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Stress Removal and Night Drive Accident Prevention Using Embedded System

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ABSTRACT

In the present world due to heavy workloads, deadlines etc. stress has become an unavoidable enemy. It has great effect on our health, memory, mood and quality of life. Stress can also induce sleep in people. Around 20% of accidents are caused due to night time driving. Drowsiness, fatigue, driving under medication or under the influence of alcohol affects our concentration and in turn causes accidents. About 3% of the public also have sleep disorders. Due to these factors driver becomes drowsy and will soon lack control of the vehicle.

In this paper, we briefly discuss about the brainwave and brainwave variation patterns during sleep and stress using electroencephalograph (eeg). The obtained data is sent through Bluetooth processed to determine the condition. If stress is identified with the help of brainwaves then these are controlled using the principle of binaural beats. If the sleep condition is identified, then an alarm is activated and information is sent to the required authorities using the mobile application. This paper assures to solve the problem of night drive accidents of vehicles and stress removal.

Keywords: Brainwave, electroencephalograph (eeg), Bluetooth, and android application.

1. INTRODUCTION

Stress in day today life affects people mentally and physically. Stress can cause memory loss, heart problems, etc. Stress can also induce sleep in people. Car accident statistics are jarring at night. Despite 60 percent less traffic on the roads, more than 40 percent of all fatal car accidents occur at night [1].

Drunk drivers (DUI) are more likely to be on the road at night. Nighttime drivers need to be vigilant and on the look-out for these major auto accident causers.

Drowsy driving is another added danger on the roadways at night as people are generally winding down their days and growing sleepy. Drivers that fall asleep at the wheel, or even ones that are dazed and unobservant, can cause fatal car accidents.

Brain is an electro-chemical organ. The Brainwaves are produced by the frontal lobe of the brain. The limbic system is important in emotional behavior and controlling movements. Researchers have speculated that a fully functional brain can generate as much as 10watts of electrical power. Even though this electrical power is very limited, it does occur in a very specific ways that are characteristic of the human brain. The side view of the brain is shown in the figure 1.

Electrical activity emanating from the brain is displayed in the form of brainwaves. There are four categories of these brainwaves, ranging from most activity to least activity. These are delta waves, theta waves, alpha waves and beta waves.

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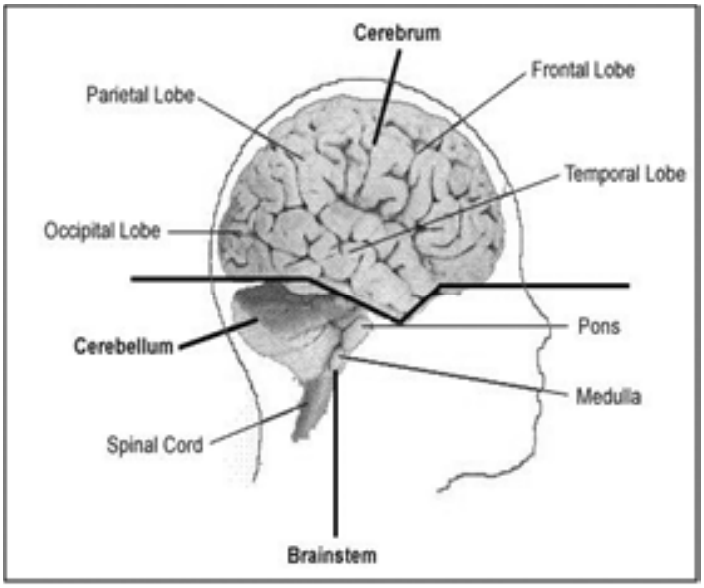

Figure 1: Side View of the Brain

- Delta Waves 0.5-3 Hz
- Theta Waves 4-8 Hz
- Alpha Waves 9-12 Hz
- Beta Waves13-30 Hz

The different brainwave with their names and the situations when it occurs is shown in figure2. Here we have to note that the beta waves are of two types which are high beta waves and low beta waves. These waves occur during alert stage. Their wave representation is shown in the figure3.

Stage 1 NREM Sleep

Stage 1 in non-rapid eye movement sleep (NREM) involves a transition stage between wake and sleep. It characteristics include reduced arousal and alternation between alpha and theta waves.

Stage 2 NREM Sleep

In stage 2 “True” sleep or alpha disappears and Theta waves predominate. “Spindles” drive increasing brainwave synchronization.

