Brainwave Maneuvered Wheelchair

Rajesh Rishi[1]

[1]Department of Electrical and Electronics Engineering, School of Technology, Assam Don Bosco University
Airport Road, Azara, Guwahati-781017, Assam, INDIA
[1]rajeshrishi26@email.com

Abstract : ***In this world, there are millions of people who suffer from quadriplegic, paralytic, mobility disorders, and neuromuscular disorders in which the organs below the neck can't be controlled by the patients. The system that has been developed in this project uses electroencephalogram-based promising and important technology using Brain Computer Interface. It helps unblessed people to control the organ below their neck using their own brain. Modern electroencephalogram-based Brain Computer Interface uses gel type electrodes, and this type of technology is only limited to hospitals and laboratories. It requires 30 minutes to acquire a brain signal, and this proposed system is very costly. But to overcome this, cup type electrodes are used and the overall cost is reduced to make it cost effective. It has been made portable, so that users can handle and carry it easily. It is possible to operate an electric wheelchair for individuals with disabilities using electroencephalogram signals of their eye movements, which is accomplished via the application of algorithms in MATLAB. Finally, the outcomes of this suggested system provide useful outputs for the user.***

Keywords: ***Algorithms; Brain Computer Interface (BCI); Electroencephalogram (EEG); Electric wheelchair and Eye movements.***

(Article history: Received: 28th September and accepted 30th March 2022)

I. INTRODUCTION

A. Overview

We could have super human vision, play our favourite albums in our head, download skills to our brain, and download our brain to a computer or even to another body. Though this may sound like an episode of our favourite science fiction show, we believe that technology could one day overshadow the human race and that, day by day, industrial robots are getting into human life. Disabled individuals' daily and professional lives are being helped by robots, which is creating a demand for them. Normal users can operate this device with a keyboard, a joystick, or a mouse. For aged or disabled people, it is tough to use these devices. As a result, robots are not able to transport disabled people to their desired location, and disabled people want to be responsible for their mobility even if they are a victim of quadriplegia. Quadriplegia is a type of disability nowadays in today's world. In quadriplegia, both arms and legs and the entire trunk below the neck are paralysed due to spinal cord damage. It is mostly caused by road traffic accidents or the growth of tumours in the spinal cord. In the early days, motorised wheelchairs with joysticks were used to somehow deal with this disabling type of disease, but the wheelchair was too expensive at that time. To deal with this challenge, an EEG-based BCI (Brain-Computer Interface) has been developed by NeuroSky company through which brain signals can be captured and those signals can be used to operate a wheelchair. In the early days, this type of EEG technique was only an imagination, myth, or science fiction story, but in today's world, everything that comes in imagination can be applied practically. An EEG based BCI creates a new communication channel between a computer and the brain. This system is truly for those people whose bodies are being paralyzed. The main point is to control the wheelchair through eye blinking, attention level, or meditation level. It will be tough to use this device for aged people because it requires training, but as soon as the people adapt to the training completely, it will be easy for them to operate. For the framework, we utilised the brain-computer interface by NeuroSky to obtain the signals from the brain. The circuit design utilises Arduino and motor drivers, notwithstanding its flexibility and execution in numerical tasks and correspondence with other electronic gadgets. The framework has been created and completed in a cost-effective manner, so that if our task is popularized, paraplegic clients in developing countries would benefit from it. For brain signals, the BCI interface by NeuroSky is utilized. The price difference between the BCI system and other brain-controlled devices or robots is that other brain-controlled devices require more safety because they are usually transporting a disabled individual. Thus, through BCI technology, devices have higher performance and safety in a shorter period of time. Recently, this type of system has received an excellent deal of attention due to its ability to bring back those individuals who are suffering from quadriplegia and improve their independence and standard of life. In 2004, Millan et al. planned the primary EEG-based mechanism. From that period, many researchers have developed brain-controlled robots. Recently, challenges highlighted by BCI-based systems and their applications such as communication and management, motor substitution, diversion, and motor recovery have been reviewed by Millan´ et al.

B. Motivation

People with severe movement disorders, such as quadriplegia, locked-in syndrome, or Amyotrophic Lateral Sclerosis (ALS), are awake and aware of what is happening in their surroundings, but they are unable to engage in or carry out any activity because, with the exception of eye movements and blinking, almost every voluntary muscle in the body is immobilized. Because of their severe cerebral palsy disease, some people are unable to talk or are not comprehensible enough to engage, communicate, or navigate with others. These people have a severe mobility problem and are paralyzed, physically challenged, or elderly. Consider these people to have a completely functional brain imprisoned inside a non-functional body. This project is for them to help them move around, talk to their caretaker, and send alerts in case of an emergency.

