Implementation of Brain Controlled Miniature Wheelchair

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Abstract— In this paper brain-controlled miniature wheelchair is implemented. Most of the handicapped and paralyzed people use wheelchair for their movement. But they need the help from some external factor for their movement. So, this brain-controlled wheelchair is developed. In this project, the gamma waves from the human brain are obtained using mindwave mobile and the eye blink strength is detected. Depending upon the blink strength and number of blinks wheelchair movement is defined. Brain Computer Interface (BCI) acts as an interface between human brain and the computer. BCI translates the signals into commands and sends it to the Arduino uno which controls the wheelchair according to the commands received. Depending on the number of eye blinks the direction (Forward, Left, Right) of wheelchair varies.

***Keywords*— Eye blink strength, BCI, Arduino uno, Mindwave Mobile**

I. INTRODUCTION

In recent days the number of paralysed people is increasing day by day due to accidents, medical issues etc. Because of injured muscles and week nervous system they cannot move themselves. Based on the survey 15% of the global population is disabled. Even though most of them use wheelchairs, power wheelchairs they need external help to do their daily activities. As they depend on others, they often feel incapable. Therefore, this brain controlled miniature wheelchair is implemented to make their movement independent. They can control this wheelchair by using their brain signals. EEG signals in the brain are detected and used to maneuver the wheelchair. This technique is considered as one of the effective ways to control a wheelchair. We apply different control techniques to drive the motors that move the wheelchair according to the received signals.

BCI (Brain Computer Interface) is an interface that enables communication between a computer and a human brain. It converts the EEG signals from brain into commands and sends to the physical device (wheelchair). Most of the BCI based systems are based on EEG signals.

The efficient method for recording brain activity is EEG. Many researches are being done on EEG signals now-a-days. It is one of the booming technologies in present days. EEG signals acquisition from the brain can be used to carry out many activities. One of the methods of controlling movement of a wheelchair is to place an electrode cap on the scalp of a person to obtain EEG signals. Then these signals are converted to commands and are sent to arduino uno which then controls the wheelchair accordingly. Using the above method, we can control the wheelchair using EEG signals from brain. There are different signals in a human body that helps in the functioning of the human body. Out of these signals Electroencephalography (EEG) signals are used to measure the brain activity. EEG helps to acquire brain signals that correlate with the various tasks in the brain. The EEG signals in the brain are classified into five types, they are: gamma, beta, alpha, theta, delta. Gamma waves has a frequency range of 30Hz and above. These waves are obtained during the concentration state of the brain. These are considered as fast produced brain waves in the human brain. Gamma waves resemble that we have reached higher concentration level. Recent researches tell that people with cognitive impairment cannot produce many gamma waves. These waves are considered for controlling the wheelchair movement. Beta waves have a frequency range varying between 12-30Hz. These waves can be obtained when the brain is in anxiety, active state, awaken state of the brain. These waves are high frequency, low amplitude waves. These betas can be further classified as: low beta waves that range between 12-15Hz, mid range beta waves that range from 16-20Hz, high beta waves that has frequency range between 21-30Hz. These waves are fast in action. Alpha waves have a frequency varying between 8-12Hz. These waves are produced when a person is relaxed or is merely paying attention on something. These alpha waves are obtained from white matter in the brain which connects all the parts with each other. These alpha waves can be increased by deep breathing and can be decreased by thinking on a particular thing. Theta waves in the brain have a frequency that varies between 4-7Hz. These waves are generated when a person is deeply relaxed or sleeping but not in deep phase. Generation of theta waves of high levels can cause a person to be inactive. Theta waves oscillations are increased when a person is in an unknown environment. Delta waves have a frequency varying between 0.1-3Hz. The time span of these delta waves is from 0.02 to 0.08 seconds. These delta waves are found in little babies and children of young age.These waves are related with deep sleep. These are the slowest recorded brain waves in a human brain. These waves are also observed in brain injury of a person. Supression of this delta waves leads to inability of refreshing human body and brain. Sufficient production of delta waves in brain makes a person feel refreshed and advances immune system in human body.