Stage 3 & 4 NREM Sleep

Stage 3&4 has minimal arousal level with slow, regular, high voltage waves. In this stage the sleeper is difficult to awaken. A “Synchronized” brain activity occurs and it happens primarily in first half of night

REM Sleep

REM sleep involves fast, irregular brainwaves as in waking. Brain is highly activated with rapid eye movement. Postural atonia with dreaming occurring primarily in second half of night

Wake

It includes full arousal fast, irregular, low voltage brainwaves, faster beta waves in *active* waking and slower alpha waves in *quiet* waking (eyes closed).

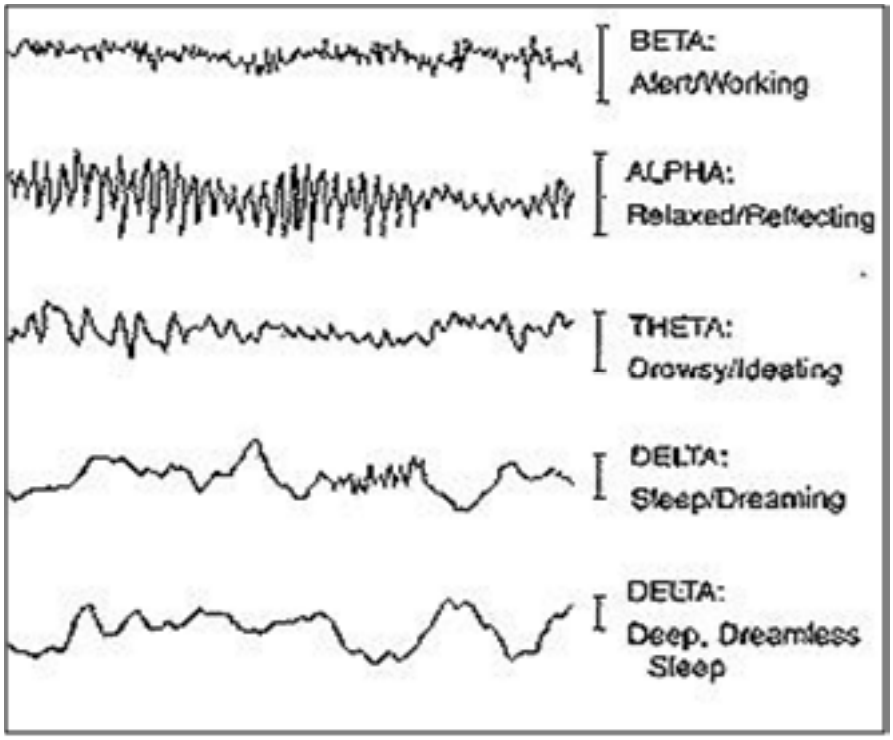

Figure 2: Different brainwaves with their names and the situations when it occurs.

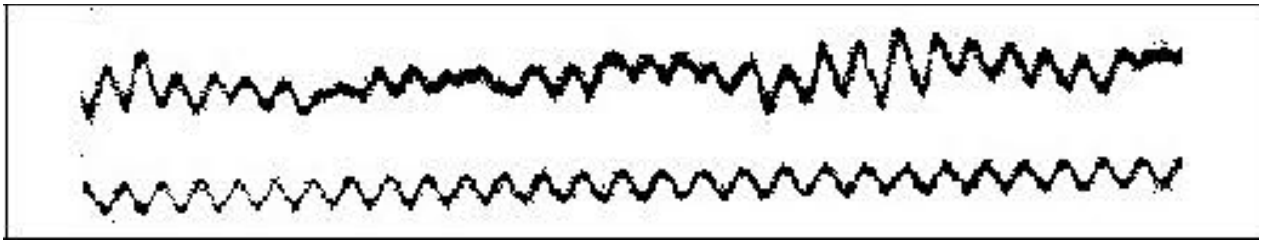

Figure 3: High beta waves and Low beta waves respectively.

2. MATERIALS AND METHODS

2.1. EEG Sensors

EEG sensors are used to measure the electrical equivalent signal value with help of brain wave. It exists in various forms. It consists of a 0.7 inch diameter hard plastic outer disc housing with a pre-jelled. Silver chloride snap style post pellet insert. These sensors do not contain any latex[3].

The sensor sends the analog value of brainwave signal into the instrumentation amplifier circuit. This amplitude is in between the range of 150 – 250 micro volts (μV). This is very low. For processing, at least gain and low noise amplifier is needed. For that instrumentation amplifier with high gain and high CMRR ratio is employed. For this purpose we can use a cascading inverting amplifier with a gain of about 20,000.

