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EEG Based Focus Estimation for Safety Driving Using Bluetooth

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***Abstract:*-- This paper describes about a robot which is controlled using brainwaves based on Brain–computer interfaces (BCI).To provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time, a brain computer interface system can be used which can bypass conventional channels of communication. A mobile robot can be controlled using these commands. The current work deals with development of a robot that can determine driver's focus and drowsiness which can in turn reduce the speed of the vehicle before a mishap happens.**

***Index Terms*— Brain Computer Interface, Neurosky, Electroencephalogram**

I. INTRODUCTION

Drowsiness in drivers has been implicated as a causal factor in many accidents because of the marked decline in drivers' perception of risk and recognition of danger, and diminished vehicle-handling abilities. The National Sleep Foundation (NSF) reported that 51% of adult drivers had driven a vehicle while feeling drowsy and 17% had actually fallen asleep. Therefore, real-time drowsiness monitoring is important to avoid traffic accidents.

The Electroencephalograph (EEG) is the most widely used device which has high temporal resolution, portability, and non-intrusive capture and so on [1].EEG is the recording of electrical brain activity through electrode sensor placed on the scalp; the EEG signals are classified into wavebands to indicate various states or activity level. There are five important signal levels like: **DELTA, THETA, ALPHA, BETA and GAMMA.** Delta waves lie in a frequency range of 0.5 to 4 Hz, with variable amplitude. Delta waves are primarily associated with deep sleep. Theta waves lie within the range of 4 to 7 Hz, with amplitude usually greater than 20 µ V. Theta arises from emotional stress, especially frustration or disappointment. Theta has been also associated with access to unconscious material, creative inspiration and deep meditation. The large dominant peak of the theta waves is around 7 Hz. Alpha wave frequency range lies between 8 and 13 Hz, with 30-50 µV amplitude. Alpha waves have been thought to indicate both a relaxed awareness and also in attention.

Bet**a** frequency ranges lies between 13 and 30 Hz, and usually has a low voltage between 5-30 µV. Beta is the brain wave usually associated with active thinking, active attention, and focus on the outside world or solving concrete problems. It can reach frequencies near 50 Hertz during intense mental activity. The beta signal can be divided into low beta, midrange beta and high beta. The low beta ranges between 13Hz to 15Hz, which is used for measuring the mental states like formerly SMR, relaxed yet focused, integrated. Midrange beta ranges from 16 Hz to 20 Hz which is used for measuring thinking, aware of self and surrounding. High beta ranges from 21Hz to 30 Hz, which is used to measure alertness and agitation. Beta waves dominate when the brain is aroused and mentally engaged in activities. Gamma waves lie in the range of 35Hz and above. It is thought that this band reflects the mechanism of consciousness - the binding together of distinct modular brain functions into coherent percept capable of behaving in a re-entrant fashion (feeding back on themselves over time to create a sense of stream-of-consciousness). **MU**. It is an 8-12 Hz spontaneous EEG wave associated with motor activities and maximally recorded over motor cortex. They diminish with movement or the intention to move. Mu wave is in the same frequency band as in the alpha wave, but this last one is recorded over occipital cortex. Most attempts to control a computer with continuous EEG measurements work by monitoring alpha or mu waves, because people can learn to change the amplitude of these two waves by making the appropriate mental effort. A person might accomplish this result, for instance, by recalling some strongly stimulating image or by raising his or her level of attention. Drowsiness appears into the EEG spectrum by an increase of activity in the frequency bands predominantly in the parietal and central regions of the brain. In the same time, a decrease of activity in the band can also be observed, as beta activity increases with cognitive tasks and active concentration.

The patterns of interaction between the neurons are represented as thoughts and emotional states. This pattern will be changing according to the human thoughts which in turn produce different electrical waves. A muscle contraction or relaxation will also generate a unique electrical signal. The brain wave sensor senses the different electrical waves and it will convert the data into packets and transmit through Bluetooth medium [1]. A Level analyzer unit (LAU) is used to receive the brain wave raw data and the extracted signal is processed using Aurduino platform. Then the control commands will be transmitted to the robotic module to process. With this entire system, we can control the speed of the robot according to the decrease in the driver's attention and drowsiness. A brain computer interface (BCI) is a communication pathway which interprets the user's command from their brainwaves to enable simple task to be carried out. BCI systems have primarily focused on assisting disable people. However, most recent applications of BCI have involved the development of products for commercial purpose, such as video game controller and mind controlled vehicles. The basic idea of BCI is to translate user produced patterns of brain activity into corresponding commands. A typical BCI is composed of signal acquisition and signal processing (including pre-processing, feature extraction and classification) [2]. Although some BCI systems do not include all components and others group two or three components into one algorithm, most systems can be conceptually divided into signal acquisition, pre-processing, feature extraction, and classification The brain signals that are widely used to develop EEG-based BCIs include P300 potentials, which are a positive potential deflection on the ongoing brain activity at a latency of roughly 300ms after the random occurrence of a desired target stimulus from non-target stimuli the stimuli can be in visual, auditory, [3] or tactile modality SSVEP, which are visually evoked by a stimulus modulated at a fixed frequency and occur as an increase in EEG activity at the stimulus frequency and the event-related de synchronization (ERD) and event-related synchronization (ERS), which are induced by performing mental tasks, such as motor imagery, mental arithmetic, or mental rotation [4].

