

Smart Band for Drowsiness Detection to Prevent Accidents

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ABSTRACT: Today we are becoming aware that most of the road accidents occur due to fatigue and drowsiness of the driver. Till now number of methods have been proposed to detect drowsiness and prevent accidents. Some of these methods are Steering Pattern Monitoring, Vehicle Position in Lane Monitoring, Driver Eye/Face Monitoring, and Physiological Measurement. Among these methods, the techniques that are best, based on accuracy are the ones based on Human physiological phenomena but they are costlier and complicated to implement. This project will generate the model to detect drowsiness of the driver using physiological measurement method. This model will be Smart band which is portable and easy to use and will monitor the heart-rate of the driver to detect the drowsiness of the driver. If the driver is drowsy, then System will give buzz the alarm to alert the driver.

KEYWORDS: “Driver drowsiness detection”, “Pulse oximetry”, “Smart-band”, “Pulse sensor”, “IR LED”.

I. INTRODUCTION

‘DON’T DRINK AND DRIVE’ this slogan is used to create awareness among the people to prevent accidents. Drinking causes Drowsiness which is leading cause of the road accidents. Drowsiness is a state in which person loses its thinking and decision making ability^[3]. However drinking is not only cause of the drowsiness but also there are many causes like fatigue and lack of sleep and many more. Driver drowsiness detection is car safety technology which is used to prevent accidents^[1]. It uses various methods to detect drowsiness of the driver. But to develop a method for drowsiness detection which will be accurate, efficient and easy to implement and also less costly is great challenge.

The aim of the project is to develop a prototype for detecting drowsiness of the driver and alert the driver. It is non-invasive method. It uses the principle of pulse oximetry to detect heart-rate. Pulse oximetry is a technique that tells us if person is getting enough oxygen or not? The operation of Pulse oximetry is based on measuring of the absorption of red and Infra-Red light that passes through the wrist. The reflected light rays received at photodetector looked as a waveform. During heart-beat blood volume increases and this AC component of the photodetector is used to calculate the heart-rate. Thus if heart-rate indicates the drowsiness then alarm will be raised to alert the driver. For the alert systems, we have beeper device. The code is developed in ‘embedded C’ language.

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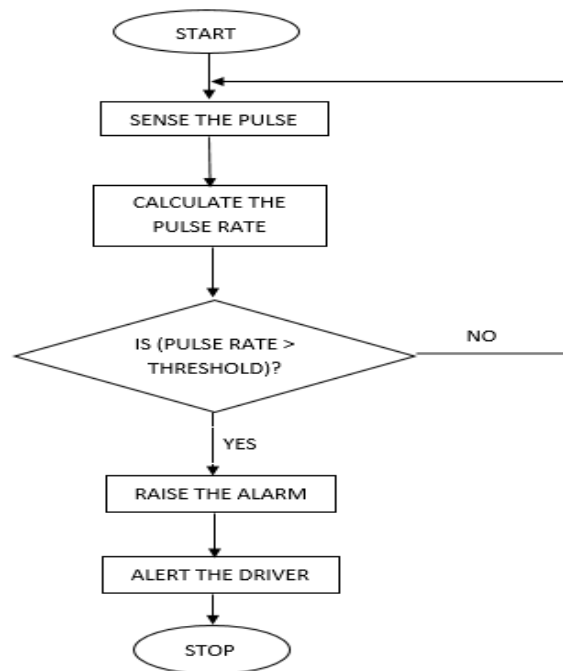


Figure 1: Drowsy Driver Alert System

II. FACTOR CAUSING DROWSY DRIVING

A number of factors influence the likelihood that a driver will become fatigued, these include:

- A. Time of day: your body and brain have a biological clock (circadian rhythm) that influences how alert or drowsy we are at certain times of the day
- B. Your level of physical or mental activity at the time (e.g. long boring stretches of road make it difficult to maintain alertness and vigilance)
- C. The presence of untreated sleep disorders (such as obstructive sleep apnea or narcolepsy)
- D. Sedative drugs
- E. *Shift workers and those working extended hours*: Shift workers are 6 times more likely to be in a fatigue-related crash, whether that be at work (operating machinery or vehicles) or commuting
- F. *Commercial drivers*: Long distance driving, often at night
- G. *Business travellers*: Drivers suffering from jet lag and crossing time zones often suffer from restricted and/or poor quality sleep^[2].

