Brain Computer Interface Controlled Voice Assistant

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Abstract*: A brain-controlled robot using brain computer interfaces (BCIs) was explored in this project. BCIs are systems that are able to circumvent traditional communication channels (i.e. muscles and thoughts), to ensure the human brain and physical devices communicate directly and are in charge by converting various patterns of brain activity to instructions in real time. An automation can be managed with these commands. The project work seeks to build and monitor a program that can help the disabled people accomplish certain activities independently of others in their daily lives. Develop open-source EEG and brain-computer interface analysis software. The quality and performance of BCI of different EEG signals are compared. Variable signals obtained through MATLAB Processing from the Brainwave sensor. Automation modules operate by means of the BCI system. The Brain Computer Interface aims to build a fast and reliable link between a person's brain and a personal computer. The controls also use the Brain-Computer Interface for home appliances. The system will integrate with any smartphones voice assistant.

Keywords: Brain Computer Interface (BCI), Smartphone Automation, Electro-Encephalogram (EEG), Android, Google Assistant.

I. INTRODUCTION

Multimillions of related neurons form the human brain. The pattern of interaction is portrayed as thoughts and emotional states between these neurons. This pattern changes according to human thoughts, resulting in different electric waves in turn. A contraction in muscles will also produce a single electric signal. The brain wave sensor senses all these electric waves and converts the data into packets and transmits the Bluetooth medium. [1]. The analyzer (LAU) level unit receives raw information on the brain wave and extracts and processes the signal using the MATLAB platform. Home automation is an environment that can use BCI and that can easily control our entire house through our brain [2]. This invention will prove to almost everyone on the planet to be a great boon. Less energy is wasted in menial tasks such as lighting, electrical equipment and other electrical equipment [3].

The neural tracts of the muscle tissues, which control or affect muscle mass themselves, are affected by Amyotrophic Lateral Sclerosis (ALS), brain stroke, talent or spinal twin damage, brain paralysis, muscle dystrophy and a few sclerosis problems and various diseases. In the United States alone, they affect nearly two million people. Those affected most seriously may lose all voluntary muscle control and may be locked up completely in their bodies.

In this article, we are going to discuss more than a few inputs are available to help people with physical difficulties manipulate a computer, an exchange machine or a wheelchair. It consists of a simple lever, which can be triggered by a variety of body parts, gazing structures or head motion structures, primarily based on a range of sizes between teeth, buttons or joysticks. The cursor can be applied on a computer. All of these systems do not represent locked men, however. The only solution for locked people is to create contact and control canals from the brain at once, bypassing the peripheral nerve and muscle outputs of the brain's impaired odium. Alerts on intelligence are obtained and processed in a brain computer interface (BCI) to identify specific aspects which represent the purpose of the user. They are then converted into instructions for running a computer.

II. TECHNIQUES FOR BCI CONTROLLED ASSITANT

Two main steps in the transmitter stage and the receiver stage are the system design. The circuit comprises the following phases which are described below:

A. Brain wave sensor

We will use dry non-invasive scalp sensors to test our brain's electrodes. In order to measure the brain activity, similar electrodes would be positioned in region of motor cortex and rest in several different areas of the brain.

B. EEG power spectrum processing

The power spectral density of the signal or signal power distribution via the frequency is the "energy quality" of the signal. Most EEG-based monitoring systems are (at least in part) based on spectral EEG analysis for anesthesia depth evaluation. The spectral resolution used to digitize the signal normalizes the PSD amplitude.

C. P300 Signal Detection

Given the importance of the P300 signal in this thesis, a brief assessment of strategies to detect it will be presented here. The main problem of the signal P300 is the very low signal-to-noise ratio. The pinnacle table indicates that the EEG sign is uncooked from 10 electrodes. The vertical traces indicate the stimulus times, red / thick. Gadgets on 6 and 6 matrix in the P300 speller via Farwell and Donchin.

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Rows and columns are flashed at random and a P300 signal is produced three hundred m after the key is flashed in line with the target stimulus the user wants to pick.

