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Brainwave Controlled Wheelchair (BCW)

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Abstract – *The locomotive disabled people and elderly people cannot control the wheelchair manually. The key objective of this paper is to help the locomotive disabled and old people to easily manoeuvre without any social aid through a brainwave-controlled wheelchair. There are various types of wheelchair available in the market such as Voice controlled wheelchair, Joystick control wheelchair, Smart phone controlled wheelchair, Eye controlled wheelchair, Mechanical wheelchair. These wheelchairs hold certain limitations for e.g. if the user is dumb; user cannot access voice controlled wheelchair, etc. Brain-computer interface (BCI) is a new method used to interface between the human mind and a digital signal processor. An Electroencephalogram (EEG) based BCI is connected with an artificial reality system to control the movement and direction of a wheelchair. This paper proposes brainwave controlled wheelchair, which uses the captured EEG signals from the brain. This EEG signals are then passed to Arduino. It converts into control signals which will in turn help to move the wheelchair in different direction.*

Keywords - *Brain Computer Interface (BCI), Locomotive disabled Persons, Mobility, Mind-link Electroencephalogram (EEG) sensor.*

1. Introduction

Fifteen percent out of the world's population that is approximately 1 billion people, suffers from some form of disability. In that some of disabled people suffering from disability like Locomotors Disability, Brainstem Stroke, paralyzed, spinal cord injury and other numerous locomotive diseases impair the neural pathways that control muscles or impair the muscles themselves [1]. Physically disabled people often use assistive devices such as crutches, wheelchairs for mobility ease, artificial limbs, etc. To facilitate their mobility, this paper brings forward the idea of moving the wheelchair with the help of brain signals.

There are many different wheelchair controlling methods available such as gesture, smart phone, voice, Electroolfactogram (EOG), Electromyogram (EMG), joystick, eye tracking, breath etc., but these methods can be efficiently used by strong people only. However, these systems are not easy to control because of the quick turn may lead to more difficulty to control the wheelchair for old and disabled people.

Dry electrodes and Wet electrodes are the two types of EEG electrodes available in the market. Wet electrodes give accurate results yet the setup takes more than 30 minutes [10]. So dry electrodes are preferred for small scale purpose. For EEG sensors, most popularly used sensor is Neurosky Mindwave sensor. In this paper, FTnS EEG headband is used to capture EEG signals from brain. It sends signals via wireless, therefore it is easier to use and more comfortable to wear. Brain produces electrical pulses from the millions of neurons communicating with each other for transmitting information. These signals are known as brain waves. The brainwaves are classified as alpha, beta, gamma, delta and theta on basis of the frequencies and their significances. The delta waves (0.5 to 3 Hz), theta waves (3 to 8 Hz), alpha waves (8 to 12 Hz), beta waves (12 to 38 Hz) and gamma waves (38 to 42 Hz) [2]

The EEG sensor measures the attention level and meditation level of the person. There are specific combinations or montages for different types of brain waves according to our requirement. The wheelchair will have the operations to go forward, reverse, to turn left, right and to stop. These five operations are the response to the waves by processing the attention and meditation levels of human and the stressed forehead.

The proposed paper is to assist their mobility, by moving the wheelchair with the help of brain signals. This paper implements brain computer interface (BCI) technique. The BCI has applications in numerous fields like medical, mind reading, remote controlling, games and many more. It is a system that obtains and inspects neural (brain) signals with the aim of building a direct high-bandwidth communication medium between the brain and the computer. The brain computer interface (BCI) is implemented in this paper to give the entire control of the wheelchair through the "brain" of the user.

2. WORKING PRINCIPLE OF EEG

The Electroencephalogram (EEG) measures brainwave of different frequencies from the brain Activities are measured on the scalp. The Amplitude of the EEG is about 100 µV when measured on the scalp or brain. The range of the signal is from 1 Hz to 50 Hz. EEG waveforms are categorized according to their frequency, amplitude, and shape, as well as the sites on the scalp. There are different types of brainwaves such as Beta, Gamma, Delta, Theta, etc. The existence of such waves are described in figure 1.

