# Brain computer interfacing for controlling wheelchair movement

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**Abstract** — The inability is extreme to the point that they can't have any sort of developments. Confronted with the present circumstance, Brain PC Interface innovation has responded to the call of creating arrangements that permit conveying a superior personal satisfaction to those individuals, and quite possibly of the main region has been the versatility arrangements, which incorporates the mind PC interface empowered electric wheelchairs as perhaps of the most supportive arrangement. Confronted with everything going on, the current work has fostered a Brain PC Interface arrangement that permits clients to control the development of their wheelchairs utilizing the mind waves created at the point when flickers their eyes. For the production of this arrangement, the Steady Prototyping approach has been utilized to improve the advancement interaction by creating autonomous modules. The arrangement is comprised of a few parts for example EEG System (OpenBCI), Main Controller, Wheelchair Controller and Wheelchair that permits to have a measured quality to do refreshes (upgrades) of their functionalities in a basic way. The created framework has shown that it requires a low measure of preparing time and has a genuine material reaction time. Exploratory outcomes demonstrate the way that the clients can perform unique undertakings with an OK grade of mistake in a timeframe that could be thought of as OK for the framework. Considering that the model was made for individuals with handicaps, the framework could concede them a specific degree of freedom.

***Key Words:** alpha waves; brain–computer interface (BCI); electroencephalography (EEG); wheelchair.*

## I INTRODUCTION

Brain–computer interface (BCI) is an immediate correspondence way between the cerebrum and the outer gadget [1-3], intended to investigate continuous mind information to control a PC, neuroprosthesis, or wheelchairs. Dissimilar to regular interfaces incorporating the sign related with eye development (electrooculography, EOG) [4, 5] or the facial muscle withdrawals (electromyography, EMG) [6], BCI does not need the association with muscles or fringe nerves, which permits to control devices without verbal or actual association [7-9]. This empowers patients in extreme phases of disease that forestall any development, like subcortical cerebral stroke, amyotrophic parallel sclerosis, cerebral paralysis to impart with the rest of the world. Generally, BCI frameworks depend on properties of electromagnetic rushes of the cerebrum, recorded utilizing electroencephalographic procedures [10-12]. In this setting, the main issue is to record and investigate the human produced electroencephalographic signs and then make an interpretation of it into the machine control succession. The probability of utilizing BCI to control a wheelchair is wanted by patients, which brought about the plan of numerous models of such BCI-based frameworks [13]. The most straightforward one controls the wheelchair that moves just in one bearing [14]. In that study, the spinal rope harmed subject had the option to produce explosions of beta motions in the EEG signal by imagination of developments of his deadened feet. The beta motions were utilized for an independent cerebrum PC interface control based on a solitary bipolar recording. The subject was put in a virtual road to mimic driving of wheelchair prior to utilizing BCI in a genuine circumstance. The BCI control system to drive a shrewd wheelchair which allows the client to choose one of four orders is proposed in Ref. [15]. When an order is chosen, the control system executes the chose order what's more, simultaneously, screens the close to home condition of the client. While the client is fulfilled, the order is executed; in any case, the control framework stops the wheelchair. A large number of the presently evolved frameworks utilize the half breed cerebrum PC interfaces [18-22]. For instance, Wang et al. [18] consolidate engine symbolism, P300 possibilities and eye squinting to carry out forward, in reverse and stop control of a wheelchair, while Cao et al. [21] consolidate engine symbolism (MI)- based bio-signals and consistent state visual evoked possibilities (SSVEPs) to control the speed and course of a wheelchair simultaneously. BCI interfaces readily utilize the EEG signal because of its great time goal and low working expenses. Notwithstanding, according to the perspective of a solitary client, these expenses are still high, and the establishment of numerous anodes awkward and badly designed. A more accommodating type of EEG signal enlistment are EEG headbands that have as of late showed up on special. They are not difficult to gather, however have a predetermined number of estimating anodes and the recorded signal is more regrettable quality contrasted with proficient recorders. We intended to add to bringing BCI frameworks outside the research center so it very well may be more open to patients, by planning a calculation which can work in view of the sign from modest number of cathodes and with a low sign to commotion proportion. Our paper portrays a mind waves impelled wheelchair idea which depends on two mental conditions of the subject condition of unwinding and condition of concentration. Our answer depends on the examination of the EEG signal for the event of the alpha waves. The state when the alpha waves are available is treated as a parallel state and the subject chooses the development bearing utilizing the word reference of paired groupings. The Human Brain is constructed with average of 100 billion neurons. The interaction between these neurons can be represented as thoughts and emotional states of human mind. Every interaction between these active neurons creates a minimal electrical discharge, which creates different amplitude and frequencies like alpha wave, beta wave, theta wave & delta wave. This is why EEG devices are used to detect the waveforms of different human activities. EEG based BCIs have potential applications for assisting paralyzed patients.