Figure 1

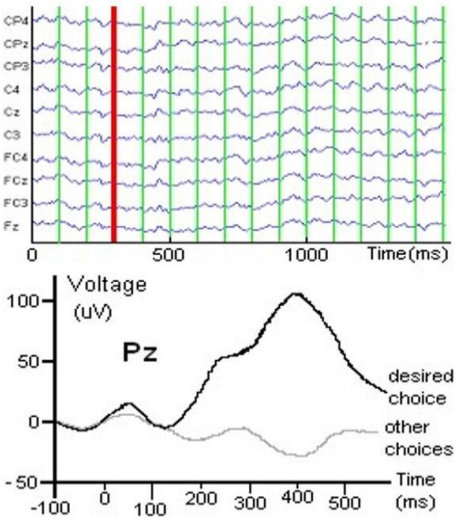

Figure 2

D. Slow Cortical Potential (SCP)

Slow Cortical Potential (SCP) is a modulation of the worldwide EEG (very low frequency) achievable. It is registered on the top of the head using a single electrode. Because SCPs indicate the standard preparatory excitement of a cortical network, they are universally present in the human brain. As a consequence, a brain laptop interface device called the Thought Translation Device (TTD), which reflects the vertical position of a comment cursor, is developed at Tu Burbingen University. Birbaumer's group reflects the amplitude of a SCP change. After a person has handled their SCP changes with trust, the answers can be used to pick items on a pc screen.

A constant left to right cursor movement is controlled by Genius activity of the user; vertical movement is controlled. This software was supplemented with a dictionary supply phrase after only a few letters have been selected to speed up communication.

E. Dry electrode unit

The benefits of the new dry electrode are no skin preparations or conductive material, lower resistance to motion and an improved signal to noise ratio. The results show that the dry electrode performs all types of EEG signals comparably with conventional electrodes.

F. Functional Near-Infrared Imaging (fNIR)

Near-infrared (fNIR) functionality is a highly revolutionary primary technology based on the idea that tissue optical homes (including absorption and dispersion) are alternating when the tissue is involved. Two types of alarms may be recorded: rapidly scattered signals associated with changes in oxy and deoxy-hemoglobin concentrations, likely because of neuronal exercise and lenient absorption signals. FNIR has never been able to measure deep-seated intelligent thinking and the spatial judgment of fMRI.

G. μ and β Rhythms

Intelligent oscillation is produced in neural compound networks via feedback loops. For example, neuron synchronization provides an increase in oscillation frequency. Sensorimotor cortices are of particular interest in EEG, μ (8-12Hz) and β (18-26Hz) rhythms steps. The laws of μ and β are seen as an alternative to "operational conditions," i.e. they are voluntary. Therefore, until it wants to achieve control /communications through the GUI, the subject will suppose something or nothing.

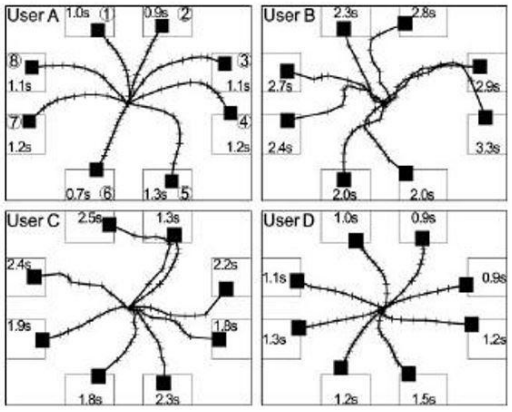

Figure 3

H. Steady-States Visually Evoked Potentials (SSVEP)

The Visible cortex's response to retinal stimulation by a blinking light source is consistent with the visually evoked potentials (SSVEP). Gives a response to the 7 Hz stimulation to the amplitude spectrum of SSVEP. It is possible to identify three peaks of 7 Hz, 14 Hz, and 21 Hz. Column (a) demonstrates the number of single trials, with column (b) indicating the average amplitude range of over 40. The favored variation is the vertical strains.2D manipulating the use of a μβ-BCI with a cursor by using four people with disabilities (Wolpaw et al). "Topics are recommended to move a cursor to one of eight objectives.

In a usual SSVEP BCI configuration, the visible subject is arranged with a range of LEDs (or button on a computer screen), which blink at exclusive frequencies and are associated with commands. If a command is to be selected the individual must definitely concentrate on the desired click. SSVEP is, just as with the P300 signal, a normal brain response, so it takes no preparation. In the order of a few seconds is the typical response time.

