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EEG-BASED BRAIN WAVE SENSOR TO DETECT DROWSINESS WITH EYE OPEN

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Abstract

Many methods have been taken to avoid accident by using drowsiness detection. Each technique has their own merits and demerits. The most practical approach to detect drowsiness was previously done by image processing techniques and by using eye blink patterns. These techniques had several drawbacks which led to the introduction of a new way of detecting drowsiness by using sensors. In the image processing technique, the driver is supposed to pick something on the floor. The moment he bends the system signal automatically alerts the user, since the user has moved away from his original position. Nowadays BCI has become popular for detecting drowsiness by capturing brain wave signals. Here, the detection is carried out by a wireless sensor which captures the brain waves and determines the drowsiness, even with eyes open. The sensor works in combination with BCI, which transmits the EEG waves to the system. During relaxation the sensor can also detect the meditation level.

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I. Introduction

Drowsiness is the transition state between awake and asleep, during which a decrease of vigilance is generally observed. The previously proposed techniques to detect drowsiness were based on facial recognition patterns. Later, it was concentrating on the physiological changes of user, like, heartbeat rate, EEG activities, reporting that the eye blink pattern and eye blink rate. EEG waves have several types of frequency waves ranging from 2 to 32Hz. Among them, one of the waves has been taken to detect the drowsiness and is noted down [1]. As said earlier, EEG works in combination with BCI which is a real time computing wireless system for drowsiness detection. The proposed Brain Computer Interface system encloses of a wireless physiological signal acquisition module and an embedded signal processing module. Here, the wireless physiological signal acquisition module is used to collect EEG signals and transmit them to embedded processing module using RF transmitter. The use of sensor has made the work easier to detect the level of alpha waves in the EEG signal which is the major contribution for drowsiness detection. The brain wave sensor not only detects the alpha waves, also it detects the other waves such as β, α, θ, δ waves (See Figure 1). Thus, the disadvantage of image processing technique has been overcome by avoiding the use of open CV of the eyes (curriculum vitae). At the same time, the user does not want to look straight ahead always. The subjects can move their eyes anyhow as they wish. Only the signals have been detected which is not actually from the eye movement [1, 2].

Brain waves have been categorized into four basic groups as shown in Figure 1.

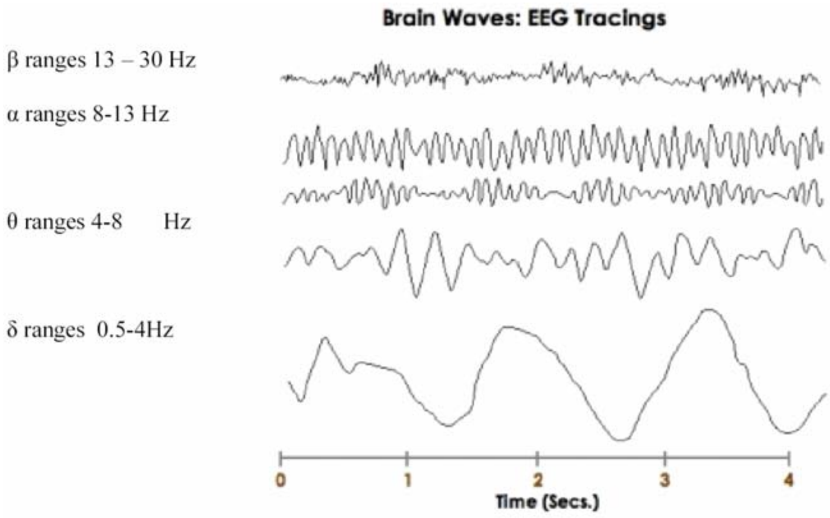

Figure 1. Different brain waves.

II. Review Stages/Related Works

An adaptive alertness estimation methodology based on EEG power spectrum analysis, Independent Component Analysis (ICA), Fuzzy Neural Network (FNN'S) and real time BCI based detection models is proposed earlier for continuously monitoring the driver's drowsiness level with concurrent changes in the alertness level [4]. Earlier studies to detect drowsiness are many. They can be classified into two major approaches. The first approach focuses on physical changes during fatigue, such as the inclination of drivers head, sagging posture and decline in gripping force on the steering wheel.

The second approach focuses on measuring physiological change of drivers such as eye activity measures, heartbeat rate, skin electric potential and Electro Encephalo Graphic activities (EEG) reported that the eye blink duration and blink rate typically are sensitive to fatigue effects [3]. Earlier methods to drowsiness detection primarily make pre-assumptions about the relevant behavior and drowsiness driver detection with the help of facial movement analysis.