III. LITERATURE SURVEY

The National Highway Traffic Safety Administration estimates that 2.5% of fatal crashes and 2% of injury crashes involve drowsy driving. At present, various technologies used today are Steering Pattern Monitoring, Vehicle Position in Lane Monitoring, Driver Eye/Face Monitoring, and Physiological Measurement. Among these methods, the techniques that are best, based on accuracy are the ones based on Human physiological phenomena but they are costlier and complicated to implement.

A. Techniques used in Drowsiness detection

i. Vehicle Position in Lane Monitoring:

In road-transport terminology, a lane departure warning system is a mechanism designed to warn a driver when the vehicle begins to move out of its lane (unless a turn signal is on in that direction) on freeway and arterial

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roads. These systems are designed to minimize accidents by addressing the main causes of collisions: driver error, distractions and drowsiness. In 2009 the U.S. National Highway Traffic Safety Administration (NHTSA) began studying whether to mandate lane departure warning systems and frontal collision warning systems on automobiles.

There are two main types of systems:

A) Systems which warn the driver (lane departure warning, LDW) if the vehicle is leaving its lane (visual, audible, and/or vibration warnings).

B) Systems which warn the driver and, if no action is taken, automatically take steps to ensure the vehicle stays in its lane (lane keeping system, LKS).

Working:

Cameras are mounted on the sides of vehicle and focus downwards on the road to capture images containing the lane lines and wheels/vehicle boundaries. The correlation of sequential images and the constraints of lane lines and cameras are used. The lane position monitoring system is assumed to be useful for unmanned vehicles, and can also provide warnings in normal vehicles to enhance driving safety. Furthermore the vehicle always occupies a fixed position in the images because the cameras are mount.

Technology used in car:

Table 1

1992	Mitsubishi Motors began offering a camera-assisted lane-keeping support system on the Mitsubishi Debonair sold in Japan.
2001	Nissan Motors began offering a lane-keeping support system on the Cima sold in Japan.
2003	Honda launched its Lane Keep Assist System (LKAS) on the Inspire.
2007	In 2007, Audi began offering its Audi Lane Assist feature for the first time on the Q7.
2009	Mercedes-Benz began offering a Lane Keeping Assist function on the new E-class.

ii. **Driver Eye/Face Monitoring:**

Driver face monitoring system is a real-time system that can detect driver fatigue and distraction using machine vision approaches. In this a new approach is introduced for driver hypo vigilance (fatigue and distraction) detection based on the symptoms related to face and eye regions. In this method, face template matching and horizontal projection of top-half segment of face image are used to extract hypo vigilance symptoms from face and eye, respectively. Head rotation is a symptom to detect distraction that is extracted from face region. The extracted symptoms from eye region are percentage of eye closure, eyelid distance changes with respect to the normal eyelid distance, and eye closure rate. The first and second symptoms related to eye region are used for fatigue detection; the last one is used for distraction detection.

The driver face monitoring system is a real-time system that investigates the driver physical and mental condition based on the processing of driver face images. The driver state can be estimated from the eye closure, eyelid distance, blinking, gaze direction, yawning, and head rotation. This system will alarm in the hypovigilance states including fatigue and distraction. The major parts of the driver face monitoring system are imaging, hardware platform, and the intelligent software.

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iii. *Steering Pattern Monitoring:*

This drowsiness detection method is the observation of the steering wheel angle signal. It has been shown that the frequency of occurrence of a typical steering pattern, which can roughly be described as a dead band followed by a rather fast correction, is an indicator for the state of drowsiness of a driver. The advantage over other techniques like camera-based detection is that it can run in standard equipped cars. Thus it is available for the largest number of drivers and can thereby achieve the greatest effect on accident avoidance. It focus on environmental effects like crosswind and can show that those events may lead to an increase of the amount of steering patterns. Finally, we quantify the influence on drowsiness measures. The underlying database comprises more than two million kilometres of more than one thousand drivers, all real-world drives. The evaluation shows that particularly on routes or in situations where those environmental influences accumulate, the drowsiness measure can be affected to an extent that leads to false triggering of the system. Therefore, we measures are suggested that can be taken to reduce the influence of steering patterns that are not related to the driver's drowsiness state. The aim of most drowsiness detection systems is to inform a driver when his state has reached a critical level and to motivate him to take appropriate measures. This presupposes confidence in the system. False warnings will negatively affect the credibility of the system.

iv. *Physiological Measurement:*

Physiological methods offer an objective, precise way to measure sleepiness. They are based upon the fact that physiological signals start to change in the earlier stages of drowsiness, which could allow the potential driver drowsiness detection system a little bit of extra time to alert a drowsy driver in a timely manner and thereby prevent many road accidents.

Few of the methods used to measure physiological parameters are as follows:

ECG (Electrocardiogram): It detects electrical activity of human heart.