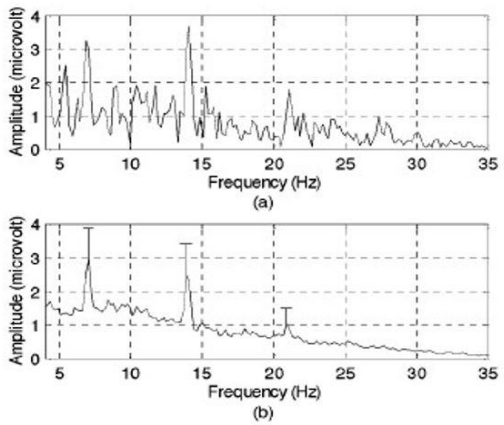

Figure 4

I. Design of embedded system

Like each other, the embedded cycle machine's creation gadget has a diagram loop as well. The waft of the device shall be as indicated in steps. The configuration considerations must take account of the software program and the equipment, the sensor, entry and output, from the pre-minimum country to the ultimate production process. Typically, both the microprocessor and a micro conductor are used in the electronics. Many broad or old organizations use computer systems or minicomputers for general purposes.

J. Classification

Real time networks. Real time networks. RTS has to react within a specific time period to events.

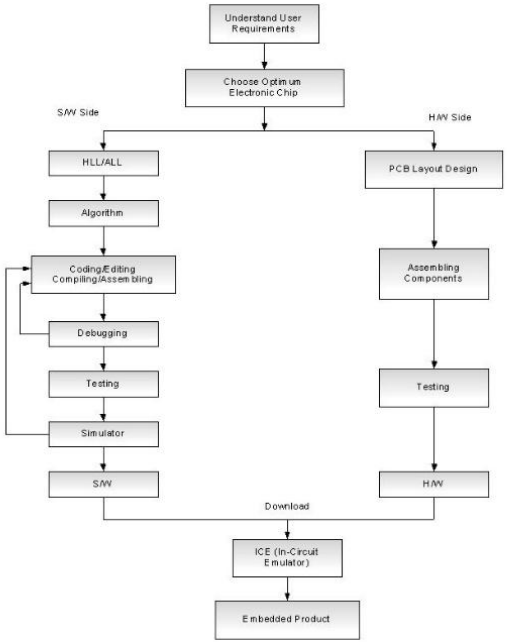

Figure 5

1. A correct reply is a wrong reply to the deadline
2. Classifying RTS
3. Difficult real time schemes
4. Hard Real Time Systems

Real-time "fast" systems are very strong. E.g. Nuclear power device, pacemaker cardiac. Unit Soft Real Time

1. Real-time "Soft" systems have reduced "lateness" constraints but must still run very quickly and repeatably.
2. For instance, the system for rail booking–it takes a couple of seconds to re-validate the data.

K. ZIGBEE receiver

ZigBee is an IEEE 802.15.4-based specification for a set of high-level communication protocols designed for small-sized digital radio networks in the personal sector, such as home automation, medical equipment selection and other low-bandwidth uses, intended for small-scale, wireless connectivity projects. ZigBee is therefore a weak, low data rate and wireless ad hoc network close to (i.e. personal area).

L. Relay

A relay is a circuit operated electrically. This consists of a set of input terminals and a variety of working touch terminals for single or multiple control signals. The transition may have several contact types with any number of contacts, like make contacts, interruptions or combinations.

M. Arduino micro-controller

The microcontroller processes the signals and produces the output by means of the appropriate algorithm after the amplification and filtering. The following operations are done by the microcontroller:

1. Take the ADC digital signals and process them according to the specified procedure. The microcontroller is connected directly to the user interface to show the selected data and information such as the concentration level.
2. The microcontroller transmits the interpreted data to a wireless broadcasting system.

N. User – interface

The user interface acts as an interface that informs the user of the device. This allows the user to choose which computer he or she wants to use. Furthermore, other additional details including focus are included in the user interface. The user interface can be fully adjusted by the user. The system the user wants to control can be attached and named. The UI can be designed to make it more user friendly as a mobile application.

O. Arduino and Google Assistant

By sending a chain from the Google Assistant, we want to search various parts of an Arduino including I / O pins, PWM, serial port and so on. First, to find out what we mean, we must define certain specific sentences to the Google Assistant. Then we create an applet and connect Google Assistant to our database on the IFTTT website. Afterwards, we read and send data from the database to the Arduino using the ESP8266 module. Therefore, an Android/iOS device can be used to pair them up for connection between BCI-Arduino-Smartphone-Assistant.