II. LITERATURE REVIEW

Now-a-days BCI is an emerging field where it is having various applications in industry as well as bio-medicine. All neurons in the human brain are interconnected. Different brain signals are generated when a person is thinking about something. These signals vary from person to person. In EEG technique electrode caps are placed on

the scalp to obtain direct or in direct potential difference of scalp and the actions performed. The different frequency levels are alpha, beta, theta, gamma, and delta. In present scenario controlling various devices with the help of brain is a wild field of research. In order to interact with an external device using brain waves, we require an interface between brain and computer which is BCI. BCI enables us to control external devices by using EEG activity from the scalp or activity of neuron from the brain. The movement of wheelchair is controlled based on number of blinks [1].

In line with previous studies, power spectral analysis results confirm that the EEG activities correlate well with the variables in vigilance. This study developed a system with wireless and wearable EEG device, an efficient prediction model, for disabled elders. A link is established between the fluctuation within the behavioural index in the brain waves and the changes within the brain activity. In this, the proposed system goes to observe the pattern of interaction between these neurons is represented as thoughts and emotional states through EEG sensors associated with BCI.BCIs are systems that may bypass conventional channels of communication to supply direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time [2].

Eye tracking technique enables us to see the eye movements of a person, where the person is looking and the sequence of eyes shifting from one location to another. One of the algorithms used to detect the motion of human eye is coherence algorithm. This algorithm operates on the frames extracted from the motion of the eye. This algorithm extracts the pixels that lie on the vertical lines on the area selected by user, from the frames and are processed and the RGB values are determined. The pixels on the vertical lines will be black if the person is looking straight. If the user looks left, the pixels on the left vertical lines are black and when the user looks right, the pixels on the right vertical lines are black. This algorithm also uses eye blink to start and stop the wheelchair [3].

Wheelchair is a travel tool for many disabled people. In real life, most of the wheelchairs are still manual. Using the brainwave technology, implementation of brain-controlled wheelchair can effectively solve this problem. Brainwave control technology uses electrical signals emitted by the brain and controls the external objects through man machine interface technology. In this design the use of TGAM module Neurosky limited launched. Blink is calculated with raw data. We can find the blink value if we detect the wave crest with code [4].

For physically challenged people there are many controlling modes such as eye movement, hand gestures, joystick control etc. These systems are designed in a way that upon interacting it can control movement of wheelchair or robot. The most effective method to control movement and direction of such system is BCI technique. Since the introduction of the dry EEG electrodes, there has been a growth of low-cost EEG recording system [5].

There are various kinds of waves in brain based on our attention and meditation levels. We get some threshold values for which guide the wheelchair in desired direction. The wheelchair is integrated with ultrasonic sensor that detects the distance between obstacle and wheelchair. If the obstacle is very nearer to the wheelchair, the wheelchair stops. The meditation and attention levels of the patient are recorded with a brainwave sensor which transfers them to the PC wirelessly using Bluetooth. Then the waves are sent to arduino module. If the patient blinks both the eyes, the wheelchair is turned accordingly depending upon the number of blinks. As a result, the patients are made to be self-reliant [6].

Wheelchair is considered as one of the helpful devices for physically challenged persons. BCI provides a way of communication that allows humans to communicate with the external devices. The electrical activity of the brain is monitored in real time interface by placing the electrodes on the scalp of the user. EEG devices are made handy and wireless. The brain waves are captured from the brain by the electrodes placed on the scalp of the user. These signals are converted to movement commands and transferred to arduino which drives the wheelchair [7].

The EEG signals represents the number of electrical signals emitted by our brain. The origin of those electrical activities is the neurons when they operate as a part of the nervous system. The brain waves are classified as delta, theta, alpha, beta, gamma based on their frequencies. BCI uses these brain signals to control the wheelchair. BCI has three functions: signal acquisition, signal processing, output control [8].