EEG (Electroencephalogram): It records electrical activity of human brain.

EOG (Electrooculogram): It records the electrical potential difference between the cornea and retina of human eye.

The physiological signals (i.e., heart rate, heart rate variation, breathing and eye blinking) will be utilized to detect the onset of driver fatigue, crucial for timely applying drowsiness counter measures. Fatigue driving is one of the most significant factors causing traffic accidents. Clinic research has found physiological signals are good indicators of drowsiness. A conventional bioelectrical signal measurement system requires the electrodes to be in contact with human body. This not only interferes with the normal driver operation, but also is not feasible for long term monitoring purpose. With delicate sensor electronics design, the bioelectrical signals associated with electrocardiography (ECG), breathing and eye blinking can be measured. The current sensor can detect the Electrocardiography (ECG) signals with an effective distance of up to 30 cm away from the body. It also provides sensitive measurement of physiological signals such as heart rate, breathing, eye blinking etc. The sensor performance was validated on a high fidelity driving simulator. Digital signal processing algorithms has been developed to decimate the signal noise and automate signal analyses. The characteristics of physiological signals indicative of driver fatigue, i.e., the heart rate (HR), heart rate variability (HRV), breath frequency and eye blinking frequency, can be determined. A robust drowsiness indicator is being developed by coupling the multiple physiological parameters to achieve high reliability in drowsiness detection.

Relationship between Physiological Signals and Drowsiness:

Bioelectricity is generated on the cell level and acts as the charge flow on human surface. The electrical charges on the skin off the chest are mainly caused by the depolarization of heart muscles during each heartbeat cycle. In each cycle, nerve excitability is triggered by sinoatrial node, and then spreads through atrium, intrinsic conduction pathways and ventricles. As a result, it causes the change of action potential in cells manifested as the form of tiny rises and falls of potential on body surface. The electrical activity of heartbeat cycle is adjusted rhythmically by central and peripheral nervous system. Fatigue causes changes in spontaneous rhythmic activity, breathing, cardiovascular reflex activity, blinking, nodding, etc. The comprehensive regulation of these changes by the central nerve system will finally cause changes in the physiological signals.

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B. Pulse Oximeter

The principle of operation of a Pulse Oximeter is based on measuring the absorption of red and infrared light that passes through a patient's finger or ear lobe by utilizing light sensors. Haemoglobin that transports oxygen (oxy-haemoglobin) absorbs infrared wavelength (800-940 nm) of light and haemoglobin that does not transport oxygen (deoxy-hemoglobin), absorbs visible RED wavelength (600-700 nm) of light. Backgrounds such as fluid, tissue and bone are factored out of the measurement by monitoring the steady state of absorption from bone, tissue, venous blood and arterial blood. LEDs are used as the light source and are sequentially pulsed at a fast rate. During a heartbeat, blood volume increases and this AC component of the photodetector's current is used to calculate the absorption of oxy- and deoxy-hemoglobin. Pulse oximetry uses a light emitter with red and infrared LEDs that shines through a reasonably translucent site with good blood flow. Typical adult/pediatric sites are the finger, toe, pinna (top) or lobe of the ear. Infant sites are the foot or palm of the hand and the big toe or thumb. Opposite the emitter is a photodetector that receives the light that passes through the measuring site.

There are two methods of sending light through the measuring site: transmission and reflectance. Pulse Oximeters are used in medical, sports training and home appliance applications. Knowing the percentage of haemoglobin that is saturated with oxygen is important to provide anesthesia, to determine the effectiveness of a patient's respiratory system, as well as help to diagnose various illnesses.



Figure 2: Pulse Oximeter

IV. PROPOSED SYSTEM

Different approaches have been proposed for drowsiness detection system. A drowsiness detection system using pulse rate is presented in this paper. The pulse rate is monitored using a pulse sensor. A method to monitor driver safety by analysing information related to fatigue using bio-signal processing. A monitoring system is designed using Microcontroller M0 cortex. This system will be used in vehicles, where pulses that are sensed will be processed using microcontroller and accordingly issue warning.