Figure 6

III. SYSTEM ARCHITECTURE

1. Block Diagram

Transmitter Side

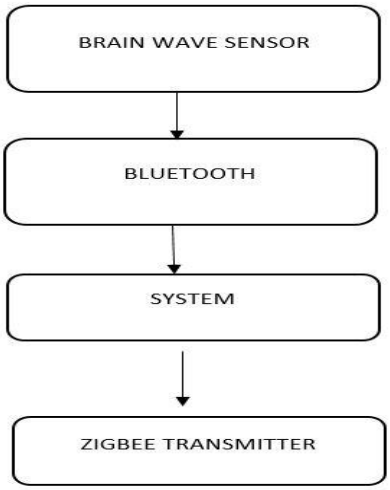

Figure 7 : Diagram of Transmitter Side

Receiver Side

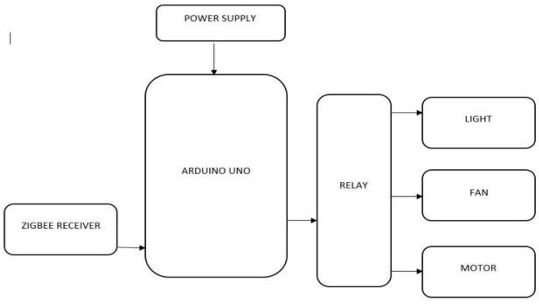

Figure 8 : Diagram of Receiver Side

2. Feature Extraction and Classification

We use the EEGLA B, an EEG signal for ceasing toolbox based on MATLAB, for the treatment of EEG data, which includes preprocessing by band-pass filtering and band-power extraction. The gdf file from the Open Vibe acquisition scenario was used to analyze EEG data offline. The data are filtered with a band pass with a Butterworth filter in fifth order. The band power features for the trials are then extracted. We use SVM classification technique once the features are collected. The open-source implementation of SVM uses LIBSVM.

IV. LITERATURE SURVEY

Khaleel Alhalaseh et al [1] introduces a new approach for a system that controls basic electrical equipment such as a kettle of water or a coffee maker, depending on consumer values of attention calculated by the handheld EEG sensor of NeuroSky MindWave. In addition to being a technological advancement in IoT, this new approach to control simple home devices can be tailored to several purposes, including those that are being proposed here to better help people with disabilities, so that it breaks the barriers to the handicapped and enables them to work freely around the home.

Marwan Nafea et al [2] the electroencephalogram (EEG) system is presented for a smart house intended to help people with disabilities and seniors. The system is made up of a NeuroSky MindWave EEG module coupled with an Android app that allows the user to monitor four home appliances. The Android app is coupled with an Arduino Uno board that controls appliances via the HC-05 Bluetooth module. Bluetooth connects the EEG sensor, the Android app and the Arduino board, providing low power consumption as well as a portable solution for smart home applications. The system allows the user to turn the four machines on and off with blink and focus. The EEG signal is extracted during the experiment to analyze the activity of the brain. The results are consistent with the power, standby, concentrate and running modes used for the study. The system can be installed effectively in clever homes and has a high potential for smart automation and biomedical wireless applications.

P.Saranya et al [3] introduces BCI's main motive is to help people with physical disabilities regain balance, interact and navigate their surroundings. There are different brain states due to different patterns of neural connections. "Waves with different amplitudes and frequencies result in these patterns. The contact between neural neurons takes place. The patterns of interaction are represented as thoughts and feelings between these neurons. The pattern will now change in accordance with human thoughts, producing different electric waves. This project deals with the specific electric signals generated by the different brain states, whereby the brain wave sensor senses these signals. The received data will then be translated into packets and transmitted via Bluetooth devices. The level analyzer unit will receive raw information about the brain wave and will ex-tract and process the signal via the MATLAB platform. "The following step will involve sending the instructions to the section concerned to operate modules including bulbs, fan and many other electrical devices.

R.Piyare et al [4] focuses on the remote monitoring and security of the smart home when the user is away. Wireless technology, such as Wi-Fi, is the SMS system used to revolutionize living standards. Fuxing Yang et al [5] they present Smart home is a big application for the network of wireless sensors. This paper incorporates a Zigbee and GPRS-based remote wireless acquisition and control system.