Electric chair provides chance to those that lost their moving capability. The primary objective of this project is to provide mobility by implementing a brain-controlled wheelchair. The second objective is to process EEG signals for controlling purpose. The EEG device used here is Emotiv EPOC Headset. We use a computer to receive and process the EEG signals and then send the control signals to the microcontroller of the electric wheelchair [9].

We have two main approaches for EEG-BCI. The first method is Evoked Potential. This method depends on EEG features evoked and time locked to specify sensor stimulus. They are also called as cue-guided. The common example of this method is P300 method. The P300 wave is an event related brain potential measured using EEG. It refers to a spike in activity approximately 300ms. The second method is Motor Imagery. In this method the user will be able to generate induced activity from motor cortex if the user imagines motor movements without any body movement [10].

Electric wheelchairs are ought to be equipped with computer control unit, sensors for navigation and obstacle detection. The design of brain-controlled wheelchair is based on BCI which processes EEG signals and classify them to required commands to control the wheelchair. Neuro-Fuzzy technique has been used in the design to operate the motors of the wheelchair. The implementation of fuzzy logic as choice tool and ANN as a modelling methodology can facilitate designers to analyse controllers without any need of accurate model of the plant to be controlled. By combining the ideas of soft-computing and mechatronics, the wheelchair has become advanced and provides individual a lot of quality [11].

Powered wheelchairs don't seem to be an option for a lot of people who have severe motor-disabilities. For some of those people, non invasive BCI supply a promising solution to this problem. Asynchronous motor-imagery approach offers users great flexibility as it allows users to interact with wheelchair naturally. Once after learning to modulate brain signals correctly, both the experienced and inexperienced users will be able to master the continuous control that is enough to safely operate the wheelchair [12].

The EEG signals in the brain are pre-processed and also the motion image of EEG signal is extracted. Based on the three algorithms: Bagging, Adaboost and Gradient boosting, the feature vectors are identified. The experiment on motion imagination EEG signals acquisition is done. The pre-processing, feature extraction and pattern recognition signal processing are administrated for the collected motion imagination EEG signals. Here the algorithm with the superior processing effect to stimulate the collected EEG signals of pure hand motion imagination and the EEG signals of simultaneously imagining hand and foot, and verifies the effectiveness of the proposed signal processing. Finally, the recognized signals are converted into external instructions [13].

The main plan of this work is to use a wireless EEG headset to control the wheelchair and to control the mouse cursor of a computer with face detection and eyeblink. The EEG signals captured needs to be pre-processed to remove the unnecessary content and the content required needs to be represented using some features that needs to be inputted to machine learning algorithms. These signals give us a threshold value of the user's attention and meditation to move the chair according to the user's brain. eSense is an algorithm used by Neurosky to show the mental state of the user. To calculate eSense, the Neurosky Thinkgear technologies amplify the raw brainwave signals and remove the background noise. Then the eSense algorithm is applied to remaining signals to get the eSense values. The eSense meditation meter shows the extent of user's calmness or relaxation [14].

portable EEG headset and a computer code signal processing facilitates the movement of the wheelchair associated with mind activity and the frequency of the eyeblinks of the patient sitting on the wheelchair with the assistance of Microcontroller Unit (MU). A Neursoky mindwave receiver is employed to get the EEG signals from the brain. The signal obtained from EEG sensor is processed by ARM microcontroller FRDM KL-25Z, a free scale board. The microcontroller takes the call for determining the direction of wheelchair and obstacle detection sensors placed on wheelchair. The MCU shows real time data on a digital display interfaced to it [15].

III. METHODOLOGY

The major steps of this project involve as follows:

A. Frame Capturing:

The first step of this project is capturing the users face using the interface(camera). To capture a video frame method will be used. Afterwards the coloured frames will be converted to gray scale frames by extracting only the brightness of component. The below Figure 1 represents frame capturing.