In other methods, a drowsiness driver detection system has been improved using a non-intensive machine vision based concepts. The system uses a small monochrome security camera that points directly towards driver's face and monitors the driver's eyes in order to detect fatigue. Here, the proposed method is using the sensor which involves the use of an electrode, the brain activity in connection with the BCI system.

Figure 2. Various views of brain wave sensor.

III. System Architecture

The human brain contains millions of neurons. The activity of neurons can be converted to EEG signals and can be used to control the system. The electrical activity of the neuron is extracted using a wireless sensor with the help of electrodes. The required signals are then sent to the Brain Computer Interface system through RF as shown in Figure 3.

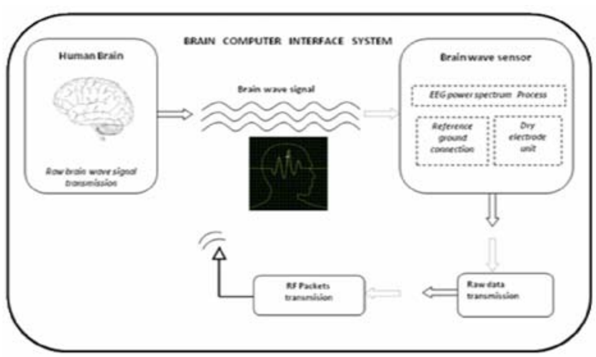

Figure 3. BCI system.

BCI transmits these signal packets to the level splitter section which distinguishes various brain wave signal levels by their frequency [5]. The level splitter section transmits only the required alpha waves serially to the vehicle section (see Figure 4).

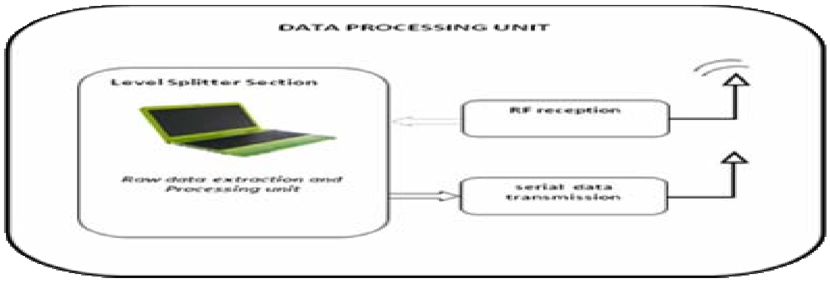

Figure 4. Level splitter section.

The vehicle section consists of an ARM microcontroller LPC2148 which compares the received signal packets with a pre-defined threshold limit. If it exceeds the threshold limit, the controller automatically sends the warning signal by which the system simultaneously controls the speed of the motor and activates the alarm to drag the driver’s attention [4] (see Figure 5).

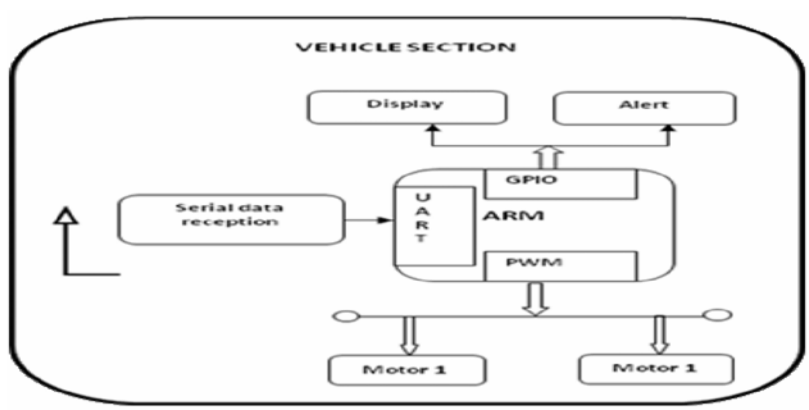

Figure 5. Vehicle section block.

IV. System Requirements

The main hardware requirements in this detection are the ARM LPC

2148, Brain wave sensor, Alert, LCD Display, Zigbee module. The ARM processor is used to control the speed of the vehicle by the output of the sensor. Thus, the work of the sensor is used to convert the wave signals from brain into packets of data to the computer by BCI interface system. For transferring the data from sensor to computer Zigbee plays a major role for wireless transmission. The another major requirement is the software for executing it in the computer. There are 4 softwares to be used in this detection. They are: KEIL IDE, which is used to compile ARM LPC2148. Next is the ORCAD which is used to load the required program in the PCB. Following this, we use Programmer's FLASH MAGIC to load the program in the ARM chip. Finally, we use MATLAB to convert the brain wave signals from sensor to packets of data values. When the subject blinks the eyes continuously, different attention levels are obtained according to the blinking pattern (See Figure 6). The pulse rate of various attention levels are shown in Figure 7.

