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Brainwave Controlled Wheelchair with Obstacle Detection and Alerting System

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Abstract- People who have extreme coordination disabilities, such as Locked in Syndrome, is a condition in which the patient is conscious and aware of the surroundings but is unable to speak or take any activity due to weakness in nearly any voluntary muscle in the body (with the exception of eye movements and blinking).In order to improve their quality of life, we propose a Brainwave Controlled wheelchair that can detect obstacles and also help alert the guardian of the person sitting on the wheelchair using buzzer when he/she needs any help. The system uses EEG headset which yields Attention level, EEG signals and blink strengths, the data is passed to a Raspberry Pi that is connected with a screen. The blinks will help the user to change the direction and attention level will help to move the wheelchair forward in the selected direction. Ultrasonic sensors will be used for obstacle detection. The wheelchair will have storage section to carry items such as essential medicines, personal belongings, etc. And it will also give a reminder to the user to take medicines on time.

Keywords — EEG, BCI, TGAM, Brainsence, Brainwave, Obstacle Detection, Blink Detection, IOT

I. INTRODUCTION

Many of those physically challenged people face the problem to maneuver freely around. A chair is the commonest device that's accustomed to give quality for physically challenged people. However, most chairs available today, particularly the cheap manual chair, need human assistance to move around. Even for the electrical motor chair, it still needs user's assistance to use the Controllers or push the button so as to manage the movement of the motorized electric chair. Many users who lost their hands or those that have the problem to manage their hands like polio patients don't seem to be ready to navigate the chair movement. Hence, themselves they're incapable to maneuver around. In order to solve this problem, additional constructive manner is by to specifically control the action of the chair by victimizing the brain. This technique can enable most of the people to navigate the chair by themselves. Therefore, this can bring an especially high impact, particularly for the challenged people.

1. EEG Technology

There are many approaches used for extracting signals from brain activity. As the EEG is efficient and non-invasive, it is the most effective approach to be used to retrieve brain activity signals for the implementation of the Brain-computer interface system.

EEG captures electrical waveforms from the brain. Due to various kinds of thoughts, patterns that the brain produces are unique. The raw EEG signals are interpreted during EEG signal processing in such a way that it can distinguish the mental commands that the consumer is thinking about. Forward, backward, left, right, and stop are among the commands available. After receiving the mental instruction, it is used to generate electrical feedback signals to control the operation of the electric wheelchair.

2. EEG Classification

EEG waveforms are generally categorised depending on the amplitude, frequency, position, and shape of the electrodes. Frequency-based waveform groups such as alpha, beta, gamma, delta and theta are well-known. Frequency bands are used to categorise the repetitive patterns of brain waves. The amplitude of brain waves varies depending on the brain's behaviour and emotional states.

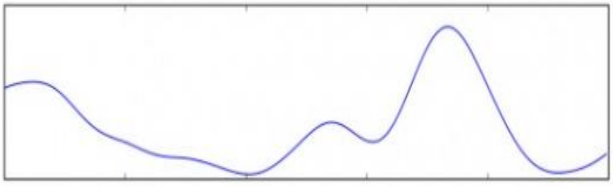

Figure 1: Delta Waves

Delta being the slowest wave, has the highest amplitude. This slowest brain wave activation is seen in all stages of

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sleep, particularly in stages 3 and 4. It's natural and it's the dominant rhythm in babies.

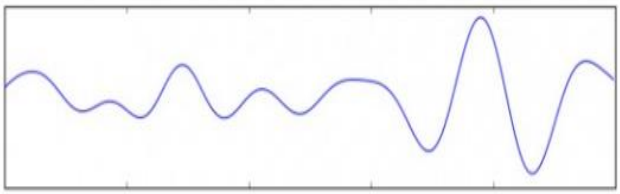

Figure 2: Theta Waves

Theta waves are related to conscious mind activity and scale from 4 to 8 Hz. During deep relaxation and meditation, these forms of brain waves are used. It is usual for youngsters under 13 years. It encourages human growth hormone production , relaxation is increased by serotonin hormone and gets relief from pain.