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A. Block Diagram:

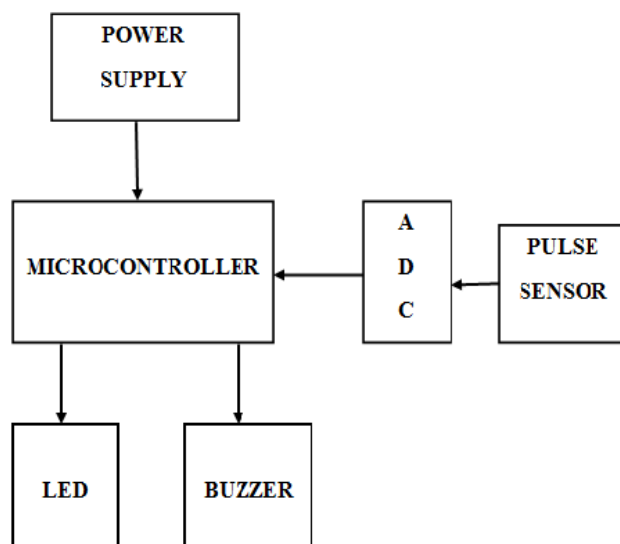


Figure 3: Block Diagram

B. Methodology:

Implementing a system to vehicles that provides high security to driver and the passengers, by designing a device which continuously monitor pulse rate, once when the pulse rate increases beyond threshold (that means the driver is sleepy), buzzer indication will be given and that wakes driver from sleep. This paper involves measuring the pulse rate using pulse sensor. The basic heartbeat sensor consists of a light emitting diodes and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects or transmits the light. Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate. The microcontroller use this information to compare with the normal pulse rate programmed in and if any abnormal situation arises, the buzzer indication is given to the driver to alert him, this operation is enabled by means of the circuit connected to the buzzer. The transmitted signal is received and the signal is decoded and given to the Microcontroller, which use this information for displaying the alert message in the LCD as programmed along with buzzer alert.

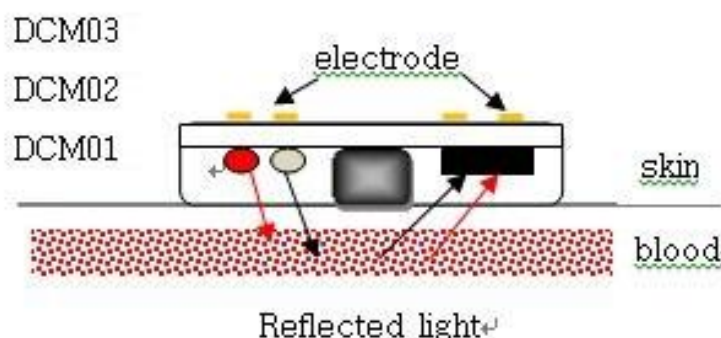


Figure 4: Pulse Sensor

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C. Algorithm:

The algorithm is as follows

- Step 1: Start process
- Step 2: Sense the data from pulse sensor
- Step 3: If the data sensed by sensor
- Step 4: Process the sensed data
- Step 5: Calculate the pulse rate
- Step 6: Compare pulse rate with Threshold
- Step 7: If pulse rate greater than Threshold then buzzer on and system off
- Step 8: else continue sensing pulse i.e. system on
- Step 9: Stop the process.

V. DISCUSSION

While creating device like this Pulse oximeter which requires the acquisition of signals such as PPGs, it is difficult to ensure the integrity of the signals that are acquired. This causes the placement of the sensor on the wrist and chest to be very important. This would help us to obtain fairly strong PPGs from the wrist because of the stronger signals due to the high levels of bone and subcutaneous tissues in these locations.

Our designed System is Considering Switch on (high heartrate i.e.; 120 heartbeat/minute), on Putting switch on We can hear the beep of alarm.

The main findings referring to construction principles of this system may be summarized as following.

- A. The heartbeat rate provides the symptoms of drowsiness. Heartbeat can be measured through the fingertip, wrist, or placing device near the heart.
- B. Our analyses documented that time domain feature subsets yielded all the advantages and disadvantages of technologies had been used for heartbeat rate detection.
- C. We found that earlier techniques used are very costly as many costly equipments have been used.
- D. As proposed system is wrist band, problem may arise of thickness of the skin of the person. As both red and Infra-red LEDs will pass the light through the skin.
- E. The future research should address the topic of increasing intensity of light rays passed through the Skin Another promising improvement could be realized by using driver state data as e.g. Drowsiness due to different reasons or fatigue. considering various driver states could be useful

VI. CONCLUSIONS

The analysis and design of driver drowsiness detection and alert system is presented. The proposed system is used to avoid various road accidents caused by drowsy driving. This paper involves a system that is used to avoid accidents by calculating the pulse rate of the driver with the help of a Smart Band which alerts the driver if they feel drowsy or are sleeping. Pulse sensors are used in this system to detect the increase in pulse rate. If the recorded pulse rate is more than the threshold value an alert is raised for the driver. Thus the drowsiness caused accidents can be avoided as much as possible if such a system is used.

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