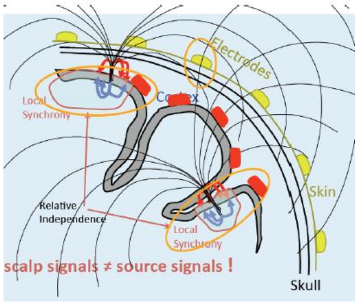
C. Objective

One of the primary goals of this research is to develop a low-cost, brain-controlled smart wheelchair. Another goal is to develop a way of communicating via blinking that includes detecting brain waves and utilising those readings to operate the wheelchair. Wireless communication should be employed as much as feasible to provide optimal dependability at the lowest feasible cost. This concept enables individuals to meet all of their basic needs from the comfort of their own wheelchair. The wheelchair is integrated with all applications, such as, they can drive their wheelchair by themselves using eye blink, they can do meditation by using BCI meditation games, and they can check their percentage attention level whether they are feeling energetic or sleepy.

II. Theoretical Background

In recent years, there have been an increasing number of surveys and many conferences focused on brain-computer interfaces. BCI is handled in many ways using different applications via attention or meditation values for applications. For example, consider a normal paralysed person who is unable to move, speak, or engage in any physical activities. By using the BCI, we are able to enable paralysed people to do a physical task by controlling it through their brains. So, in paralysed people, only their brain is activated. So, by using the brain, they are able to move everything. Those kinds of technology which are under the BCI are specially used as an EEG.

A bio signal is nothing but the signal which is obtained from a living creature, such as animals, humans, etc. The first biosignal is the heart ECG signal. An ECG is nothing but an electrocardiogram wave that is obtained from the heart. So, in the hospital, we might have seen that there are lots of spikes of this signal. If the spikes go in a line, the patient is declared dead. Another type of bio signal is EMG, which is called an electromyogram, which is a muscle-related wave. For example, if we want to move any finger of our hand, there will be specific nerve activity in the muscles around the wrist. So, by placing the ECG here, we can detect the waves obtained from the muscles. ECG is heart-related waves, but EMG is muscle-related waves. Another kind of bio signal is EEG, or electroencephalography, which is obtained from the brain. Another type of bio signal is MEG, which stands for Magnetoencephalography and Galvanic skin response. is nothing but a signal that is obtained from the brain. It will monitor the electrical activity of the brain. The brain contains billions of neurons, and for every neuro of every activity we do, there will be a minor electrical activity. Using electroencephalography (EEG), which captures the electrical activity of the scalp, we may learn more about our brains. In the brain, the electroencephalogram (EEG) is used to monitor voltage changes produced by ionic current flows inside the neurons' membranes. If someone pinches us, electrical activity will be activated in certain kinds of neurons, causing them to fire in response. Electroencephalography is a kind of electrical wave that may be obtained by monitoring certain electrical activities, and the study of electroencephalography is referred to as electroencephalography. Hans Berger (1873–1941), a German psychiatrist and scientist, was the first to record the first human EEG in 1924.



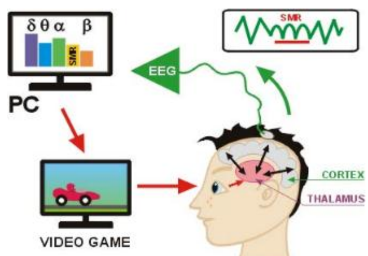


Figure 2.1 : Neurofeedback

Neurofeedback is a method of directly teaching the brain's function, through which the brain may learn to operate more effectively. Children with attention deficit hyperactivity disorder (ADHD) may benefit from neurofeedback training to help them calm down and focus.

TYPE	FREQUENCY (HZ)	CURRENT STATE OF EXISTENCE
DELTA	0.5-4	Adults slow wave sleep

THETA	4-8	Adult drowsiness and idling
ALPHA	8-13	Mentally inactive awareness, Relaxed State, Eye Blinking and Mentally inactive awakens
BETA	13-32	Alert/working and Active and it is aided by anticipation moods and a sense of urgency.
GAMA	> 32	EEG recordings often omit clinical and physiological details, although they have nothing to do with clinical and physiological aspects. Fastest waves pass information rapidly and quietly.

Table 2.1 : Comparison of EEG Bands

In the EEG, there are several kinds of bands. The first band is Delta, and the range of the Delta is 0.5–4 Hz. If the person lies at the delta frequency, then we can say that the person is an adult and has slow wave sleep. The second band is Theta and the range of the delta is 4–8 Hz. If the person lies in the theta frequency, then we can say that the person is an adult and the person is in a drowsy state. The third band is Alpha and the range of the delta is 8–15 Hz. If the person lies in the alpha frequency, then we can say that the person is in a relaxed state like meditation and eyeblink is also detected in the alpha frequency. The fourth band is Beta and the range of the delta is 15-32 Hz. If the person lies in the Beta frequency, then we can say that the person is alert, like during study or when we play games or anxious thinking. The fifth band is Gamma and the range of the delta is > 32 Hz. To attain this band we should be extremely quiet as well, as the information will be passed very fast.