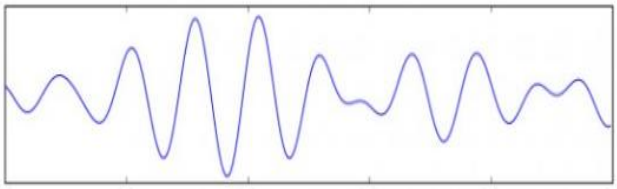

Figure 3: Alpha Waves

Alpha waves are generally found in adults during their awake state. These waves occur on both sides of the head, slightly larger amplitude on the non-dominant side. It serves as a connection between the conscious mind and the subconscious mind. It induces the production of serotonin, a chemical reactor that increases relaxation and relief from pain.

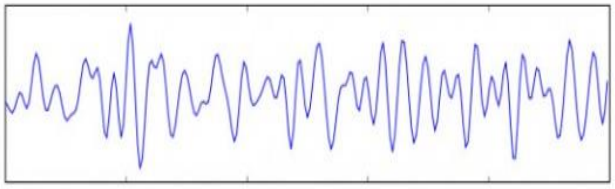

Figure 4: Beta Waves

Beta waves focus on conduct and activity. It's connected to what we see, touch, sound, scent, and taste. These waves can be found in conscious states such as communicating, judging, making decisions. These are based on cortical activity having the ability to think and access information.

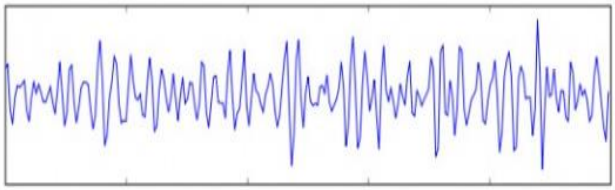

Figure 5: Gamma Waves

Gamma waves are correlated with vision and consciousness, with frequencies ranging from 30 to 70 hertz. When sensory impulses are hyperalerted and combined, these waves arise. Gamma combines the senses and memories properly for a total experience.

II. LITERATURE SURVEY

In this paper [1], People with disabilities can use an electroencephalogram (EEG)-based brain-controlled electronic buzzer system to get help from caregivers at home or in hospitals. The signal processing unit was constantly filled with brain wave epochs obtained by portable non-invasive EEG cameras for processing and feature mining. In order to test the brain wave transition, frequency domain measurements were performed at successive epochs.

In this paper [2], Electroencephalography (EEG) or brain waves are collected and examined to yield Focus, Meditation and Eye Blink Power using the NeuroSky Mind-wave smartphone headset. The EEG signals are used to build a miniature wheelchair using the Arduino microcontroller to help manoeuvre the BCI. In order to develop algorithms for comparative study of the system's reliability, three different combinations of focus, meditation and eye blink power were used.

Here [3], with the support of wearable EEG products offered in the consumer market, we present a technique for the eye blink pattern managed framework. With the help of EEG signals captured at the scalp for the proposed eyeblink pattern operated device, this technique can be used to monitor many systems such as home appliances, robots, wheelchairs, etc.

In this paper [4], a Fast Fourier Analysis (FFA) with brainwave-controlled wheelchair dependent electroencephalogram (EEG) classification is constructed. BCI approach helps the brain to connect with the electric wheelchair directly. The EEG signal is referred to as a signal from brainwaves. The signal processing approach is called Fast-Fourier Transform Analysis and EEG Classification for EEG signal processing (FFTA & EEGC).

In this paper [5], the method uses NeuroSky's BrainWave Headset, where the EEG raw signal is analysed by the compact Raspberry Pi single-board device. It is possible to recognise a slow voluntary blink with the introduction of certain filters and recognition algorithms, converting this movement into a signal as true as a certain wheelchair control order. With this, the patient would be able to boost his stability and update his wheelchair's control system. The usability of the modules also makes this production affordable for the consumer and scalable.

In this paper [6], The EEG Signal-brain lobes relationship was identified. EEG signals are categorized based on various signal frequencies such as eyeball acceleration, opening of the eye, eye closing, etc.

In this paper [7], The main aim is to resolve the issue of disabled people's travel and mobility by means of multiple technology integrations, multi-intelligence networks to achieve multi functional disability tools.

In this paper[8], BCI is based on electroencephalogram (EEG) signals in which the participants are required to focus

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on a particular mental activity. Characteristics are derived from these signals using a variety of techniques, including: Time, Frequency, Time-Frequency, and Time-Frequency-Space Analysis are all terms for the same thing.

