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An Efficient Drowsiness Detection System For Pilot Using Wearable Body Sensor Networks

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ABSTRACT

Driver drowsiness detection is a car safety technology which helps prevent accidents caused by the driver getting drowsy. Various studies have suggested that around 20% of all road accidents are fatigue-related, up to 50% on certain roads. Negative emotional responses are a growing problem among drivers, particularly in countries with heavy traffic, and may lead to serious accidents on the road. The focus of this study was to develop and verify an emotional response-monitoring paradigm for drivers, derived from Respiration signals, photoplethysmography signals, and eye blink signal. The relevant sensors were connected to a microcontroller unit equipped with a ZIGBEE-enabled low energy module, which allows the transmission of those sensor readings to a vehicle. When drowsiness is detected in driver then the driving mode is automatically going to automatic mode for driving using image processing and sent information to the transport department officer using GSM.

Keywords: Negative emotion, Roadway accident, Stress, Wearable system, PPG, ZIGBEE, GSM

I. INTRODUCTION

Driver fatigue is a significant factor in a large number of vehicle accidents. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects. The aim of this project is to develop a prototype drowsiness detection system. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves the observation of eye movements and blink patterns in a sequence of images of a face. Initially we decided to go about detecting patterns using Matlab. The procedure used was the geometric manipulation of intensity levels. The algorithm used was as follows. First we input the facial image using a webcam. Preprocessing was first performed by binarizing the image. The top and sides of the face were detected to narrow down the area where the eyes exist. Using the sides of the face, the center of the face was found which will be used as a reference when computing the left and right eyes. Moving down from the top of the face, horizontal averages of the face area were calculated. Large changes in the averages were used to define the eye area.

1.1 Drowsiness

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Drowsy means sleepy and having low energy. Drowsiness is position of near to sleep, a strong desire for sleep. Drowsiness refers to being unable to keep your eyes open, or feeling sleepy or tired. Drowsiness, also called excess sleepiness. Drowsiness may lead to forgetfulness or falling asleep at inappropriate times. It can be accompanied by weakness, lethargy, and lack of mental alertness. Depression, sorrow and stress are also associated with compromised sleep. Now drowsiness of person driving vehicle is very important.

1.2 Driver Fatigue and Road Accidents

Driver fatigue sometimes results in road accidents every year. It is not easy to estimate the exact amount of sleep related accidents but research presents that driver fatigue may be a contributing reason in up to 20% in road accidents. These types of accidents are about 50% more expected to result in death or serious hurt. Drowsiness reduces response time which is a serious element of secure driving. It also reduces alertness, vigilance, and concentration so that the capacity to perform attention-based activities i.e. driving is impaired. The speed at which information is processed is also reduced by drowsiness. The quality of decision-making may also be affected. It is clear that drivers are aware when they are feeling sleepy, and so make a conscious decision about whether to continue driving or to stop for a rest. It may be that those who persist in driving underestimate the risk of actually falling asleep while driving. Or it may be that some drivers choose to ignore the risks in the way drivers drink. Crashes caused by tired drivers are most likely to happen on long journeys on monotonous roads, such as motorways, between 2pm and 4pm especially after taking an alcoholic drink, between 2am and 6am, after having less sleep than normal, after drinking alcohol, it driver takes medicines that cause drowsiness and after long working hours or on journeys home after long shifts, especially night shifts.

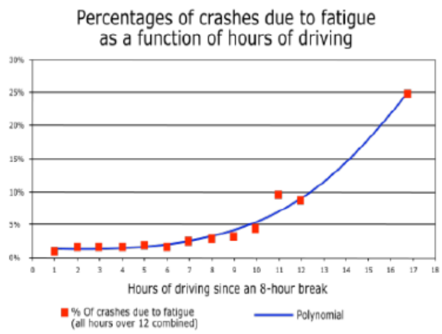


Figure 1.1. Graph between number of hours driven and % of crashes due to drowsy.