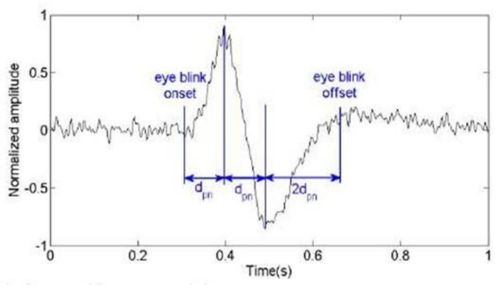


Figure 2.2 : Signal Detection

In signal detection, there are two types of electrodes – invasive and non-invasive. Invasive electrodes will be placed in the brain tissue (cortex) and non-invasive electrodes will be placed on the scalp. For every type of electrode, electromagnetic fields will cancel each other out so that we can detect what is happening inside the brain, amplitude and time between the frequencies. For example, if we want to detect the eye blink waves, we will get the eye blink offset and onset. During blinking, when we close our eyes, there will be a positive cycle, and when we open our eyes, there will be a negative cycle. The complete graph is shown in the figure. Finding the source of a problem in signal detection may not be readily apparent (e.g., deep brain structures, dopaminergic system, few neurons). Actually, this non-invasive technique records the brain's spontaneous electrical activity along the scalp by connecting multiple electrodes on the scalp. Due to neurons, EEG is generated, and as the neurons travel down, the potential is generated, which results in a neurotransmitter that activates a receptor in the dendrite, and together the receptor and neurotransmitter generate an electrical voltage of 1 V to 100 V. The voltage that is generated is called an EEG signal. The main causes probably won't be straightforwardly discernible (e.g., dopaminergic framework, profound mind structures, barely any neurons). Here, electromagnetic fields can offset one another. Neuralink uses BCI technology for major applications such as treating brain disorders and building toward potential symbiosis with artificial intelligence. The electrodes which are used in Neuralink are extremely small, about 0.004 mm.

Communication using perception of the brain (EEG) without using any muscle control is especially important for severely paralysed people.

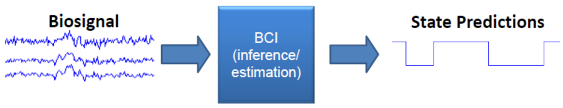


Figure 2.3 : BCI Interference

A BCI generally consists of three main components:

A signal-acquisition module (electrode, filtering, and amplifier) records data from the brain, and after recording data, some low-level filtering is done, as a result of which the data after filtering is clarified. A signal-processing module (ASIC, DSP) checks whether a particular feature is present in the data or not after receiving data from the acquisition module. A control module (microcontroller and driver).

With Brain Computer Interface, we can play games like Brain Fitness, Games with a Benefit, measure our daily meditation level and get reports to analyze, measure our focus with visual feedback and real-time monitoring of the brain, do research on EEG signals for Brain Computer Interface, and read RAW Brain waves for the developer community. By exercising the brain, we can make it smarter. can make our brain fit by improving aspects of cognition like attention, focus, memory and brain speed.

III. Literature Survey and Problem Statement

A. Literature Survey

Our human brain is composed of an average of 100 billion neurons. Neuron interaction is represented as emotional states and thoughts of the human mind. An EEG device is used to detect the waveform of the neurons. EEG-based BCI has the capability to solve problems for paralysed patients and people with quadriplegia. In the early days, a motorised wheelchair with an automated joystick control was used to solve problems for paralysed patients, but this system is too expensive and a patient cannot be fully satisfied by this system. To overcome this problem, an EEG-based BCI system is used to make a wheelchair for paralysed patients. This system is more cost-effective and reliable than the earlier system.

In order to determine the user's purpose, the brain-computer interface must analyse the brain signals. It can also operate computers and robots. An intrusive technique for monitoring brain signals is one that requires surgical intervention, while a non-invasive one does not require surgical intervention. An invasive technique may be used to detect epilepsy by putting needle electrodes into the brain and measuring spike signals, which are signs of single or multiple unit activity. Both magnetoencephalography (MEG) and electroencephalography (EEG) are non-invasive methods that may be used to detect electrical changes in the brain and monitor magnetic changes in the brain, respectively (MEG). By monitoring brain signals using intrusive methods, it is possible to obtain a high signal-to-noise ratio (SNR) in a small area. However, this requires surgery, which is a significant disadvantage of this method. However, the non-invasive technique does not require the use of a surgical instrument. However, the main drawback of this simple technique is that the SNR signal is low since the signals from different areas are jumbled together. This method is useful for measuring signals with non-disabled individuals and seeing changes across the brain. In non-invasive techniques such as SCP, where EEG rises or decreases according to attention; SMR (sensorimotor rhythms), where four directions may be regulated; and Steady-State Visually Evoked Potential (SSVEP), there are many fundamental concepts to consider (SSVEP). Finally, electroencephalography (EEG) is a noninvasive method for detecting electrical changes in the brain that has the added advantage of being completely risk-free since it connects the brain to a computer through a wire. [1]