The system is a star network that includes sensors, electronic devices, acquisition and control nodes of terminals, family gateways and data viewing platforms. The device is low-cost, energy efficient, easy to deploy and very wide in scope. The whole device not only acquires and shows ambient data, but can also question and monitor remotely, the experiment displays a strong remote alarm and control. Manual operation and automatic control mode are included in the control system. This paper also presents the structure and composition of the system, hardware and software design. The energy efficiency was concentrated in the design process.

A ElShafee and et al [6] presents that it is a very attractive idea of a smart home with built-in cameras, actuators, a wireless network, and an interface. In this paper, a robust, scalable, safe and economical sensor network is designed and implemented, to transform conventional houses into a smart home. Indoor use is made of heterogeneous sensor and actuator nodes based on wireless network technologies. These nodes are attached to a middleware that operates home automation servers and acts as a broker to facilitate the MQTT protocol communication. The central device allows wireless node control over both local and remote networks. The system proposed is low-cost and scalable to accommodate a range of controlled devices.

Nicholas D et al [7] present a system that incorporates the smartphone, cloud, wireless, electricity-based connectivity multi-touch de-fails to ensure that users have remote control over different lights and devices in their own homes. This system uses a consolidation of mobile telephone app, hand-held remote and PC-based software for the user to use. The home automation system differs from other systems in that the user operates the system on the internet wireless remote without depending on a mobile carrier or Internet connection. This system is designed to be cost-effective and expandable to operate various devices.

T. Yashiro et al [8] proposes a new architecture for hosting IoT services on common embedded systems, such as the usual consumer appliances, uID-CoAP architecture. Often in comparison with simple sensor nodes, they require a number of sophisticated functions, so we combine the limited application protocol (CoAP) with an omnipresent ID (uID) structure. The latter plays a key role in preserving the knowledge and information needed for complex IoT services. Additionally, we provide an embedded device nodes development platform that decreases the burden of built-in system producers by offering an intuitive, reliable and easy to use API. In addition to the low-level communication API, our framework provides functions in this context for building RESTful services. We assessed our system through a case study and demonstrated that our framework can be efficiently utilized to implement practical IoT applications with little programming effort on existing embedded systems.

Deepali Javale et al [9] presents the Conceived and implemented an intelligent electricity consumption monitoring system based on the real-time monitoring of the INTEL GALILEO 2ND developed a choice board generation devices used in house-and company buildings at home. The system is designed to monitor and control electronic devices and switches with or without Android-based applications in real time. Different sensors are used not only to monitor the monitoring of real time devices but also to keep your home safe. The Internet or Intranet Connectivity is monitored and controlled remotely via an Android app. The proposed outcome of the project is to save on the electricity bills of the house and also to keep users up to date on their domestic safety by using an alternative means of controlling the switching on of the devices via the use of their speech or simply by pressing a touch on their smartphone.

S. Aishwarya et al [10] presents The BCI (brain machine interface) technology is based on the device. The BCI is a new and unique method for transmitting the human brain to an external device such as light, fan, and television. The impulses of the human brain wave include millions of neuron patterns. This interaction between patterns generates an electric wave of various kinds. The Neurosky headset consists of a sensor to feel at a level of attention, which ensures that human concentration and guided mental activity occur during intense concentration. The signal is converted into a raw data packet and is transmitted via the Bluetooth medium into the Arduino (microcontroller unit). The Arduino processes the signal received and drives the device's relay circuit to automatically start and run. The lamp, the fan along with the voice module are used for demonstration.

V. EXISTING SYSTEM

In this system, In contrast with functional magnetic resonance imaging (fRI) methods, EEG has a minimal spatial resolve. The electrodes are used to measure brain operations from a certain scalp region, which makes measurements from the measured areas of the skull not assured. Signals may originate and be captured by other electrodes in neighboring brain areas. Due to the poor signal-to-noise ratio of small signals, a complicated data analysis and large numbers of subjects is necessary to ex-tract useful information from EEG. Gels, saline solutions and/or pastes and electrodes may cause discomfort to the user.

Disadvantages:

1. No remote-control operation available.
2. It always depends on others to operate so not future proof.
3. Also, it always depends upon user's manual implementation.

VI. PROPOSED SYSTEM

EEG-based equipment may be mobile, the procedure is relatively cheap, easy-to-use, rapid, quiet and safe, with no real safeguards and no risk. No pain is caused by the EEG invasive procedure. EEG provides a large time resolution or the ability to better understand the moment when the event took place with respect to stimuli. EEG-based equipment can be designed for consumer and non-medical use to be accessible. The phases of a BCI pipeline are listed in this section. Actually, there is a sub-section of an EEG signal acquisition procedure, followed by pre-processing techniques in sub-section, sub-section extraction of features and sub-section classification.