In this paper [9], a system is designed and built to assist quadriplegic people to perform some of their everyday activities on their own and to create a sense of independence and trust in them.

III. PROPOSED WORK

The main motive behind the project is to help people suffering from paralysis, people who met with accidents that left them with an extremity and people with any impairment in motor or sensory function of the extremities.So to ease their movement the proposed work uses Voluntary blinks extracted from the EEG waves will be used to change the directions of the wheelchair. The directions will be displayed on the GUI. The attention levels derived from EEG waves would be used to guide the wheelchair's acceleration in the chosen direction. Ultrasonic sensors will be used for obstacle avoidance , if the wheelchair moves towards an object and the threshold is reached the wheelchair will stop automatically. If the user wants any help or assistance he/she can alarm the buzzer and notify the caretaker with the help of the buzzer system. We will also implement a medicine reminder in which User is reminded to take his medicines on schedule.It will allow them to set up regular reminders in specific intervals. Users also will be able trigger voice assistants and use the assistant's functionalities such as controlling appliances and setting any reminders.

IV. SYSTEM DESIGN

Figure 6 illustrates the block diagram of the work done.There are basic three modules taken into consideration: EEG headset,Raspberry Pi,Wheelchair control.The brainwave sensor senses the EEG brainwaves from the human brain and then the raw data is extracted from these brainwaves.Bluetooth transmitter is used to transmit the raw data present on the EEG headset and then received by the raspberry pi with the help of bluetooth receiver. Then the raw data is processed and eye blinks,attention levels are extracted and accordingly commands are sent to the motor driver, motor driver acts as an intermediate between the motor and raspberry pi to pass the commands to the motor and to make it move forward, backward, left, right.

Figure 7 shows the flow of the system, first it is checked whether the user is wearing the headband or not, if the condition is satisfied the system checks for the connection via Bluetooth. If the connection is established successfully the raw data is sent to raspberry pi from the headband and the raspberry pi processes the raw data into blinks and attention levels and then the commands are given to the motor drivers for moving the wheelchair.