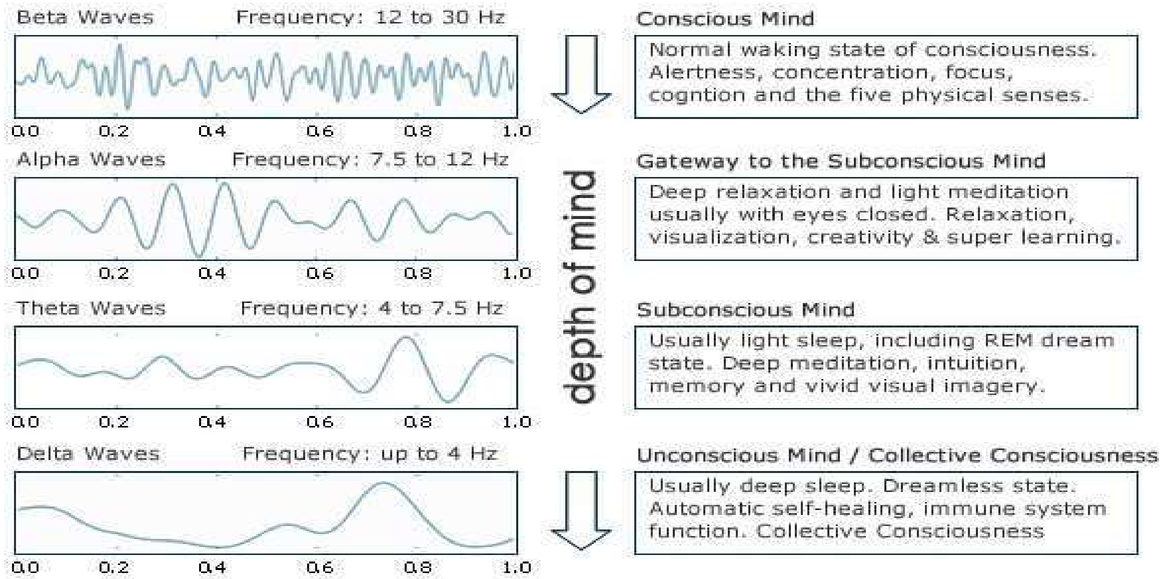

Fig. 1 Different Brain waves [18]

3. METHODOLOGY

3.1 BLOCK DIAGRAM:

This system is basically providing a total remote access to the implemented wheelchair. The main entities or blocks of this system are The EEG sensors, Arduino and the Wheelchair. The working of each of the block is as follows:

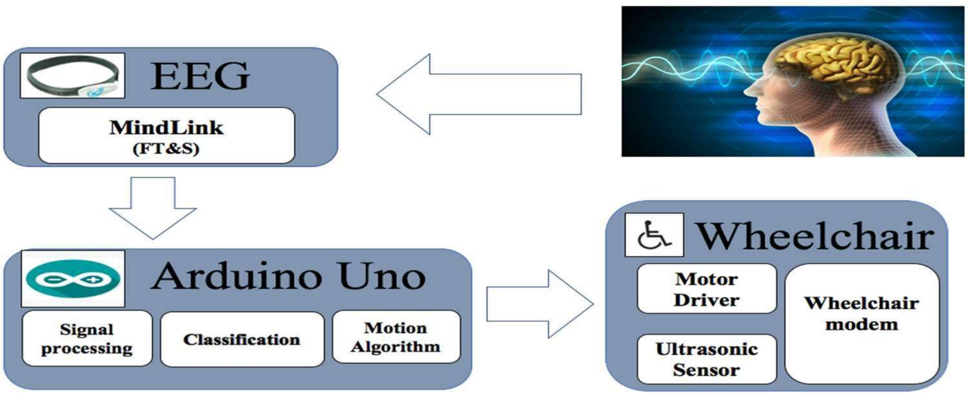

Fig. 2 Block Diagram

3.1.1 EEG Sensor:

The function of electrode sensor is to sense electric field changes due to the neural activities in the different lobes of the brain when person's body part moves. These field changes can also be sense even when a person think soft his body part movement without moving actual body parts, just through imagination. More probably, the range of brainwaves is from 0.5 Hz to 40 Hz. The EEG data captured with sampling rate 512Hz. This EEG sensor made by three electrodes: Ground, Reference and EEG. This will basically extract the EEG signals and pass on to the Arduino.

3.1.2 Microcontroller ATMega 328P:

A Brain Computer Interface or BCI system is a system which consists of various subsystems such as Amplifiers, Analog to Digital converters (ADCs) and a Controller section. This system is used to process a raw data or we can say a Brain signal and it will convert it into a control signal in order to control a wheelchair. This all Processes are done by Arduino. And hence the wheelchair is being controlled from the control signals passed on from Arduino.