Tiredness and fatigue can often affect a person's driving ability long before he/she even notices that he/she is getting tired. Fatigue related crashes are often more severe than others because driver's reaction times are delayed or the drivers have failed to make any manoeuvres to avoid a crash. The number of hours spent driving has a strong correlation to the number of fatigue related accidents.

II. MEASURES FOR DETECTION OF DROWSINESS

The study states that the reason for a mishap can be categorized as one of the accompanying primary classes: (1) human, (2) vehicular, and (3) surrounding factor. The driver's error represented 91% of the accidents. The other two classes of causative elements were referred to as 4% for the type of vehicle used and 5% for surrounding factors. Several measures are available for the measurement of drowsiness which includes the following:

1.Vehicle based measures.

2.Physiological measures.

1. Vehicle based measures. Vehicle-based measures survey path position, which monitors the vehicle's position as it identifies with path markings, to determine driver weakness, and accumulate steering wheel movement information to characterize the fatigue from low level to high level. In many research project, researchers have used this method to detect fatigue, highlighting the continuous nature of this non-intrusive and cost-effective monitoring technique. This is done by:

1.Sudden deviation of vehicle from lane position.
2.Sudden movement of steering wheels.
3.Pressure on acceleration paddles. For each measures threshold values are decided which when crossed indicated that driver is drowsy.

Advantages:

1. It is non invasive in nature.
2. Provides almost accurate result.

Disadvantages:

1. Vehicle based measures mostly affected by the geometry of road which sometimes unnecessarily activates the alarming system.
2. The driving style of the current driver needs to be learned and modeled for the system to be efficient.
3. The condition like micro sleeping which mostly happens in straight highways cannot be detected.

2. Physiological measures. Physiological measures are the objective measures of the physical changes that occur in our body because of fatigue. These physiological changes can be simply measure by their respective instruments as follows:

- ✓ ECG (electro cardiogram)
- ✓ EMG (electro myo gram)
- ✓ EOG (electro occulo gram)
- ✓ EEG (electro encephalo gram)

Monitoring Heart Rate: An ECG sensor can be installed in the steering wheel of a car to monitor a driver's pulse, which gives a sign of the driver's level of fatigue indirectly giving the state of drowsiness. Additionally the ECG sensor can be introduced in the back of the seat.

Monitoring Brain Waves: Special caps embedded with electrodes measures the brain waves to identify fatigue in drivers and report results in real time. Then each brain waves can be classified accordingly to identify drowsiness. **Monitoring muscle fatigue:** As muscle fatigue is directly related to drowsiness. We know during fatigue the pressure on the steering wheel reduces and response of several muscle drastically reduces hence it can be measured by installation of pressure sensors at steering wheel or by measuring the muscle response with applied stimuli to detect the fatigue.

Monitoring eye movements: Invasive measurement of eye movement and eye closure can be done by using electro occulogram but it will be very uncomfortable for the driver to deal with. Though this method gives the most accurate results regarding drowsiness. But it requires placement of several electrodes to be placed on head, chest and face which is not at all a convenient and annoying for a driver. Also they need to be very carefully placed on respective places for perfect result.

3. Behavioral measures. Certain behavioral changes take place during drowsing like

1. Yawning
2. Amount of eye closure
3. Eye blinking
4. Head position

III. LITERATURE SURVEY

Yuichi Saito, Makoto Itoh, Toshiyuki Inagaki have described an assistance system which effectively prevents sleep related accidents. They presented a multilayered assistance with dual control scheme which can help in reducing sleep related accidents. This assistance system interacts with driver to determine driver's state in a multilayered way. They used driving simulator which was equipped with assistance system for investigating the effectiveness of finding out drowsiness of driver and avoiding accidents due to lane departure.

D. Tran, E. Tadesse and W. Sheng, Y. Sun, M. Liu and S. Zhang, "A Driver Assistance Framework Based on Driver Drowsiness Detection Proposed the designing of a driver assistance framework which allowed switching between manual and autonomous driving on a simulated testbed. They proposed a framework for monitoring driver's state. If a driver is non-drowsy then he/she can manually control the simulated car. Otherwise it is run along the predefined trajectory by switching to autonomous driving.