1. EEG Signal Earned Paradigm We acquire a high-resolution Wireless neuroheadset. Signals by Emotiv EPOC. In order to detect users ' thoughts, feeling and expressions in real time, EPOC uses a set of 14 sensors, plus 2 references to measure electrical activity from signals generated from the brain. It is ideal for collecting EEG data from 14 channels on 10-20 International locations.
2. The Emotiv headset pro-vides uses basic signal processing for the pre-processing of EEG signals, which includes a low pass filter of the EEG data with a cut-off frequency of 85 Hz and a high-pass filter at a cut-off frequency of 0.16 Hz. Finally, a noise filter of 50-60 Hz is used to eliminate the noise generated by interference with the supply lines. In addition, our procedure includes the detection of the eye blinks, the right wink of the eye and the left wink of the eye. The EEG activity in the alpha frequency band determines these attempts and thus the EEG signal is subjected to a band pass filter in the range 1 to 4 Hz. For band passing of information we use a Butterworth filter.
3. The feature extraction technique used in our application is covered in this chapter. We use the band power of the EEG signal as an easy to calculate and computer-cheap feature. In BCI systems, band power computation as a method has already occurred. We measure the features of the EEG signals in a study, which are presented as matrix X size [channel-samples] (where channels reflect the number of channels recorded) for the band power features against traditional feature extract techniques. EEG data and measurements are calculated by the sample rate for the EEG purchasing tool multiplied by the time frame in which the test data is collected, as shown in Equation 2 for the I the channel band capacity.

$$BP_{x^i} = \sum_{j=1}^{samples} [X(i,j)]^2$$

We take the band power logarithm as features in practice. The size vector FV of feature [channelsX1] is calculated for the EEG data denoted with X as displayed in Equation 3 on the i th channel.

$$FV[i] = \log(BP_{X^i})$$

4. Using the Google-developed, primarily on smart home devices, artificial intelligence-driven virtual aid. In contrast, the Google Assistant can engage in two-way discussions, as opposed to the company's previous virtual assists. You can better recognize your words than other apps and answer your commands quickly and correctly. Users interact mainly with the Google Assistant via a natural voice, although they also support keyboard input. The Wizard is able to search the Internet, schedule events and alarms, change the system hardware and display details on the Google user, in the same way as Google Now does. Google also revealed that it will be possible for the Assistant to identify objects and collect visual information via the device's camera, and to support goods, money, and the identification of songs. The service runs on iOS and Android as well as the web-based platform.

VII. RESULT ANALYSIS

The result obtained from the work is that the device can now be connected to a subject's brain having all the signals which would provide feedback to the Arduino micro-controller which output is showed below. The Arduino micro-controller will then provide a connection to the mobile device, this would control the Google Voice Assistant and hence the subject can perform several activities with the AI. This provides a feedback from the cortex of the brain to the AI.

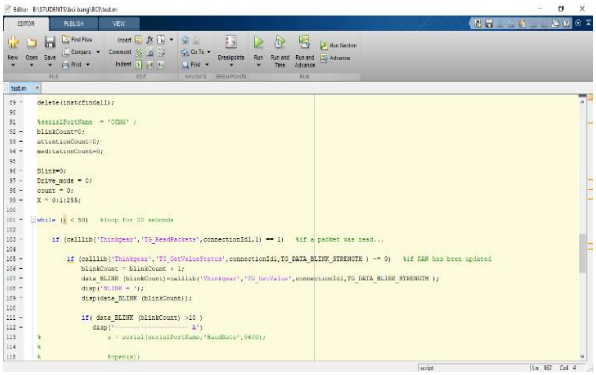

Figure 9

The main aim of this research work is to provide a user the benefit of utilising a Brain Computer Interface to interact with the environment around him/her ,the result can be described briefly below as follows :

1. BCI to Arduino :

A function has been formulated to connect and plot raw EEG data , which includes

data_blink
data_meditation
data_attention

A pre-allocation of buffer is produced , Bluetooth sensor is connected TG_Connect() and Baud rate is set up as TG_SetBaudrate() and values is being generated as TG_GetValue()

Values of TG_GetValue() are :

