the Eye blink the particular function is selected as per the indicator is blinking on the window. When the system detects a Bluetooth connection between the module Bluetooth and the PC the blinker or indicator is initiated where the frequency map is in the working mode the parsing of data will start and the Bluetooth will start to get the brain wave data which is shown in the graph. As the Blinker is initiate it will rotate on each function provided in that module with the given time stamp.

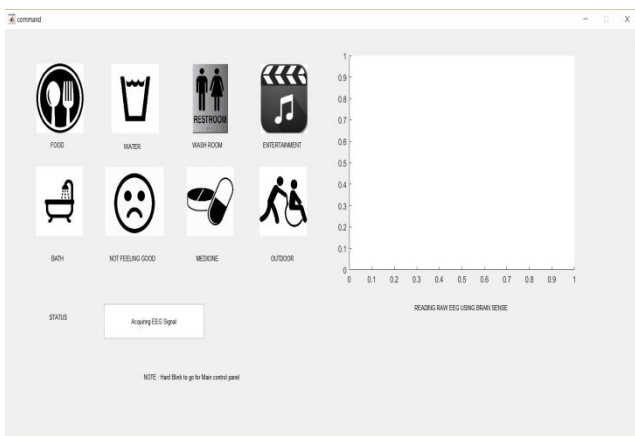


Fig 8:- Commands

Using this Brain waves the all the modules can be controlled by the user just by his Brain signals.

A synaptic and smooth interface is developed on matlab where the user needs less training for handling this system. The interface is light weight with proper feedback system whenever faulty or successful interaction is subjected.

**V. MATHEMATICAL MODEL**

➤ *Conversion of Raw Values to Voltage and waveforms spike extraction*

For TGAT-based hardware devices (such as TGAT, TGAM, MindSet, MindWave, and Mind Wave Mobile),

- The formula for converting raw values to voltage is:  

$$[\text{raw Value} * (1.8/4096)] / 2000$$
- This is due to a 2000x gain, 4096 value range, and 1.8V input voltage.
- The EEG raw values from Cardio Chip based devices must use following conversion:  

$$(\text{raw Value} * 18.3) / 128.0$$
- Please note the gain on actual hardware may be slightly off from 2000x (maybe +/- 5%?), but unless you need to make ultra-sensitive measurements.

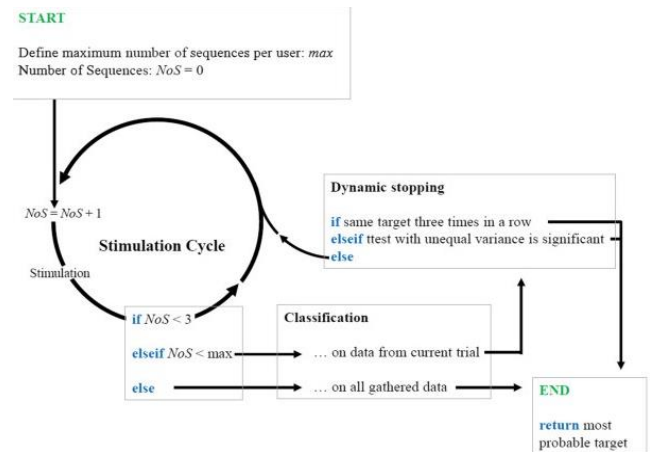


Fig 9:- Mathematical Flow Diagram

**VI. RESULTS AND CONCLUSIONS**

*A. System Outcome:*

The Successful Implementation of three modules i.e. Home automation, Wheelchair, Emergency Commands is done with the help of BCI. The Data Acquisition is done using ThinkGear algorithm . Using this Brain waves the all the modules can be controlled by the user just by his Brain signals.

A synaptic and smooth interface is developed on matlab where the user needs less training for handling these system. The interface is light weight with proper feedback system whenever faulty or successful interaction is subjected.

A proper hardware management is done where the Cost optimization is also taken under consideration. This product is also designed for the reducing the cost of tradition BCI system by implementing adaptive system.

**B. Future Scope:**

To increase the efficiency of the product the system can be introduced to a new classification model that uses neural network classification algorithm. The proposed technique can be based on removing artifacts using feature extraction using 4 levels discrete wavelet transform. Experiments reveal that the proposed fusion technique results a considerable improvement over the KNN classifier.

Also subsequent efficiency can be increased using the multiple electrode method a proper feature extraction method can give accurate results which can be used as the input to any system

**VII. CONCLUSION**

The proposed System successfully fulfill the requirement. Also provide enhancement in using Brain waves. With minimal use of brain waves controlling of three modules can be done. Here only one electrode is used for cost effectiveness. Use of multiple electrode multiple signals can be managed and more devices can be easily controlled over. Hence this system perfectly manages to provide control over the modules.

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