A non -invasive technique called EEG can record the brain's spontaneous electrical activity along the scalp by connecting multiple electrodes on the scalp. Due to neurons, EEG is generated, and as the neurons travel down, the potential is generated, which results in a neurotransmitter that activates a receptor in the dendrite, and together the receptor and neurotransmitter generate an electrical voltage of 1uV to 100uV. An EEG signal is the voltage that is produced as a result of the stimulation. EEG signals are classified into five kinds of waves: beta, alpha, delta, mu, and theta. Delta, theta, and alpha waves are the most common. The Mindwave device by NeuroSky company is used to extract EEG signals, which can be observed on the computer using MATLAB. Each time we blink our eyes, a sinusoidal signal is amplified. This sinusoidal signal is used to operate a microcontroller-based wheelchair. The conclusion is that this brain-controlled wheelchair is slow, but if we train the physically challenged people to operate it, it will be a reliable method for a physically challenged person. [2]

In quadriplegia, both arms and legs and the entire trunk below the neck are paralysed due to spinal cord damage. It is mostly caused by road traffic accidents or the growth of tumours in the spinal cord. The EEG-based BCI by NeuroSky company is used for capturing the brain signals. Here, eye blinking is used to operate the microcontroller-based wheelchair. That is, each time eyes are blinked twice by patients, the direction of a wheelchair is selected. But we have to train the quadriplegic patients. The conclusion is that patients may find it uncomfortable at first, so we have an attention-meter from Neurosky so that patients can see their attention level, and based on that level, they can decide their best attention level for training. [3]

In the brain, neural processes trigger each and every physical movement we want to do. These processes are possible to read and record by using EEG analysis by LabView software from NeuroSky. This system uses NeuroSky Mindwave to get the EEG signals from the brain. This technique can be utilised to operate an electric wheelchair for immobile people, disabled people, or quadriplegics. In LabView software, attention or meditation, the level is analysed and this signal is used to operate the wheelchair. The conclusion is that this wheelchair is operated based on the user’s attention or meditation label and the chair is set on a particular attention or meditation label to choose the direction of the wheelchair. So, at the start of the training, it may be difficult to adopt that feature. [4]

A wheelchair with a Brain-Computer Interface is designed based on the processing, receiving, and classification of electroencephalography, as electroencephalography helps in controlling the wheelchair. The wheelchair is being controlled by the algorithms of fuzzy neural networks. The system is made wireless by introducing the Bluetooth module. The conclusion is that 72 sensors are used to get a 100% accurate result. [5]

A brain-computer interface is a device that allows signals from the brain to directly control some external activity, such as the control of a wheelchair. It creates a direct pathway between the object and the brain. This method will be useful for people who cannot control their muscular body parts. Here, brain waves are captured using brain computer interface under noninvasive techniques, data is processed into the computer with the help of certain algorithms, and signals are transferred to the wheelchair via Bluetooth modules, which makes the relationship between the user and the wheelchair user-friendly. [6]

Brain Computer Interface can control and communicate between devices and the human brain in real time by bypassing standard muscle and thought channels. from interconnected neurons of the human brain, brain wave signals are analyzed. The primary goal of this article is to use brainwaves to operate a robot in real time. The ARM CPU, wireless communication devices such as the XBee and XBee-PRO OEM RF Modules, and a brain computer interface for collecting EEG data are all utilised in the construction of this model. The result is that this research allows individuals suffering from neuromuscular diseases to regain their mobility. [7]

To assist people with disabilities, an EEG-based electronic wheelchair is utilised to operate the wheelchair so that it can reach the target location. It is the goal of this study to acquire data from 10 people, who together contributed 137 samples. The data is then analysed and filtered using the Hamming band-pass filter to create a clean and noisy signal. In order to operate a wheelchair, a technique known as the threshold algorithm is used to extract characteristics from EEG signals of eye movements. After extracting those features, different types of eye blink signals are classified, and blink durations are computed using the information obtained from the threshold algorithm. The conclusion is that this model gives 86.2% accuracy and that this model can be easily adopted by disabled people. [8]

The wheelchair is controlled by using eye movement using EEG in which five types of eye movements are used, such as looking left and relaxing, double blinking, looking right, and blinking. These eye movements are associated with five different wheelchair movement directions, including Go ahead, Turn right, Turn left, Go backward, and Stop (to name a few). The EEG signal is then looked at with MATLAB to find the set threshold, which is the same as the signal amplitude of the Alpha and Delta bands. The conclusion is that this model gives an average accuracy of 83%, which helps disabled people engage with their surroundings. [9].

The DC motor is controlled using an EEG headset. Here, raw EEG signal is extracted and classified using SVM (Support Vector Machine) and PSD (Power Spectral Density) features, and this PSD feature of the EEG signal is selected to control three directions of the motor, such as left, right, and forward. This entire process is done wirelessly. The conclusion is that this entire setup works with 92% accuracy, which is beneficial for disabled people. [10]

B. Problem Statement

As I began working on the project, I learned that there are five fundamental motions of a wheelchair that the user may employ. The wheelchair may be thought of as having five conditions, listed as follows: Forward movement, backward movement, left turns, right turns, and stop states. Another issue is developing a brain-computer interface system that can detect eye blink signals and use them to operate the wheelchair.