II. OBJECTIVE

Driver drowsiness and deviation of attention are the main factors in many traffic accidents. As drowsiness is the transition between awakening and sleep, it induces an increase of the number and the duration of blinks and yawns. Fatigue which means an extreme tiredness that result from physical or mental activity and the amount of sleep during night is the most common factors of drowsiness. Other factors contributing are the amount of light, sound, temperature and oxygen contents. It can be detected by monitoring physiological signals in order to detect drowsiness with the change in the patterns of the EOG, EEG and ECG signals. The main issue in such a technique is to extract a set of features that can highly differentiate between the different drowsiness levels. In this work, a new system for driver's drowsiness and focus detection based on EEG using Neural network is proposed. This uses physiological data of drivers to detect drowsiness. These include the measurement of brain wave by using EEG channels and approaches based on EEG signals. EEG data is converted into excel sheet from where we detect the beta waves, which are indicators of attention level and theta waves which indicates drowsiness

III. BLOCK DIAGRAM

Brain-controlled mobile robots can be grouped into two categories according to their operational modes. One category is called "direct control by the BCI," which means that the BCI translates EEG signals into motion commands to control robots directly who first developed a brain-controlled robotic wheelchair whose left or right turning movements are directly controlled by corresponding motion commands translated from user brain signals while imagining left or right limb movements, and tested this system in real-world situations. The robotic platform illustrated here also used as a BCI based on motor imagery to build a brain-controlled mobile robot, which can perform three motion commands including turning left and right and going forward, and validated this robot in a real world.

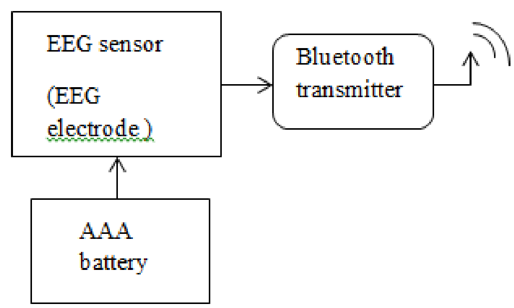

Figure 1: Brain secret card section

As shown in Figure. 1 the Brain secret card section contains EEG Sensor to sense the Human brain activity by using the Brainwave Headset which is provided by NeuroSky. Technologies and those signals will be transferred by using Bluetooth which is there in the Brainwave headset. For this Brainwave headset, we need to give power using a AAA battery which is shown in Figure 2. The brainwave headset comes with power switch, a sensor tip, flexible ear arm and a ground connection Ear clip.

Figure 2: Neurosky headset

In this headset, we use non-invasive sensor that won't cause any pain to the user who wear the headset. After inserting an AAA battery, switch on the brainwave headset using the power switch. The LED indicator will blink and if the Red colour light not blinking the headset is powered on but not connected to with the computer's Bluetooth. If the Blue colour LED is not blinking that means the headset is powered on and connected. If the red or blue color blinks it shows that the battery is getting low. The Mind Tools line of headset products contain Neurosky Think Gear technology, which quantify the analog electrical signals, commonly referred to as brainwaves, and exercise them into digital signals. The Think Gear technology then makes those computations and signals available for application. ThinkGear is the technology inside every NeuroSky product or partner product that empowers a device to interface with the wearers' brainwaves [5]. It includes the sensor that touches the forehead, the contact and reference points located in the ear clip, and the on-board chip that processes all of the data. Both the raw brainwaves and the e Sense Meters are computed on the ThinkGear chip.