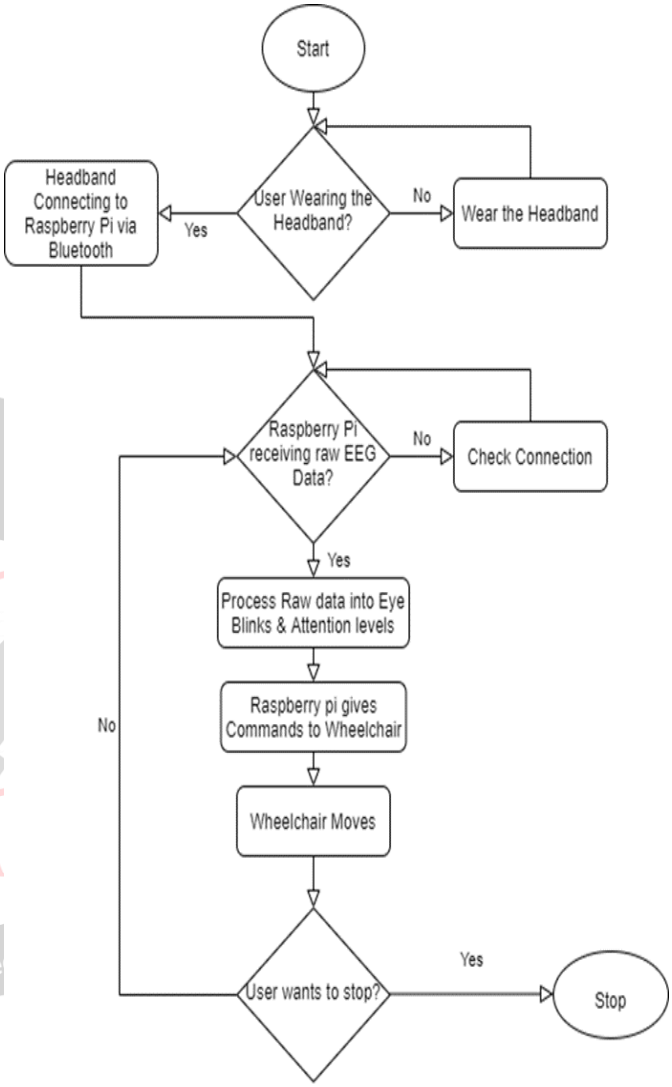

Figure 7

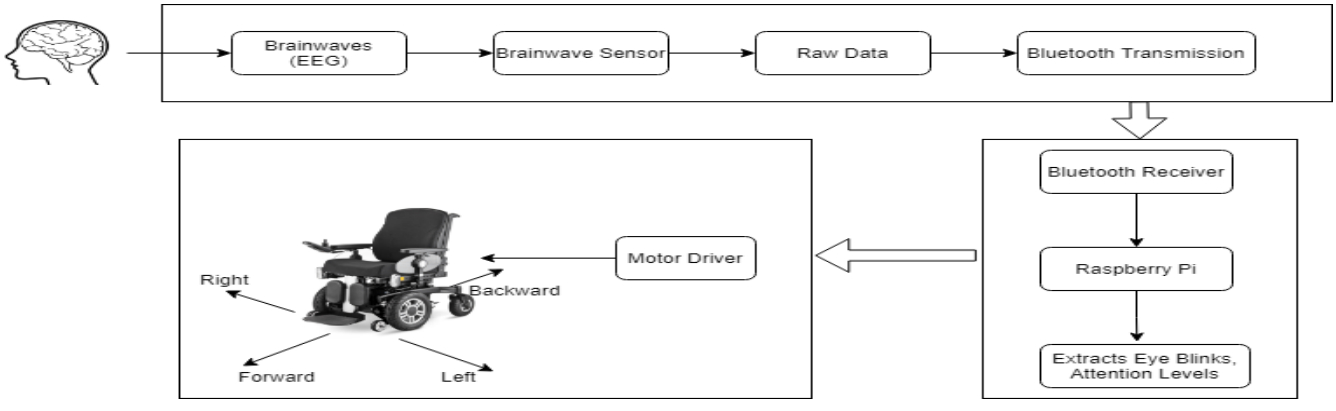

Figure 6

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V. HARDWARE DESCRIPTION

Brainsense EEG Headset: The Brainsense EEG Headset is a sleek, single-channel, wireless headset. It keeps the track of your brain activity and converts EEG into meaningful data. To put it another way, brainsense is a combination of headband and mobile app which tracks and helps you improve your focus with respect to your activity, your environment, your emotions, and any other cognitive behavior you want to track. Brainsense headset uses the TGAM1 module, Dry Electrode and Ear clip control. It follows the concept of Automatic wireless pairing. It has a 6-hours battery. The Bluetooth version it has is Bluetooth v2.1 Class 2 and has a range of 10 meters.

Ultrasonic sensor: An ultrasonic sensor is basically an electronic system which uses ultrasonic sound waves and then detects and measures the distance of the object which is targeted and then the reflected sound is converted into an electrical signal. The non-contact measurement range of the ultrasonic module HC-SR04 is 2cm-400cm, with a precision range of up to 3mm.

Raspberry Pi: One of the most widely used Microcontrollers is the Raspberry Pi. It is powered by a Broadcom BCM2837 quad-core 1.2GHz 64-bit CPU. It has 40 GPIO pins and is powered by a 2.5A upgraded switched Micro USB power source.

L298N Motor Driver: L298N Motor Driver is used to concurrently control two DC motors. The acceleration and direction of the motors can also be controlled. Drivers are responsible for controlling the DC motors.

VI. CONCLUSION

The key goal of the proposed project is to bring mobility back to individuals who have physical disabilities and to paralyzed patients who cannot walk on their own without someone's help. As a result, the single electrode mind wave headset can be used to track eye blinking and attention level via the FP1 (Frontal Point) located in front of the eyebrow. The use of BCI (Brain Machine Interface) technologies in human life ensures a comfort space for disabled people and the proposed project is one of them. In terms of cost, the project is very cost-effective because monitoring of the wheelchair is carried out in real time. In the future, we can increase the number of wheelchair function controls and reduce the EEG signal measurement time used to assess brain activation. If this approach is developed and widely adopted, it will not only encourage patients to live more independently, but it will also assist caregivers in keeping up with the demands of today's hectic world.

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