C. Problem Formulation

The figure 3.1 shows the flow of a wheelchair controlled by EEG signals. Once the brain computer is initialized, eye blink values are captured. The brain-computer interface captures impure sinusoidal signals of eye blink signals continuously. If the eye blink signals match with the selection of direction of the control panel, it chooses one direction. If it does not get the eyeblink signals, then it will wait to blink in the next direction. If eye blink is continuous, then the wheelchair will stop.

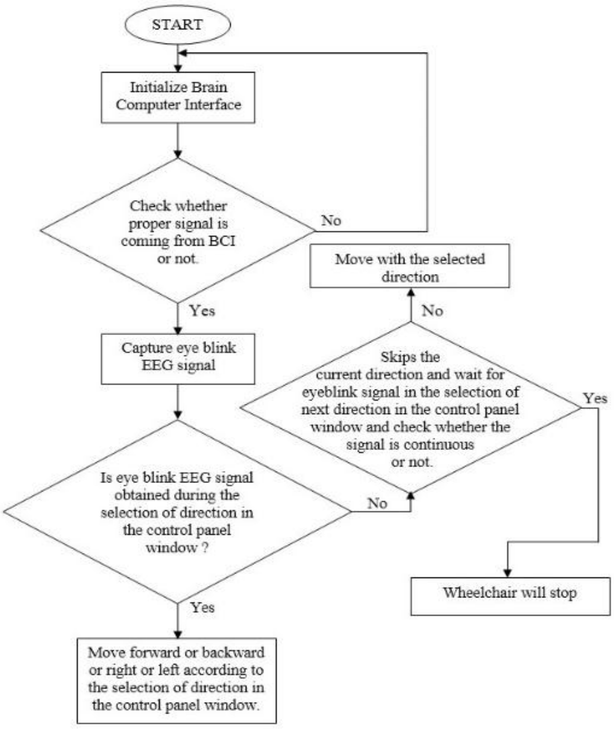


Figure 3.1 : Flowchart of the model

IV. Methodology and System Design

A. Methods and Tools Used

The required operation of motors can be attained by this method. In this method, an L293D dual H-Bridge motor driver is used to control two DC gear motors simultaneously. The direction of motors can be changed by changing the polarity.

a) Capturing brainwaves

Using the non-invasive BCI technique, brain waves are captured.

b) Data processing

NeuroSky's BCI technology, which uses a forehead sensor to detect electrical impulses, is used to diagnose and treat patients. NeuroSky's proprietary technology translates brain signals collected by the TGAM module.

c) Wheelchair Control

As the forehead sensor is initialised and attention values are obtained and cross the threshold of a wheelchair, one direction of the wheel is selected. In this way, users can select the different directions of the wheelchair according to their needs.

d) Data Transmission over Bluetooth

The Bluetooth device is connected to both the receiver's end and the sender's end and the transmission of data occurs through Bluetooth.

e) Arduino IDE:

This software tool is used to programme the Arduino Microcontroller.

f) Arduino wheelchair Control:

It is a MATLAB programme used to identify the EEG signals from the brain and process them into a string of data.

B. Proposed Diagram of the Model

Fig 4.1: Block Diagram of the model

The model's operation is shown in the block diagram that has been suggested. This block diagram includes 3 processes. They are: Signal Acquisition, Signal Transmission, and Signal Detection.