3.1.3 Wheelchair Body:

Wheelchair body consists of a Chassis, a Battery, a Ball bearing, a motor driver circuit and two motors for moving the wheelchair. As a control signal has come from BCI system, it is given to the motor driver circuit. Motor driver circuit consists of a motor driver IC L293D which can drive two motors at a time. A battery of 9V is used to provide power supply to motor driver circuit. Now according to the control signal which has come from BCI system, the motor driver circuit will turn on the motors forming various movements like Forward, Reverse, Left, Right and Stop with respect to the corresponding control signal. The ultrasonic sensor has been used for obstacle detection.

3.2. FLOW CHART:

Description:

Initially it will check whether the device is connected or not. If the device is connected, then the device will retrieve the data from FT&S mind link EEG sensor via Bluetooth module. This retrieved data will be processed to generate or determine the mental command i.e. forward, reverse, left, right or stop. This determined signals will be sent to the Arduino Uno and this will pass the control signals to the wheelchair. According to the control signals received wheelchair operation will be performed. If the device is not connected, it will be in the scanning mode. This process is continuously repeated.

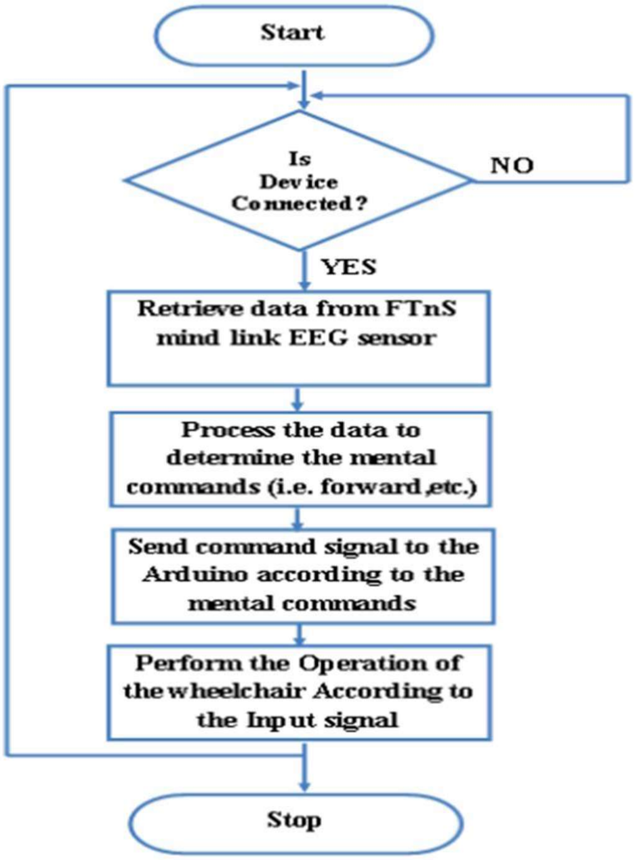

Fig. 3 Flowchart

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4. RESULTS

Various results were obtained through different software. To achieve end result step by step process is mandatory. Firstly, we observed different kinds of brain waves. From EEG sensor, two kinds of data is being obtained; (a) Raw data (b) E-sense data. Here, E-sense data is being used and accordingly we developed our motion algorithm.

