DETECTION OF DRIVER'S DROWSINESS USING EEG SYSTEM.

K.Pragatheeswaran, S. Mahashruthi.
Third year Biomedical Engineering,
Agni College of Technology, Chennai.

Abstract

In twentieth century various kinds of vehicles have been introduced to provide convenience in human daily life but it makes many car accidents around the world and cause many casualties and injuries. Driver's drowsiness monitoring systems is one of the main approaches for detection of driver fatigue or distraction and accident prevention. The system estimates driver alertness based on extracted symptoms and alarms. The objective of the paper is the development of an unobtrusive and reliable in-vehicle system to monitor the driver and the environment, for real-time detection of driver fatigue and distraction, based on EEG.

I. INTRODUCTION

Sleep is a naturally recurring state characterized by reduced or absent consciousness, relatively suspended sensory activity, and inactivity of nearly all voluntary muscles.The primary factors responsible for sleepiness are: physical and mental activities, prolonged awaken state, anxiety, some sort of disease etc. From a study conducted by Mercedes Benz it reports the road accidents cause an average of 1.2 million deaths and 50 million injuries around the world each year. However, these vehicles are prone to accidents due to issues as driver fatigue and distraction. If driver can get an extra 0.5 seconds in the warning period it will avoid 60% of the overrun accidents. There are a number of safety devices present in market which are utilizes to conserve the driver at currently, for examples, seat belts, airbags, brake systems and hard sheet metal, etc. Yet, these devices always take action after the causality happened. There are fewer of asset can warn drivers earlier the hazard happened.This paper presents a driver's drowsiness/ fatigue detection system using EEG, it can effectively decide whether the present driving situation of drowsy and falling asleep, and then alert drive. The existing driver monitoring systems have the potential to detect driver drowsiness before an accident occurs, but they rely on being able to monitor a driver's eyes to determine if they are open. According to Barr et al. "For real-world, in-vehicle applications,sunlight can interfere with IR illumination, reflections from eyeglasses can create confounding bright spots near the eyes, and sunglasses tend to disturb the IR light and make the pupils appear very weak." An EEG based device may be able to detect the onset of sleep before erratic driving has begun, and it has the added benefit of not requiring an unhindered view of the driver's eyes.

The paper is ordered as follows. Section II, details the Brain signal analysis. Section III, explains system overview. Section IV, describes the experimental setup and Section V explains the expiremental result. Finally, Section VI concludesthepaper.

II. BRAIN SIGNAL ANALYSIS

A. ElectroEncephaloGram

An EEG tracks and records brain wave patterns. Small metal discs with thin wires (electrodes) are placed on the scalp, and then send signals to a computer to record the results.Electroencephalography allows the processing of brain signals to investigate the internal functionality based on pre-defined protocols. The measure of brain activities are the potential difference of two fixed points in scalp. Alpha waves with a frequency between 8 to 13 Hz are reduced with open eyes, drowsiness and sleep. Beta wave, or beta rhythm, is the term used to designate the frequency range of human brain activity between 12 and 35 Hz . Beta waves are split into three sections: High Beta Waves (19 Hz+); Beta Waves (15–18 Hz); and Low Beta Waves (12–15 Hz). Beta states are the states associated with normal waking consciousness. A gamma wave is a pattern of neural oscillation in humans with a frequency between 35 to 100 Hz though 40 Hz is prototypical and according to the drivers brain activity we can control the vehicle. This causes a remedial change in the accident prevention system. A tabular form of EEG signal's frequency to compare is shown in Table 1.EEG signal frequency

Band	Frequency (Hz)	Location
Delta	2-4	Adults
Theta	4-8	Hand Tasks
Alpha	8-13	Posterior Regions
Beta	13-35	Low-Amplitude Waves
Gamma	35+	Somatosensory cortex
Mu	8-12	Sensorimotor cortex

Table 1. EEG signal's frequency

B.Brain during Sleep

Sleep is typically broken into four sleep stages.Fig.1. Shows that the different stages of sleep.

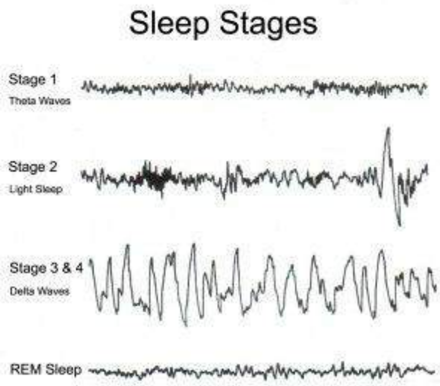

Fig.1. Different stages of sleep

During stage 1 sleep, EEG signals are low amplitude and low frequency. During stage 2 sleep, body temperature decreases and the heart rate slows. In stage 2 sleep, alpha waves are periodically interrupted by alpha spindles or sleep spindles.Stages 3 and 4 are deeper sleep, with stage 4 being deeper than stage 3. REM sleep follows stage 4 sleep. REM sleep is most readily identified by rapid eye movement. During REM sleep, brain activity increases. Each of these stages continue to cycle from stage 1 through REM sleep throughout the sleeping period.

III. SYSTEM OVERVIEW

This section describes the backbone of the system, which comprises several modules. Basically, these are: a bio-signal acquiring module; a smartphone device module; alert system. Fig 2. illustrates an overview of the system design for the proposed system. Essentially, the smartphone device receives sensory data via EEG electrodes.