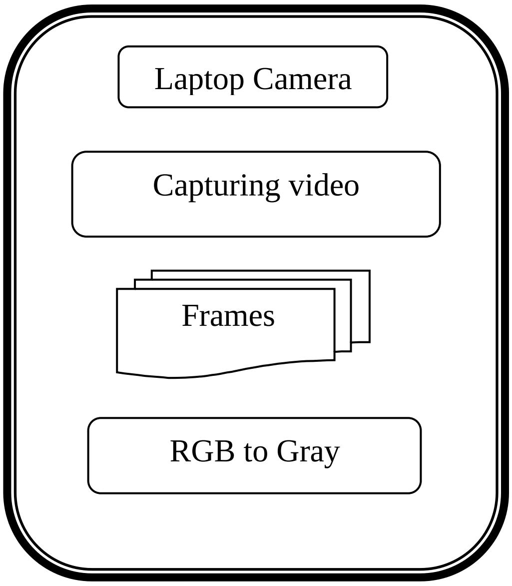

Figure 1 Frame Capturing

B. Face Detection

The CV2 is employed for face detection.CV2 chop-chop detects any object, based on detected feature not pixels, like facial feature. However, the area of the image being analysed for a facial feature must be regionalized to the situation with the best chance of containing the feature. By regionalizing the detection space, false positives square measure eliminated. because the result, the face is detected and marked with colour parallelogram and can be used later to approximate Associate in Nursing axis of the eyes for eye detection step.

C. Eye Detection

To detect the eye, first, the CV2 library should be trained. in order to train the features of the eye it must be implemented. The set contains an image or scene that contain the object. And the result shows the detected eye in colour rectangle.