Here one operational is not enough to produce this much high gain. So a series of amplifier is cascaded to give required gain. The gain of an individual inverting operational amplifier is given by.

$$\text{Gain (A)} = -R2/R1$$

Here we can use four inverting amplifier in cascade. Let the gain of each inverting amplifier from left to right be A1, A2, A3 and A4. And let V_i and Vo be the input and output voltages of the amplifier.

Now,

A1 = (-R2/R1) = (-2/1) = -2

A2 = (-R4/R3) = (-10/1) = -10

A3 = (-R6/R5) = (-10/1) = -10

A4 = (-R8/R7) = (-100/1) = -100

*All resistors are in kilo ohm.

Now total gain of the amplifier(A eff)

A eff = A1*A2*A3*A4*

A eff = (-2)*(-10)*(-10)*(-100)

A eff = 20,000

Therefore,

Vo = Vi*A eff*Vi=15*10^-5*20,000V

Vo =3Vi

Hence an amplifier with gain 20,000 is designed using basic operational amplifier.

2.2. Bluetooth headphones

Bluetooth is a universal wireless standard for connecting various digital devices. It transmits data wirelessly through radio frequency. Each device will have a transreceiver microchip that allows to it connect and communicate with other Bluetooth enabled devices that are within the range, about 30feet. In this case, we use BT between headphones and the mobile phones. In this proposed system we use headphones that contain attached eeg sensors on its headband. So it transmits the brainwave data to the mobile via Bluetooth and also can receive audio signals [2]. A proposed eeg based headphones is shown in the figure 4.

2.3. Android mobile application

Android is a mobile operating system developed by Google for mobile devices like smart phones, tablets etc. Android applications extend the device's functionalities and are written using Android software development kit (SDK). The programming language is usually in Java. In this system, we require an application for Bluetooth communication and for processing the received eeg brainwave data.

Figure 4: Proposed EEG Headphones

The Bluetooth app is designed in two stages. First, for pairing the devices and secondly for establishing a connection between two devices. It is based on server-client model and allows bidirectional data transmission and reception. For eeg data processing app, the received brainwaves are checked for it range of frequency and compares it with predefined brainwave values to determine if the person is stressed or drowsy. If stressed, it generates binaural beats via Bluetooth to the headphone speakers. If sleep signal is identified then the mobile activates the alarm for a specified time and sends the information to the authorities.

2.4. Binaural Beats

The principle used for stress management is binaural beats. Binaural beats or binaural tones are an auditory illusion or apparent sound perceived in the brain when two slightly different frequency sounds are played into each ear, i.e. dichotically. The person will perceive an illusion of a third tone that has a frequency of the difference between the incoming two tones. This third sound is known as binaural beat. The frequency of the tones must be between 1000Hz to1500Hz. The difference of the two tones must be small with the range of 30Hz for this effect to occur. The brain generates a brainwave similar to the third tone. This is called frequency following response. Alpha range is used for relaxation effect. Thus if the person is stressed, then the app send binaural audio to the headphones.

2.5. Sleep Condition

If sleep signals are identified, then the mobile turns ON the alarm for an allotted time. If the user switches it OFF then no action is taken. If the alarm timer exceeds its limit, then information or a call can be notified to the authorities about the persons state and location [4].

The system has to recognize two conditions:

1) Stress
2) Sleep

2.6. Condition 1: Stress

If the brainwave frequency is between 30-40Hz then it is considered that the person is under stress. The app then checks for required audio of binaural beat so that the audio produces a difference of 10Hz.the two tones is played dichotically through the headphones. As the difference between the two tones is below 10-20Hz it cannot be detected by the human ears. The neuron called afferon neuron inside the brain sends the 10Hz signal as a stimulus to the brain. It entrains the brain to generate a similar stimulus of brainwaves, thus reducing the brainwave frequency from 30-40Hz to about 9-14Hz, thus relaxing the mind.

2.7. Condition 2: Sleep

If the brainwave frequency is below 7Hz, then the person is drowsy or falling asleep. Then the mobile triggers an alarm to awake the person in order to avoid accidents. the alarm sound should be played loud enough so that the person immediately awakes. If the alarm timer expires, the app automatically sends the person's state, car number and location to the required authorities [5].