A. Mittal, K. Kumar, S. Dhamija, M. Kaur Presented a survey which includes the techniques for detecting driver drowsiness by monitoring the driving pattern. A number of measures like subjective, physiological, behavioral and vehicular were used in this model. Among various behavioral measures the most precise and effective is head movement measure. Aleksander, Oge and Borko Alesandar, Oge Marques and BorkoFurht Discussed the process of designing and implementing driver drowsiness detection system by combining off-the-shelf the algorithm with some suitable approaches. The system is dynamic, user specific. The models created are totally based on driver's current features.

Anjali.K, Athiramol.K Thampi, AthiraVijayaraman, Franiya Francis M, Jeffy James N, Bindhu .K Rajan Proposed a driver alertness detection system depending on fatigue detection at the given instant. They used image processing algorithms to identify the position of eyes. They obtained visual cues by observing rate using camera which characterize the alertness level of a driver.

J. Ahmed, Jain–Ping Li, S. Ahmed Khan, R. Ahmed Shaikh Illustrated the process of locating the eyes of a person to decide whether they are open or not. The system utilized the data which is in binary form obtained for the image to locate driver's face and eyes. They developed an unobstructive driver drowsiness detection system to concentrate on eyes of driver.

A. Rahman, M. Sirshar, A. Khan Proposed an algorithm to monitor which uses eye feature points to determine the state of driver's eyes and activate an alarm if the driver is drowsy. This technique gives correct results when the camera used is of high resolution. They proposed an algorithm which is less complex than the Flares et al algorithm and gives same accuracy.

H. NilaNovita Sari and Yo-Ping Huang presented a two-stage intelligent model which combined the wavelet packet transform (WTD) and functional-link based fuzzy NN (FLFNN) to obtain the level of drowsiness. The proposed model is effective in detection of drowsiness level which can be further by extending the duration of experiments.

IV. EXISTING METHOD

Negative emotional responses are a growing problem among drivers, particularly in countries with heavy traffic and may lead to serious accidents on the road. Measuring stress- and fatigue-induced emotional responses by means of a wireless, wearable system would be useful for potentially averting roadway tragedies. The focus of this study was to develop and verify an emotional response-monitoring paradigm for drivers, derived from electromyography signals of the upper trapezius muscle, photoplethysmography signals of the earlobe, as well as inertial motion sensing of the head movement. The relevant sensors were connected to a microcontroller unit equipped with a Bluetooth-enabled low energy module, which allows the transmission of those sensor readings to a mobile device in real time. A mobile device application was then used to extract the data from the sensors and to determine the driver's current emotion status, via a trained support vector machine (SVM). The emotional response paradigm, tested in ten subjects, consisted of 10 min baseline, 5 min pre stimulus, and 5min post stimulus measurements. Emotional responses were categorized into three classes: relaxed, stressed, and fatigued. The analysis integrated a total of 36 features to train the SVM model, and the final stimulus results revealed a high accuracy rate (99.52%). The proposed wearable system could be applied to an intelligent driver's safety alert system, to use those emotional responses to prevent accidents affecting themselves and/or other innocent victims.

Disadvantages:

1. High power consumption.
2. Complexity is very more.
3. Accuracy is low.
4. Replacement of device is difficult.
5. Components are costly.