## II RELATED WORK

A number of previous studies have been conducted to analyze brain wave signals for different applications using BCIs . EEG based BCIs have been used for analysing several human activities including attention level with corresponding brain wave signals . Some studies shows deflection in brain wave signal due to eye blink and several applications and aspects based on eye blink . Assistive control system and wheelchair have been designed for paralyzed and quadriplegic patients. These designs are based on head movement and retina and ocular movement which uses accelerometer and image processing technique respectively. Moving head repeatedly is not convenient for quadriplegic patients as it causes fatigue. Besides accelerometer can not detect eye blink. Moreover, in image processing of ocular and retina movement a convenient light source is needed to be present always near the eyes of the patient. This causes fatigue of the patient's eye. In both of these techniques, while moving with wheelchair the patient can not move his head and eye arbitrarily. Using EEG signals according to attention level can solve these problems. The use of Neuro Sky Mind wave EEG Headset is convenient for working with brain signals, attention level and meditation. The difficult stage in planning BCI is in removing the highlights from the EEG signals. The important highlights technique respect high exactness in the order. For example, the work by Samraj et al. [2], utilized versatile recursive band pass channel and autoregressive displaying as another strategy for separating the elements. The dataset was given by the division of clinical informatics, University of Graz Signals from C3 and C4 cathodes were utilized as the prevailing signals from the EEG. The examination to gauge the information was performed on a 24-years of age single female unwinding on a seat. The extricated highlights was utilized as a contribution for machine figuring out how to group the elements to left and right engine symbolism. Support Vector Machines (SVM) and Linear Discriminant Analysis (LDA) are utilized as order techniques, the level of blunder was gone between 17.1% to 24.2%. Li et al. [7] performed probe 8 subjects, utilizing Muse headset. Utilizing Common Space Pattern calculation (CSP) for separating highlights, of left/right-hand development symbolism, then, at that point, by applying SVM to order the result. The trial was done two times effectively, first with C3 and C4 sensor terminals with exactness of 90%, and second, by adding gamma wave information from F7 and F8 cathode sensors, which work on the exactness from 90% to 95.1%. One more execution of BCI is accounted for in [8], where a servo engine control was finished utilizing EEG signals utilizing Emotiv Epoc signal and F3 anode sensor channel. The antiquity commotion was eliminated and the signs was separated to get the alpha recurrence band (9-13 Hz) as an element extraction. The servo settled to turn 90ι when it gets a heartbeat from the PC, and afterward pivot 90ι back when gotten the second beat. The examination applied on one individual and the level of precision was not announced. The work detailed by Rani et al. [9] depends on consideration level what's more, eye flickering solidarity to control Robotic wheelchair. EEG furthermore, EMG signals were caught utilizing Neyro Sky Headset and signals are separated for the scope of Alpha (8-12 Hz) and Beta (13-30 Hz) in Matlab. The strength saw of the flicker level range from 0 to 255, zero methods little eye flicker and 255 implies enormous eye flicker. Also, for the consideration, 40 to 60 implies regular consideration, from 61 to 80 methods marginally raised also, greater than 80 implies that raised. The qualities and the grades of consideration and eye flickering were planned to explicit bearing. The quantity of workers for the trial and exactness were not referenced.

## III OVERVIEW OF OUR SOLUTION

The filtered EEG data is converted to frequency domain to estimate the Power Spectrum Density (PSD). The current EEG data is compared with the EEG reference data. If the reference data is smaller than the current data then, it means the user is not focusing in any direction, hence, the control signal is to stop the wheelchair. Otherwise, the step which follows is to extract the features by Mu and Beta frequency bands. Then, extracted features represent input for the machine learning using SVM algorithm, which will predict the output, to be transferred to the wheelchair wirelessly and control it into the different directions. Finally, taking new EEG signals and repeat the procedure.

Fig. 1 shows the system block diagram of components and interconnection. It consists of an Arduino microcontroller to control the wheelchair to the required direction. The wheelchair is connected to EEG, Pulse sensor,lm35 The motor driver shield is an output, as it receive directions via the controller module to controls the motors. Fig. 2 shows some hardware details of the wheelchair control circuit.