IV. NEUROSKY HEADSET TECHNOLOGY

i. Brainwaves:

The knowledge about the brain and particularly, the electrical signals generated by neurons firing in the brain has greatly increased in the last century of neuroscience. A sensor can be placed on the scalp to measure the patterns and frequencies of these electrical signals. The Mind Tools line of headset products contain Neurosky Think Gear technology, which quantify the analog electrical signals, commonly referred to as brainwaves, and exercise them into digital signals. The Think Gear technology then makes those computations and signals available to games and applications.

ii. Think Gear

Think Gear is the technology which is there inside every NeuroSky product or a partner product that empowers a device to interface with the wearers' brainwaves [5]. It includes the sensor which is placed on the forehead, the contact and reference points located in the ear clip, and the on-board chip that processes all of the data. Both the raw brainwaves and the e Sense Meters are computed on the Think Gear chip.

iii. e Sense

It is a proprietary algorithm of neuro sky for representing mental states. To calculate e Sense, the Neuro Sky Think Gear technology intensifies the raw brainwave signal and removes the ambient noise and muscle movement. The e Sense algorithm is then applied to the remaining signal, resulting in explicated e Sense meter values. Please note that e Sense meter values do not interpret an exact number, but instead describe ranges of activity. The e Sense meters are a way to show how effectively the user is captivating Attention (similar to concentration) or Meditation (similar to relaxation) [5].

(a)Attention e Sense:

The e Sense attention meter shows the intensity of a user's level of mental "focus" or "attention", such as that which occurs during intense concentration and directed (but stable) mental activity. Its value ranges from 0 to 100. Distractions, wandering thoughts, lack of focus, or anxiety may lower the attention meter level.

(b) Meditation e Sense:

The e Sense Meditation meter shows the level of a user's mental "calmness" or "relaxation". Its value ranges from 0 to 100. Note that Meditation is a measure of a person's mental states, not physical levels, so simply relaxing all the muscles of the body may not instantly result in an intensified effect meditation level. However, for most people in most normal circumstances, relaxing the body often helps the mind to relax as well. Meditation is related to reduce activity by the active mental processes in the brain. It has long been an observed that closing one's eyes stops the mental activities which process images from the eyes. So closing the eyes is often an effective method for increasing the Meditation meter level. Distractions, wandering thoughts, anxiety, agitation, and sensory stimuli may lower the Meditation meter levels [5].

V. E SENSE METER - TECHNICAL DESCRIPTION

For each different type of e Sense (i.e. Attention, Meditation), the meter value is reported on a relative e Sense scale of 1 to 100. On this scale, a value between 40 to 60 at any given moment in time is considered "neutral" and is similar in notion to "baselines" that are established in conventional brainwave measurement techniques (though the method for determining a ThinkGear baseline is proprietary and may differ from conventional brainwaves)

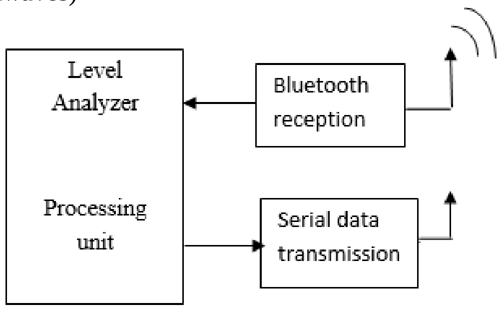

Figure 3: Data processing unit

As shown in Figure 3, the Data transmitted by the Brainwave headset will be received by the Computer's Bluetooth . Receiver data will be analyzed by the Level Analysis platform. The Level Analysis platform will extract the raw data using the aurduino. After the analysis of this data, ie will be sent to the robot module using serial data transmission.

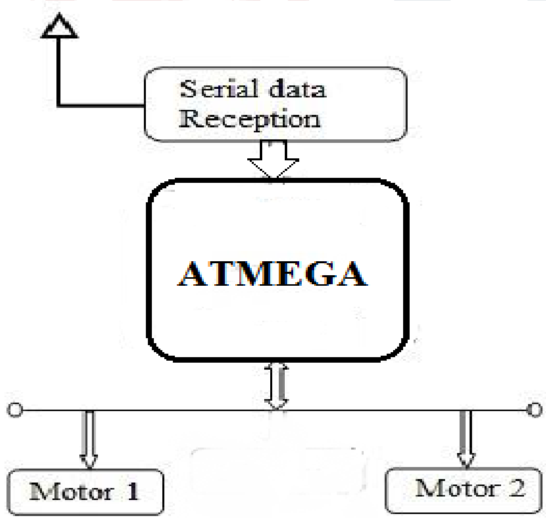

Figure 4: Robotic module

As shown in Figure 4, in the robot module is connected to PC which will receive the data and processes it. According to the data received by the ATMEGA microcontroller, it will control the speed of the motors.

VI. PULSE WIDTH MODULATOR:

Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a commonly used technique for controlling power to inertial electrical devices, made practical by modern electronic power switches. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. When the on switch period is long compared to the off periods, the higher is the power supplied to the load. The PWM switching frequency has to be much faster than what would affect the load, which is to say that the device uses power. The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.