Signal Detection

It is important to note that the accuracy with which the EEG signal from the user's scalp is detected is an important consideration at this stage. The human brain has millions of neurons that are connected to one another by dendrites and axons, respectively. When we move, sense, think, remember, or feel anything, our neurons are activated and work hard to keep us moving. Every task is carried out by small electric impulses that move from neuron to neuron at rates of up to 250 miles per hour. Signals may be generated as a result of changes in electric potential sent across the membrane of particular neurons as a result of ions crossing the membrane. If you already know what they are, knowing where to look for these signals may help you explain what they represent and how to utilise them to operate a device of some sort. It is possible to read and record electroencephalography (EEG) when electrodes or sensors are put on the head, enabling researchers to get a more complete knowledge of how the brain works. The electroencephalogram (EEG) is a technique that detects voltage changes in the brain's neurons caused by ionic current. It has been estimated that the human brain has millions of neurons, each of which generates a very tiny electric voltage field. An electrical potential difference is created by the sum of all of these electric voltage fields, and it is this electrical potential difference that electrodes on the scalp can detect and record, utilising their recording skills. Consequently, the electroencephalogram (EEG) is a superposition of a large number of individual component signals. The typical amplitude of an EEG signal in a healthy adult varies from approximately 1 V to 100 V on average, depending on the subject's age. It is common to define and characterise the phenomena using the frequency range of electroencephalography (EEG). The delta, theta, alpha, beta, and gamma frequencies of human EEG waves are the basic frequencies of the human brain.Frequencies generated by several kinds of brain processes are shown schematically in Table 2.1. In order for the Brain Computer Interface to function, dry electrodes must be used in conjunction with an electrical circuit that is specifically designed for the dry electrodes. Various kinds of brain activity produce various frequencies, which are shown in the following table. In order for the Brain Computer Interface to function, dry electrodes must be used in conjunction with an electrical circuit that is specifically designed for the dry electrodes. In this method, analogue electrical impulses, also known as brainwaves, are calculated and converted to digital signals via the use of mathematical formulas. It is a gadget that enables a tool to communicate with the brainwaves of the person who is wearing it. It is equipped with a detector that just has to be touched on the forehead, reference points, and a contact set that is included inside the ear clip, as well as an on-board computer that analyses all of the data. Using the ThinkGear Module, which is contained inside the headset, each raw brainwave is square measured and calculated. In our brainwave detection system, TGAM acts as the basis for the detection of brain waves. Because of TGAM, brain signal partners may bring EEG-based consumer goods to market more rapidly and efficiently than they have ever been able to do previously. In order to capture signals from the human brain using dry electrodes, the TGAM first filters out unwanted noise and electrical interference before converting the data to digital power. Mental strength may be used for a variety of topics, including health and well-being, education, and entertainment. It is a single-chip EEG sensor that is both long-lasting and completely integrated, and it is integrated into the TGAM microcontroller for use. EMG noise filtering, NeuroSky eSense, 50/60Hz AC powerline interference, A/D, and A/D are all pre-installed on the chip, as is NeuroSky eSense.

Signal Acquisition

The signals picked up by the Brain Computer Interface headset are sent to the laptop through Bluetooth technology. The headset does all the detection, analysis, and digital-to-analog transformation. A laptop is used to receive the signal. In order to get the raw brainwave data from the Neurosky Mindwave Headset, the laptop is needed to run MATLAB code. Matlab helps the wheelchair operation by collecting real-time raw brainwave signals, which may be used to control it. With the transceiver module, the raw brainwaves will be used to power the microcontroller, which in turn transmits the brainwaves as command signals.

Signal Transmission

The signal is sent to the wheelchair using Bluetooth and Arduino, which are both open source projects. Bluetooth WLAN technology, which links devices to infrastructure-based services via a wireless carrier provider, is a kind of wireless network technology. Personal Area Networks (PANs) were created in response to the requirement for personal devices to communicate wirelessly with one another in the absence of an established infrastructure (PANs). The Bluetooth specification goes into great detail on the whole protocol stack. Bluetooth communicates via radio frequency (RF) and frequency modulation to produce radio waves in the ISM band, which is the frequency range in which it operates. Bluetooth transmits a bidirectional signal at a theoretical pace of 1,600 hops per second when spectrum spread is used; it communicates at a hypothetical rate of 1,600 hops per second when spectrum spread is not used. Bluetooth operates in the unlicensed industrial, research, and medical (ISM) band, which runs between 2.4 and 2.485 GHz and is utilised for wireless communication. But, even though the ISM band (2.4 GHz) is available, it is not allowed in most countries. Bluetooth's operational range is one metre or three feet for devices with class 3 radios, ten metres or thirty feet for Class 2 radio devices, which are most commonly found in mobile devices, and one hundred metres or three hundred feet for Class 1 radio devices, which are mostly found in industrial applications. The Arduino Uno is a free and open source microcontroller platform built on standard I/O boards such as the ATmega328P. It is designed to be inexpensive and easy to use. It also gives us a development environment that lets you use the processing language to make applications.

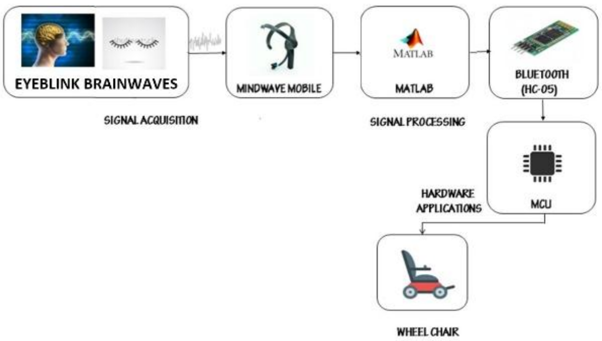


Figure 4.2 : Detailed Block Diagram of the model

C. Prototype Configuration

Scan this QR code for a live demo.

Figure 4.3 : Prototype of the model

In this system there is two software application, attention level checking, meditation level checking, attention and meditation mind game.

Figure 4.4 : Attention mind game

Figure 4.5 : Meditation mind game

D. Operation of the System

By blinking their eyes, paralysed people may be able to operate their wheel chairs. As a result, they do not need the services of a caregiver to transport them; they may do it themselves. To operate, first programme the Arduino and setup the hardware. Then connect Mindwave mobile and the Bluetooth module to the laptop via Bluetooth. Then open MATLAB and configure the COM port. Then run the MATLAB code and at that time, Thinkgear should run in the background. The main control panel wizard opens as shown in figure 4.6.