Figure 6. Pulse rate of packets.

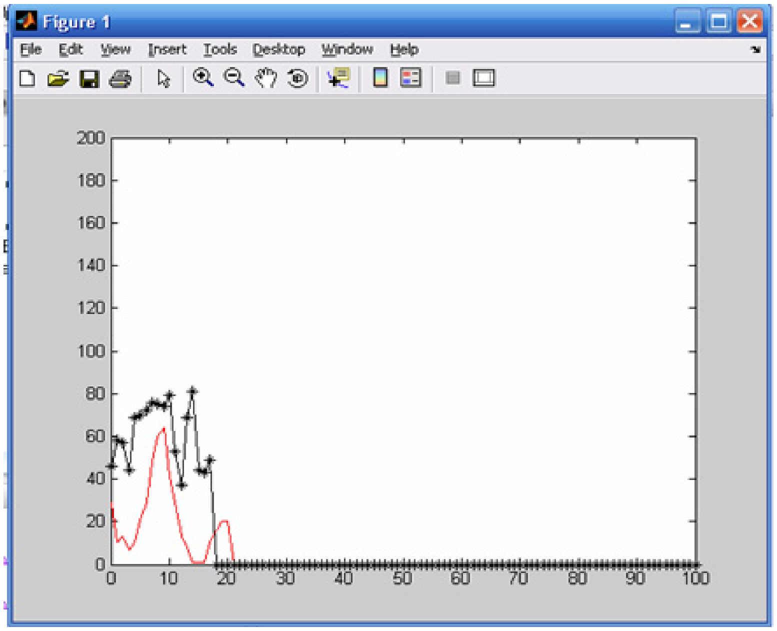

Figure 7. Output for different blink levels.

V. Algorithm

The algorithm is as follows: (See Figure 8).

Step 1: Initialization process.

Step 2: Sense the data from wireless EEG sensor.

Step 3: When the data is sent, the sensor processes it by transmitting it as RF packets.

Step 4: Check the levels of the attention.

Step 5: If the attention level is low, then the alert module will start buzzering.

Step 6: It alerts the user through the LCD module and an alarm fixed.

Step 7: The final step is that the engine is slowed down.

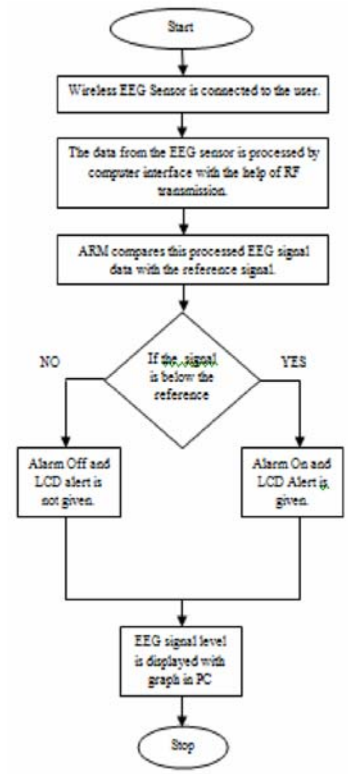

Figure 8. Flowchart of the algorithm.

VI. Conclusion

This research has developed an innovative and non-invasive bio-electrical measurement system. The system features high sensitivity in non-contact measurement of vital physiological signals on human body. Using the developed signal processing algorithm, the brain rate and brain wave frequency can be obtained in real time. Also this sensor detects eye blinking, which is a good indicator of fatigue. Experiments were conducted on a high-fidelity driving simulator to evaluate the performance of this sensor and signal processing algorithm. The sensor is applicable for railroad train operators, large truck and bus drivers. By monitoring the four independent physiological indicators of drowsiness under holistic driving conditions, the sensor data provided important input for sensor fusion and the drowsiness detection algorithm. This safety idea project successfully showed the concept of non-contact sensing physiological signal for drowsiness detection. This technology has great potentials to reduce the drowsiness related crashes and improve the health of road operators and truck drivers.

Some aspects are suggested for the further development of this project. This could also include the use of advanced fabrication technology (i.e., IC designs, which could significantly reduce the size of the sensor to the size of the cloth button). The reduced size will find more attractive responses in the future. For example, the sensor could be integrated into a "Small Cloth button" that monitors the physiological status of the user. An extended, future field testing program could investigate the sensor functionality under various conditions.

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