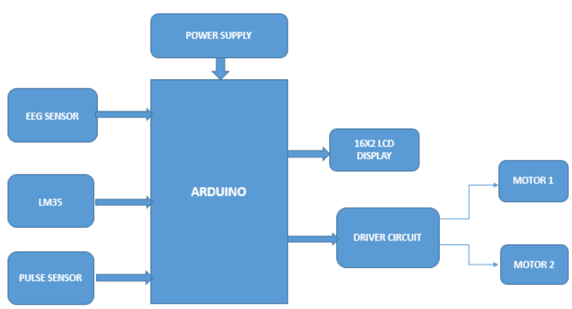


**Fig-1** Block diagram of the EEG-based BCI system main components and sensors.

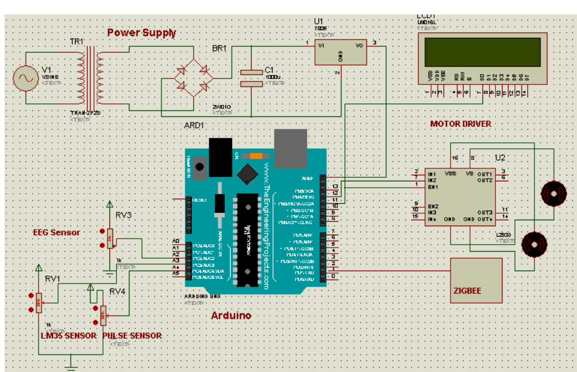


**Fig 2**: Circuit Diagram of the control circuit of the Wheelchair.

The designed system consists of two main parts, the transmitter side, which sends the human brain thought command, and the receiver side is the wheelchair with its control unit.

## III PROPOSED ALGORITHMS

### A.EEG data recording rule

The subject envisioned a sum of 20 developments. The trial directed in a tranquil spot and the method of the trial is as follows: The subject sets quiet on a seat and attempt to restrict his body developments previously and during recording EEG. The subject likewise is approached to restrict his eyes development to decrease the eye curios. Then the subject thinks and envision outwardly moving a pen as it was by all accounts a development with his arms. The subject educated by a program on the PC, which shows the guidance on the screen for synchronizing the occasions of all investigation preliminaries.

### B. EEG data recording method

For the training, the volunteer will think for four seconds of each direction and in the same time should satisfied the rules. Then, rest for 3 seconds, and repeat once more. Finally, it will indicate the end of recording EEG data by a message box. EEG data, shown in Figure 3, is saved for four different directories in an Excel file formats from all 14 electrodes.

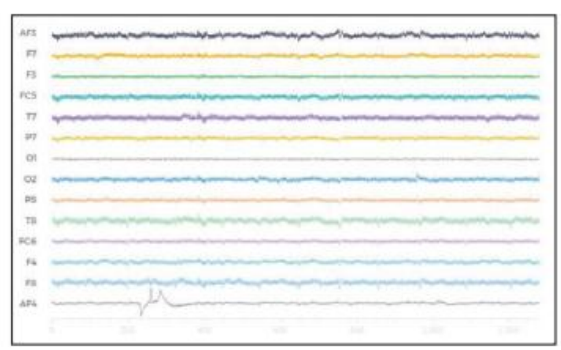

Fig 3: EEG data acquisition in time domain

## IV.RESULTS

As it was mentioned earlier, EPOC headset does not provide standard sensors for C3 and C4 electrodes, therefore, the solution is to extract the frequency band related to motor brain movement that will give a high accuracy. Alpha and Beta bands provide a good discrimination for the motor imagery. Hence, to select the best classifier model we test two specific frequency bands: Mu and Beta frequency bands (8 to 30 Hz) and Theta to Beta frequency bands (4 - 30) Hz. For the first frequency bands Mu to Beta, SVM classifier has the highest accuracy with 79.2 % as shown in Table 1. For other frequency bands the frequency ranged between 70% and 75%.

| Selected Frequency range | Matrix feature size | SVM | KNN |
|---|---|---|---|
| Mu and Beta (8 -30 Hz) | 24x322 | 79.2% | 70.8% |
| Theta to Beta (4 -30 Hz) | 24x379 | 75% | 75% |

**Table 1: Percentage of accuracy through different frequency bands and classifiers**

This result shows that the Mu and Beta frequency bands are the most suitable frequency bands to extract the features for the motor imagery movement. Whenever decreasing the number of hidden layers, the performance of the network design will increase, the highest performance is 0.4412 with 3 hidden layers (Fig. 4).

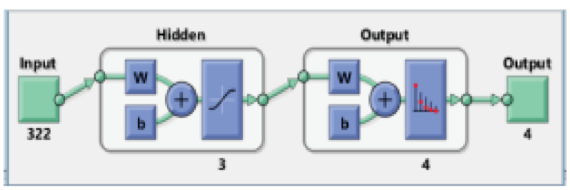


Fig 4: Neural Network Pattern Recognition

## V CONCLUSION

We propose a wheelchair constrained by EEG cerebrum PC interface completely constrained by alpha mind waves, utilizing the peculiarity of unwinding, which can work on a sign with a low sign to-clamor proportion and a not many anodes. It depends on the condition of unwinding and a set of eight paired words that permit to push ahead, in reverse, turn both ways, pivot 45° right and left as

well as to speed up movement. The application empowers observing and controlling of electric wheelchair by the career of the deadened individual. It is feasible to right the subject's track or to close down the whole framework in case of a perilous circumstance. Our tests performed on three subjects uncovered high awareness of the proposed BCI-framework with any preparation stage. Our answer is thusly a basic and compelling technique to control a wheelchair by individuals with engine paresis, which doesn't require the use of many cathodes restricting the patient's development or different reiterations of picture assignments which a little while later make the patient tired.

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