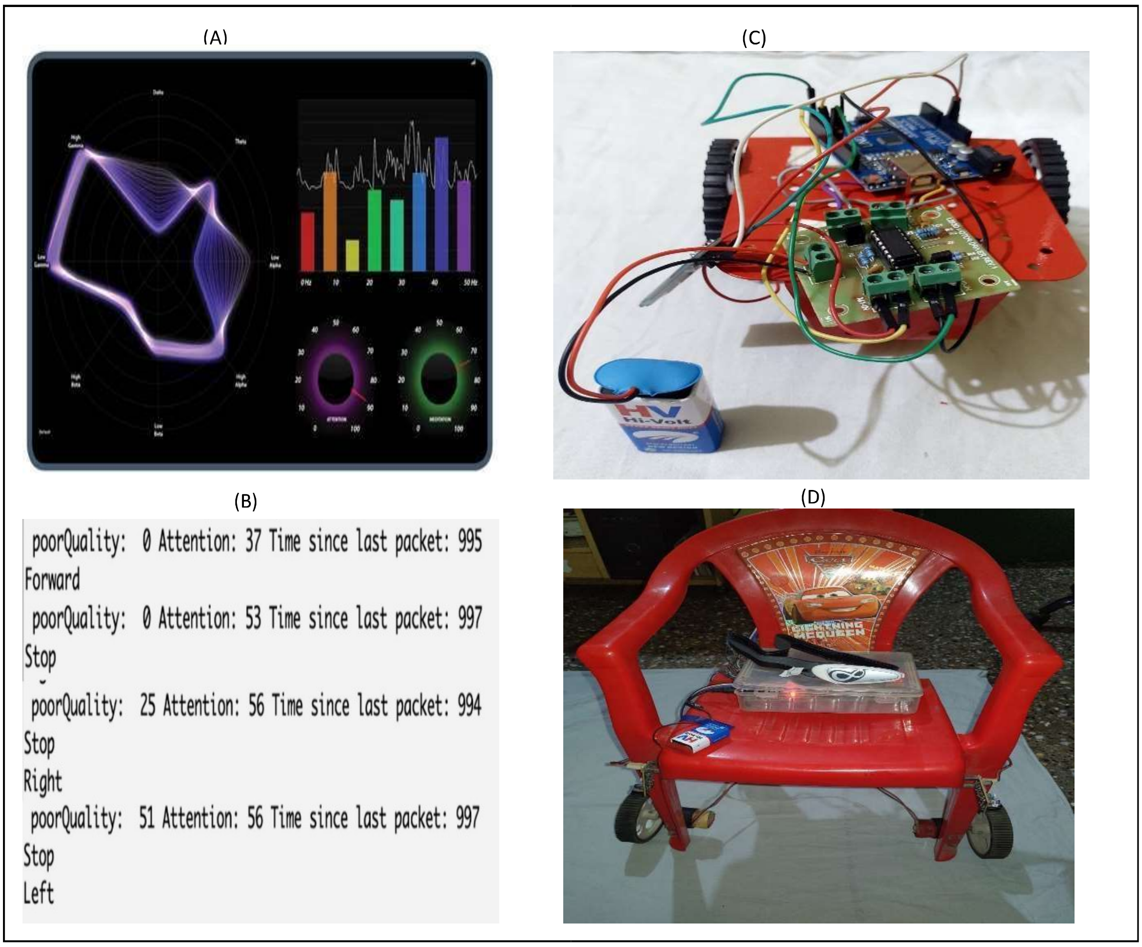

Fig. 4 Results: (A) - Brainwave Visualizer Readings; (B) - Serial Monitor readings; (C) – Prototype designing; (D) – Wheelchair prototype

The captured signals from FTnS sensor shows various attention and meditation levels. This levels have been observed through Brainwave Visualizer software as shown in Fig. 4(A). Once the device is connected, the attention and mediation levels gets varied according to the user in this software.

The direction of the wheelchair is being controlled using these levels and poor quality as shown in Fig. 4(B). If the attention level goes above 50 then the wheelchair will be in stop direction. And if the attention level is below 50 then the wheelchair will move in forward direction. Similarly, if the meditation level is above 50 then wheelchair will move in right direction; and if meditation level is below 50 then it will move in left direction.

The simple prototype was designed to verify and test the above conditions as shown in Fig. 4(C). This algorithm worked well.

After testing all the parameters and testing conditions, project was implemented as shown in Fig. 4(D).

5. CONCLUSION

This paper is implemented for locomotive disabled people for their ease of mobility and hence reducing dependency. Brain Computer Interface is the emerging technology in the field of Neuroscience. Hence a person with locomotive disabilities or elder person can control the wheelchair without using any external body parts.

After seen by many patients who are suffering from paralysis attack. Since no use of voice control or access through speech is used, the patient who is dumb or who cannot speak fully or partially can access and control the wheelchair very easily. While taking the reverse action of the wheelchair, sometimes it is difficult to

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accidentally crash a wall or whatever entity is there, because the patient is partially paralyzed and cannot look behind easily.

This paper implementing a backward obstacle detection sensor alarm. Hence if an object comes within a 10 meters' range, the alarm will start ringing and patient can stop the wheelchair by sending corresponding control signal. The scope of the paper was primarily to establish the motion through no physical movement on part of the user and it has been successful in doing so but it has also laid a foundation for many applications which would greatly improve the standard of life for all.

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