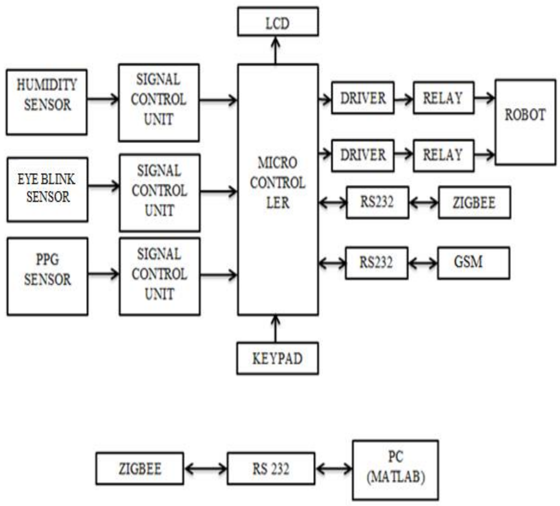
V. PROPOSED METHOD

The proposed system also indicates the driver's fatigue level, using humidity, eye blink and photoplethysmography (PPG) signals collected from an in-door driving simulation as its training set. The PPG signal system is a non-invasive optical technique that measures changes in skin blood volume and perfusion. It contains components that are synchronous with respiratory and cardiac rhythms. The focus and objective of this study was to develop a reliable, well-controlled and non-intrusive drowsiness monitoring system that comprises the following aspects:

1) Fusion of attributes or data that are obtained from sensory data to derive an accurate drowsiness prediction;
2) Implementation of a multi-functional monitoring system and predict from drowsiness detection.
3) When the drowsiness is detected in driver the driving mode is automatically going to automatic mode for driving using image processing.

This vehicle aims at taking control of certain aspects of their driving, whilst a human driver retains control of others. Autonomous systems are already being used in vehicles today, like cruise control, lane keeping, collision detection, park assists, and even blind spot warnings. Our proposed model is equipped with the features such as lane keeping, lane assist and cruise control. This car provides the driver freedom to engage in other activities while driving. The car can accelerate, brake and steer itself to a limited extent. In a semiautonomous car the driver is expected to actively participate and side by side enjoy peace of mind and feeling of control.

VI. BLOCK DIAGRAM



Figuer 1

Eye blink sensor is used for sense the eye is open or closes. Sensed value from eye blink sensor is given to the SCU then microcontroller. The PPG sensor is used to measure the heart beats of the driver. Similarly the respiration sensor is used to sense the respiration rate respectively. Signal control unit is used for amplify the signal value. The output of the sensors is given to the microcontroller. A microcontroller (or MCU) is a computer on-a-chip used to control any electronic device. The micro controller is programmed already according to our objective. The corresponding measurements are displayed on the LCD display. Keypad is used for control the vehicle such as forward, reverse, left and right, stop. And then entering the mobile number and set the predefined valueWe use 5 keys in keypad for five functions.In PC side MATLAB software is used for image processing technique using image processing toolbox. The received image is processed in PC and then get the information about the image using image processing.RS 232 In telecommunications.Zigbee is a low-power wireless communication device. Zigbee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz. It covers 100 meters from origin.Then the corresponding output is send to the microcontroller using wireless communication (zigbee). The controller receives the PC output then controls the vehicle using relay. Relay is an automatic on/ off switch or electromagnetic switch. It is used for control the vehicle. Driver (transistor) is used for control the relay. When an abnormal condition (drowsiness) is detected then a GSM sent a SMS to a transport department officer mobile number.

Advantages:

1. It detects driver drowsiness
2. Decreasing the road accidents
3. System implemented without using database storage
4. No wires, cameras ,monitor or other devices are to be attached or aimed at the driver
5. Due to the non obstrusive nature of these methods they are more practically applicable.

VII. CONCLUSION

A novel method for detecting drowsiness by making use of easily obtainable PPG signal is proposed. This signals were very much affected by motion artifacts, and wavelet based methods are used for denoising. The peaks are detected with 100% accuracy. Even though there is ambiguity in deciding the point of drowsiness a drowsiness period can be easily identified. The major application of this algorithm will be in workers safety gadgets like a watch or glove which can detect the sleepy worker for overnight working shifts. This can be also employed for drowsy driver detection to prevent accidents on road. In future PPG technique can also be used as a tool for detecting sleep and sleep stages for various medical applications. The respiration and temperature sensor output was linked with microcontroller and SMS facility is also incorporated to notify the corresponding officer. The behavioural and physiological sensors resulted in providing appropriate safety measures for safe driving.

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