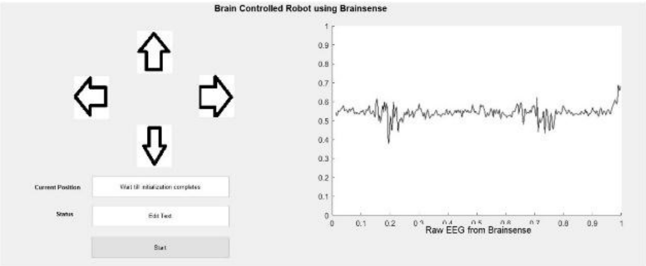


Figure 4.6 : Operation of wheelchair

After selecting the Wheel Chair application from the main control panel, observe the location of the "BLINK TO CHOOSE" image, and make a blink at the appropriate location to choose a certain direction. Then the wheel chair will start moving as per the direction chosen by eye blink. Giving large high-intensity eye blinks, the wheel chair can be stopped.

E. Result

The testing of the system is done through MATLAB and NeuroView software. The programme code is tested by compiling and running it through the Arduino IDE and MATLAB software.

SL. NO.	EYE BLINKS (YES / NO)	DIRECTION SELECTED IN BRAIN CONTROLLED GUI	DIRECTION OF WHEELCHAIR
1.	Yes	Left direction selected	Left
2.	Yes	Forward direction selected	Forward
3.	Yes	Right direction selected	Right
4.	Yes	Backward direction selected	Backward
5.	No	No direction selected	If no direction will be selected, then wheelchair will skip that direction and wait for the eye blink signal in the next direction in the control panel window.

As a result, the circuit responds to the algorithms, and the direction of the wheelchair will be selected according to the eye blink EEG signals, thus giving the output of the system.

F. Conclusion

As a result of the fact that it is powered by a AAA-battery and that the electrode is simply placed on the scalp, there is no risk of damage to the brain while using the Brain Computer Interface for any application. It is possible to pre-configure the software for each user in order to enhance the accuracy of blink classification while using the programme, which is beneficial. It educates handicapped people to be self-sufficient and provides them with a means of communicating their ideas and feelings. It provides entertainment for disabled individuals via the use of brain computer interface games and mood evaluation. It responds in a short period of time.

G. Future Research

It might be enhanced even further by incorporating a password authentication software to open a smartphone, computer, or other device, as well as an application to detect brain states like alertness, tiredness, and so on. It may be further enhanced by applying neuromarketing apps so that others can know the victim's area of interest, such as when shopping or watching movies, and so on. It could be even better if it had the Neurospeller tool for communication, which lets people write letters by recognising EEG patterns.

REFERENCES

[1] Hong Gi, "Trends and Future of Brain-Computer Interfaces", presented at the 2018 Joint 10th International Conference on Soft and Intelligent Systems and 19th International Symposium on Advanced Intelligent Systems, Yeom Department of Electronic Engineering, Chosun University, Gwangju, Republic of Korea, July 2018, pp. 785 – 788, 978-1-5386-7/18/$31.00 ©2018 IEEE, DOI 10.1109/SCIS-ISIS.2018.00130

[2] Keerthi Kumar M Asst. Professor, Dept. of Telecommunication Engineering, GSSS Institute of Engineering and Technology for Women, Mysuru and Chaitra Rai, Manisha R, Priyanka C B, Syeda Saniya Anis Dept. of Telecommunication Engineering, GSSS Institute of Engineering and Technology for Women, Mysuru, " EEG Controlled Smart Wheelchair for Disabled People ", *International Journal of Engineering Research & Technology (IJERT), NCRACES - 2019 Conference Proceedings*, vol. 7, no. 10, 2019, ISSN: 2278-0181

[3] Antora Dev, Md. Asifur Rahman, and Nursadul Mamun, "Design of an EEG-based Brain Controlled Wheelchair for Quadriplegic Patients", *2018 3rd International Conference for Convergence in Technology (I2CT),* Department of Electronics and Telecommunication Engineering, Department of Electrical and Electronic Engineering Chittagong

University of Engineering and Technology, Chittagong-4349, Bangladesh, 978-1-5386-4273-3/18/$31.00 ©2018 IEEE

[4] Anupama H. S and N. K. Cauvery of Department of Computer Science and Engineering, R. V. College of Engineering, Bangalore, Karnataka, India and Lingaraju G. M of Department of Information Science, M. S. Ramaiah Institute of Technology, Bangalore, Karnataka, India, " Brain Controlled Wheelchair For Disabled ", *International Journal of Computer Science Engineering and Information Technology Research*, Vol. 4, No. 2, pp 157-166, April 2014, ISSN(P): 2249-6831; ISSN(E): 2249-7943