Fig.2. System overview

In addition, the system optimizes a built-in sensor to gather the required sensor readings. The three-axis accelerometer reading from a built-in accelerometer sensor can be used to measure the speed of the vehicle. An extraction process is performed to extract meaningful features from the received data. these features then serve as input models to an inference network to analyze the driver's drowsiness level. Then EEG data were preprocessed using a simple low-pass filter with a cut-off frequency of 50 Hz to remove the line noise (60 Hz and its harmonic) and other high-frequency noise for further analysis.The network predicts the driver's alertness state through a series of computations, and displays the computed results on the smartphone's screen. An alert system is triggered if the statistical results indicate that the driver's alertness is predicted to be low.

A. EEG electrode cap

The EEG electrode cap holds nineteen embedded tin electrodes closely to the subject's head. Electrodes are pre-positioned in the international 10/20 montage, so operator can minimize electrode placement errors.the electrode cap consist of five ribbon cable, each ribbon cable can contains five electrodes except front and back it contains only two electrode.Fig. 3. Shows the EEG eelectrode cap. The electrode cap's connector arrangement permits the electrode cap to be easily disconnected from the recording amplifiers, allowing the cap to be fitted in one location and used in another.

Fig.3. EEG eelectrode cap

B. Sleep Detection

Morrow et al. outlined a method for the realtime detection of sleep by focusing on three critical parameters in EEG recordings: waveform amplitude, waveform frequency, and duration of synchronization of the waveform. This last parameter is critical in that the waveform amplitude may meet a predefined voltage threshold for a frequency band for short periods of time, but this does not necessarily indicate sleep unless it meets the threshold for a given duration. Morrow et al. used a 50 µV predefined voltage threshold. The frequencies of focus were 8-12 Hz

(Alpha) and 11.5-15 Hz (low Beta). Two counters were used to detect EEG threshold crossing with one counter for the number of sequential pattern matches indicative of sleep, and the other counter for the number of sequential non-matches. When a frequency and amplitude matched the focus frequencies and thresholds the matching counter was incremented. When it did not match, a non-matching counter was incremented. When the match counter reached 3, sleep was indicated. When the nonmatching counter reached 8, wakefulness was indicated. Morrow et al. was able to reach a reliability of 97.9% for 48 of 49 alpha-spindle epochs. In addition, the detector was able to detect about 12.2% more epochs than visual scoring. This methodology may be applicable to sleep detection.

C. Alarm system

The Alarm helps you stay guarded with high tech sleep detectors , geared to track when the aquired signal matches with the reference signal. In case of drowsiness, the system sends an immediate alert and raises an alarm to warn you of any such activities. The brain behind Alarm System composes of its Main Panel and the iAlert Station system. The Main Wireless Panel works rigorously to support the sleep detectors . To add to the convenience of the panel, the user can easily arm or disarm the system through a smartphone.The Wireless Main Panel can be connected to a smartphone. In case of a drowsiness the system starts alerting the driver for the further action.

IV. EXPERIMENTAL SETUP

The setup depicts the installation of EEG sensor modules near by the seat, which are connected to an Atmega128 microprocessor with a Bluetooth module attached on it; the EEG data packets are transmitted to the smartphone device through a Bluetooth connection. The smartphone device used in our proposed system is the Samsung Galaxy S III . The experiments were simulation-based, where the smartphone device was placed behind the steering wheel.

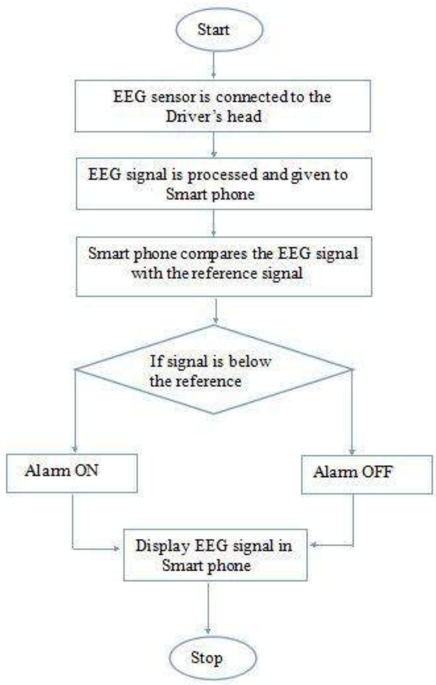

Fig.4. work flow of the system

The implementation of the software is done in a stepwise manner. First the EEG sensor is connected to the driver's head to procure the signal. The obtained signal is then processed and given to the smart phone. The smartphone compares the acquired signal with the reference signal. The EEG signal is displayed on the smartphone after comparision and if the signal is found lesser thanthe thereshold value,the alarm is in ON state otherwise it is in OFF state.

V. EXPIREMENTAL RESULT

The EEG based driver monitoring System is a unique vehicle safety system designed to stop vehicle accidents due to driver sleepiness / drowsiness. A method to monitor driver safety by analyzing information related to drowsiness using EEG-signal processing. The reliable detection of drowsiness is an important factor in this system. An accurate Real time monitoring of driver's drowsiness by warning system to driver, is implemented in this paper. Wireless and wearable EEG Dry electrode used for recording EEG signal. If a person mentally sleeping with eyes open for few seconds, then the level of brain signal will get change than the normal level. EEG is used to detect the abnormal conditions related to the electrical activities of the brain.

VI. CONCLUSION

If many instruments are equipped in a high speed vehicle to provide more than necessary information to the driver they will draw the driver to pay particular attention to these instruments and furthermore he needs to learn how to maneuver there instruments. Diversion, fatigue are two fatal factors in the car accidents. The main task of our study is trying through the study of driver's driving behavior and in coordinating with the information provided from the pre-warning system to decelerate the vehicle speed prior to the happening of accident and if accident happens to reduce the damage to the least level.

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