The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off, there is practically no current, and when it is on, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM also works well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle.

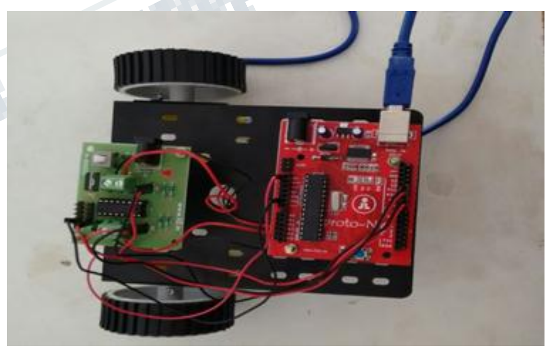

Figure 5: Robot

VII. DESIGN FLOW

The flow diagram of Brainwave Controlled Robot unit is shown in Figure 5. It shows all the step by step functions of robot, how it will be controlled by using brainwave signals. After Switching on the Brainwave headset and the Robot kit, the processor will initialize and the headset will start sensing the neuron signals. After sensing the signals it will transfer them through the Bluetooth and the acquisition module will receive the signals in the processor. Then the average of the processed

EEG signal will be compared to the threshold and the decision to control the motor will be done.

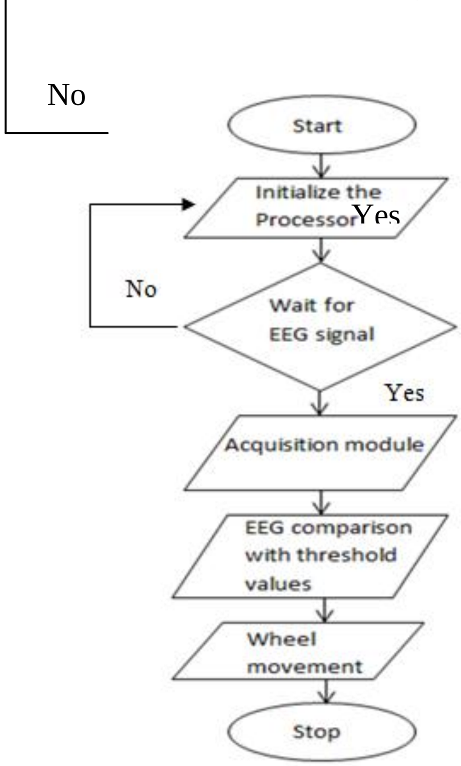

Figure 5: Design flow

VIII. RESULT

The brainwave signals which are acquired by the neurosky headset are digitized and processed. The e Sense meter shows the attention level of the driver, which varies from 0-100. Depending on the received attention level the speed of the wheel is controlled. As the attention level decreases the speed of the wheel also decreases and as the attention level reaches zero the vehicle stops.

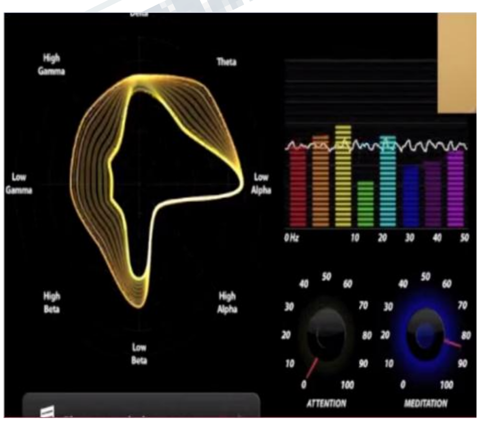

Figure 7: Attention level when 0

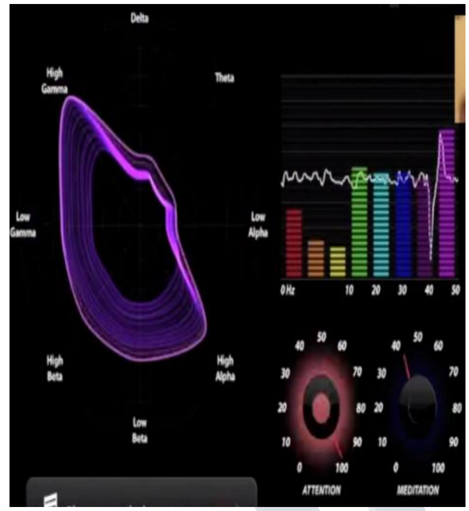

Figure 8: Attention level when 100

VI.CONCLUSION

The technique employed in this project is used to detect the driver drowsiness and the attention deviation of the driver and vary the speed accordingly for safety driving by avoiding accidents and hence reduces the casualties.

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