[5] Rahib H. Abiyev, Nurullah Akkaya and Ahmet Çagman from Department of Computer Engineering, Applied Artificial Intelligence Research Centre, Near East University, Lefkosa, Northern Cyprus, Mersin 10, Turkey; Ersin Aytac and Irfan Günsel from Applied Artificial Intelligence Research Centre, Robotics Research Lab, Near East University, Lefkosa, Northern Cyprus, Mersin 10, Turkey, " Brain-Computer Interface for Control of Wheelchair Using Fuzzy Neural Networks ", *Hindawi Publishing Corporation BioMed Research International*, Vol.2016, 6, Article ID 9359868, 9 pages, [Online] Available: http://dx.doi.org/10.1155/2016/9359868

[6] Pranamya Bandyopadhyaya from Department of E&TC Engineering, Sinhgad College of Engineering, Pune, Maharashtra, India and Dr. S. D. Lokhande from Sinhgad College of Engineering, Pune, Maharashtra, India, " EEG Based Smart Automation Using BrainComputer Interface Approach ", *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 7, June 2018, ISSN(Online): 2319-8753, ISSN (Print): 2347-6710

[7] Siliveru Ramesh , K.Harikrishna and J.Krishna Chaitanya from Vardhaman College of Enggineering, Hyderabad, India, "Brainwave Controlled Robot Using Bluetooth", *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 3, August 2014, ISSN(Online): 2278 – 8875, ISSN (Print): 2320 – 3765

[8] Hue T. Tran and Van Toi from Biomedical Engineering Department, International University, VNU-HCMC, Vietnam ; Hai T. Nguyen and Thuyen V. Ngo from Faculty of Electrical-Electronics Engineering, UTE-HCMC, Vietnam; Hieu V. Phan and Cao Bui-Thu from Electronics Technology Department, Industrial University of Ho Chi Minh City, Vietnam, "An EEG-Controlled Wheelchair Using Eye Movements", *Springer International Publishing Switzerland 2015*, Vol. 46, DOI: 10.1007/978-3-319-11776-8_116

[9] Nhan Thanh Le, Hai Ngoc Nguyen, and Dang Cao Le from BME Laboratory, Faculty of Applied Science, Ho Chi Minh City University of Technology, Ho Chi Minh City, Vietnam; Van Cam Thi Le and Keiji Iramina from Graduate School of Systems Life Sciences, Kyushu University, Fukuoka, Japan, "Controlling the Wheelchair by Eye Movements Using EEG", *Springer Nature Singapore Pte Ltd. 2020,* 7th International Conference on the Development of Biomedical Engineering in Vietnam (BME7), 4 pages, Available: https://doi.org/10.1007/978-981-13-5859-3_41

[10] Norizam Sulaiman, Nawfan Mohammed Mohammed Ahmed Al-Fakih, Mamunur Rashid, Mohd Shawal Jadin, Mahfuzah Mustafa, and Fahmi Samsuri from f Electrical and Electronics Engineering Technology, Universiti Malaysia Pahang, Pahang, Malaysia, "Offline EEG-Based DC Motor Control for Wheelchair Application", *Springer Nature Singapore Pte Ltd. 2021, Proceedings of the 11th National Technical Seminar on Unmanned System Technology 2019*, ISSN : 1876-1100, Vol. 666, 965-980, Available: https://doi.org/10.1007/978-981-15-5281-6_69

[11] Bremer F. Cerebral and cerebellar potentials. Physiol Rev. 1958;38: 357–388.

[12] Bishop GH, Bartley SH. Electrical study of the cerebral cortex as compared to the action potential of excised nerve. Proc Soc Exp Biol (New York). 1932;29:698–699.

[13] Davis H, Saul LV. Action currents in the auditory tracts of the midbrain of the cat. Science. 1931;86:448–450.

[14] Ebersole JS. Cortical generators and EEG voltage fields. In: Ebersole JS, Pedley TA, eds. Current Practice of Clinical Electroencephalography. 3rd ed. Philadelphia: Lippincott Williams and Wilkins; 2003:12–31.

[15] Grass AM. The electroencephalographic heritage. Am J EEG Technol. 1984;24:133–173.

[16] Hayne R, Meyers R, Knott JR. Characteristics of electrical activity of human corpus striatum and neighboring structures. J Neurophysiol. 1949b;12:185–195.

[17] Ebersole JS. Cortical generators and EEG voltage fields. In: Ebersole JS, Pedley TA, eds. Current Practice of Clinical Electroencephalography. 3rd ed. Philadelphia: Lippincott Williams and Wilkins; 2003:12–31.

[18] Niedermeyer E. The clinical relevance of EEG interpretation. Clin Electroencephalogr. 2003b; 34:93–98.

AUTHOR PROFILE

Rajesh Rishi, *a M.Tech student of electrical and electronics engineering from Assam Don Bosco University, Assam, India. He is from Assam, India. He has also completed his B.Tech in the same department and from the same university. His fields of interest are smart grid control, renewable energy, power quality, microgrid, electrical machines and drives, and sensor-less motor control. He is also interested in microcontrollers, IOT, electroencephalogram (EEG), and artificial intelligence.*