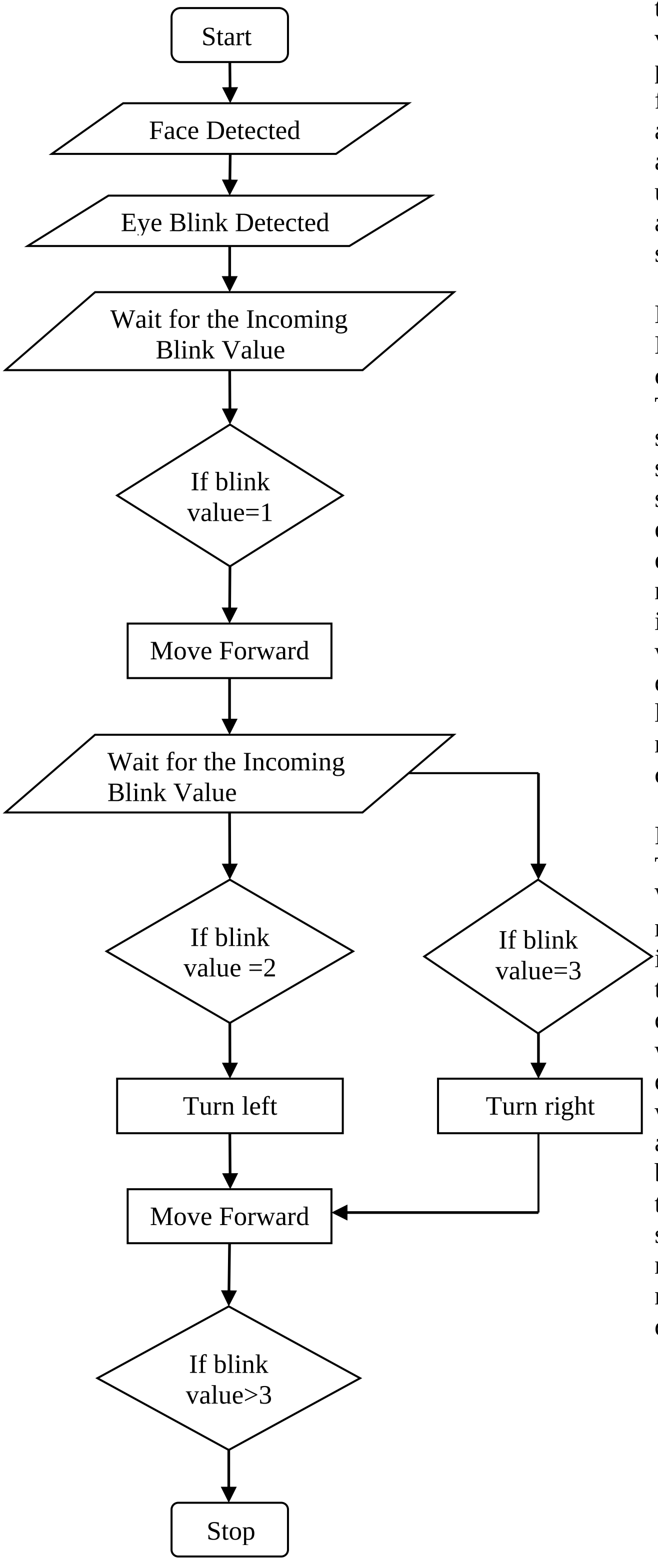

Figure 2 Flowchart

The above Figure 2 shows the flow diagram of this project.

D. Eye Tracking

The corneal-reflection and pupil-center are the 2 eyes' parts that are the foremost vital elements to extract the options. These options facilitate in tracking the eyes movement. By distinctive the middle of the pupil and therefore the location of the membrane reflection, the vector between them is measured. Besides, with additional pure mathematics calculations, point-of-regard are often found. to create the face and therefore the eye's pupil affected together within the same direction synchronously and with constant direction. Let suppose that X is that the user face that has been detected, P1 and P2 are 2 points associated with the left and right eye, and they are moving synchronously with the movement of X.

E. Eye Blinking

Eye blinking and movement is detected with comparatively high reliableness by unobtrusive techniques. Though, there are few techniques discovered for the active scene wherever the face and also the camera device move severally and also the eye moves freely in each direction severally of the face. Although, care should be taken, that eye-gaze pursuit information is employed in an exceedingly smart means, since the character of human eye movements may be a combination of many voluntary and involuntary psychological feature processes. If the blink worth is one then the wheelchair moves in forward direction, blink worth is a pair of then the chair moves in left direction, blink worth is three then the chair moves in right direction and if the blink worth is quite three then the chair stops.

F. Hardware Description

The hardware components used in these project are Wheelchair, Aurdino Uno, HC05 Bluetooth Module, L23d motor driver,DC Motors,Battery and Laptop.Aurdino uno is interfaced with all other components before connecting to a circuit.Aurdino board is connected to L293D motor driver,HC05 Blueetooth module and to the 12volts battery which gives the power supply to the circuit.L293D Motor driver is connected to two DC Motors which moves the wheelchair. The number of blinks detected by the laptop are sent through the aurdino by the means of HC05 bluetooth module connected wirelessly. Depending upon the blink value received from the laptop the aurdino board sends the commands through the motor driver and the dc motors are driven accordingly. Therefore, the wheelchair movement is controlled. The below Figure 3 shows the designed wheelchair for this project.

Figure 3 Wheelchair Prototype

IV. CONCLUSION

The process of controlling the wheelchair using brain waves is a bit complicated and takes more time to complete this project. So, we used eye blinks which are detected by the camera in laptop to move the wheelchair.

The user has to blink the eyes to move the wheelchair. The directions (right, left and forward) are based on the number of eye blinks given. The design requires a laptop with good camera quality to detect eyeblinks, Aurdino UNO, L293D Motor driver, HC-05 Bluetooth module and a pair of dc motors. The image is processed by using python software and the movement of the wheelchair obtained. A prototype a developed with the above-mentioned specifications and tested. It came out to be working successfully.

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