TG_DATA_BATTERY
TG_DATA_POOR_SIGNAL
TG_DATA_ATTENTION
TG_DATA_MEDITATION
TG_DATA_RAW
TG_DATA_DELTA
TG_DATA_THETA
TG_DATA_ALPHA1
TG_DATA_ALPHA2
TG_DATA_BETA1
TG_DATA_BETA2
TG_DATA_GAMMA1
TG_DATA_GAMMA2

TG_DATA_BLINK_STRENGTH

2. TG_DATA_READYZONE

These values will be stored from the BCI device and triggered to Arduino UNO and therefore processed in MATLAB & there will be threshold limit stored for each of these values stored from the device.

Each of the values generate EEG values from different parts of the brain with the help of the BCI device . Hence , the feature extraction is complete and can be processed further for more relative use by the micro processor .

3. Arduino to MATLAB:

The feature extracted data provided from the BCI now can be implemented in MATLAB for analysis.

The MATLAB code than resolves the analysis of each (Figure)of the electric signal data to output as :

Attention:

Meditation:

Blink:

4. Arduino to Voice Assistant:

The result obtained from connecting to a Voice Assistant to control the environment as follow:

"OK Google" > saying a phrase > "Turn on the lights" > ON .

IFTTT applet is then used to trigger and webhook request is made to Blynk server to send this text as authentication token.

Blynk app is receiving such texts in the app.

Text will be received in Arduino code through the given predefined methods of Blynk library when Arduino board is connected to Blynk via internet.

Finally lights , fans , etc are connected

Hence, the whole device will work as mentioned, a small result table would give more relevance to the research given below:

RESULT TABLE

Table 1 : Shows the result analysis of the research

Sr no.	Task As Thought	Google Assitant	Mode	EEG Data	Action By Arduino
1			ATTENTION	40	
2	FAN	"Switch on fan"	MEDITATION	43	FAN(ON/OFF)
3			BLINK	50	
1			ATTENTION	44	
2			MEDITATION	40	
3	LIGHT	"Switch on light"	BLINK	71	LIGHT (ON/OFF)
1	CALL	"Call 911"	ATTENTION	81	CALL EMERGENCY
2			MEDITATION	41	
3			BLINK	64	

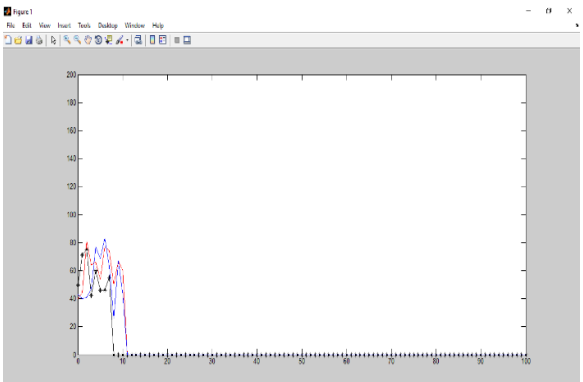

Figure 10

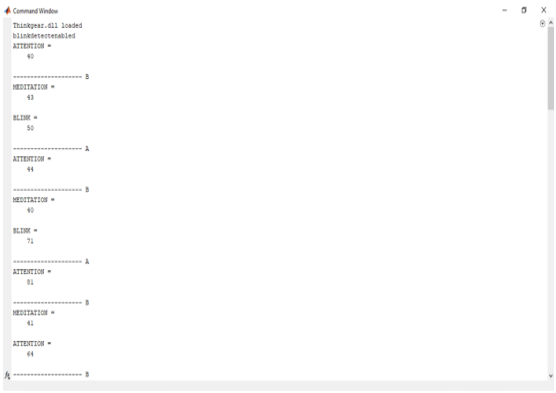

Figure 11

VIII. CONCLUSION

The proposed system will give the result on basis of the data sets which we will train and test. It is expected to give much better result as this system will analyze the historical data and find the most suitable place to cultivate paddy according to the soil type, weather condition, rainfall, maximum and minimum temperature, etc. The accuracy level is also good. In future I will try to enhance the accuracy level and do the same for all states of India instead of four states.

The proposed system will give the result which will provide additional access to the disabled or patients suffering from heart ailments who will require to call for help without the possibility or the need of speech, rather than just thinking and asking Google Assistant to make the call and hence would be very useful outcome for the people/users in need.

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AUTHORS PROFILE

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