2.8. Block diagram

The General block diagram of controlling stress/sleep is shown in the figure 5.

i) Operation

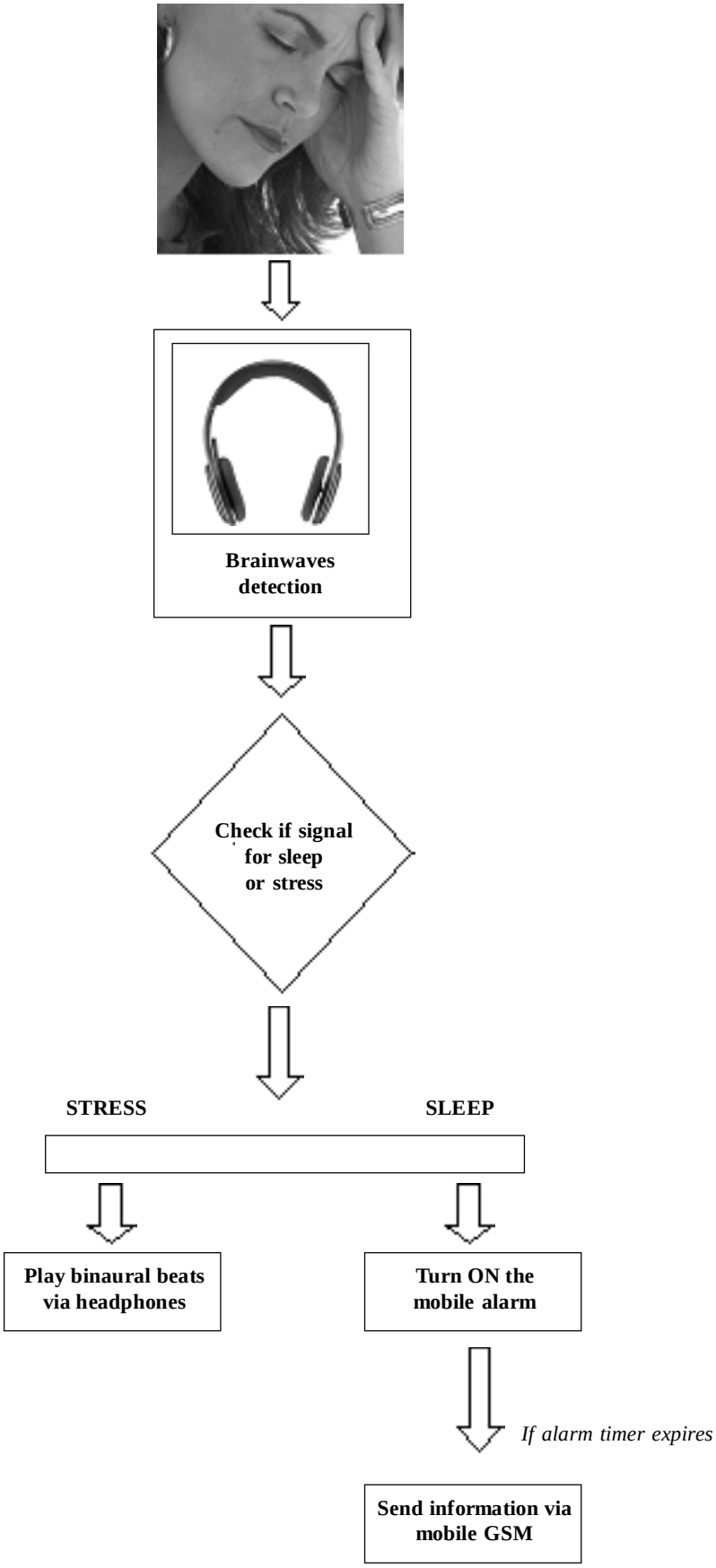

Figure 5: Proposed system general block diagram

Figure 6: Operational procedure

The figure 6 shows a general operation procedure of this proposed system. This device is used to control stress and sleep during long drive and in turn avoid accidents. During long drive, the headphones should be worn by the person always. The mobile and headphone Bluetooth must be in paired condition. The headphone mounted with eeg sensors continuously monitor the brainwaves. If the brainwave signal is in stress frequency range, then binaural beats are played via the headphones. If the frequency in sleep range, then mobile alarm is activated. If the person switches it OFF then no action is taken. If the alarm timer expires, then without any delay a message sent to the authorities via mobile GSM automatically [6]&[7].

3. CONCLUSION

In this paper we have proposed a device that serves two purposes. Firstly, using the principle of binaural beats and frequency following response brainwaves are controlled by the reducing stress or making the mind relaxed temporarily. Secondly, the brainwaves are continuously monitored to detect the falling asleep while driving long distance in a vehicle. The main advantage is that the whole device is light weight and just a modification of the existing system. Also the whole device including sensors and headphones is cheap.

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