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A Survey on IoT Based Smart Alert System for Driver Drowsiness Detection

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A B S T R A C T

More and more vocations today demand long-term focus. Drivers need to pay full attention to the road so they can respond quickly to unexpected incidents. Many road incidents frequently have driver weariness as a primary contributing factor. As a result, methods that can identify and alert a motorist to their poor psychophysical condition as needed, which might greatly minimize the occurrence of incidents involving exhaustion. However, there are numerous challenges in the development of such systems that are related to the quick and accurate identification of a driver's fatigue symptoms. The deployment of a vision-based method is one among many of the technical options for enacting driver drowsiness detection systems. The systems used to detect driver drowsiness are discussed in this article. By assessing the driver's vision system, we can here identify tiredness. The IoT module sends a warning message together with collision impact and location information when the driver's weariness is recognized, notifying by voice speaking over the monitoring system.

Keywords: Drowsiness Detection System, Node MCU, Crash Sensor, GPS Module, Facial Landmark Algorithm, Eye Aspect Ratio (EAR), OpenCV, Dlib.

1. Introduction

Numerous accidents have been caused by tired drivers, tiresome road conditions, and unfavorable weather conditions. The National Highway Traffic Safety Administration (NHTSA) and World Health Organization (WHO) estimate that 1.35 million individuals worldwide lose their lives in car accidents each year. In general, poor driving practices are the main cause of traffic accidents. These scenarios occur when a driver is intoxicated or sleepy. The maximum type of fatal accidents has driver fatigue as a major contributing element.

Drivers lose control of their vehicles when they nod off. Using cutting-edge technology, smart or intelligent vehicle systems must be designed. The method used in this project warns the driver if he is falling asleep or daydreaming. In a behavioral-based approach, a webcam tracks the driver's eye blinking, eye closure, facial detection, head posture, etc. using a face landmark algorithm and Euclidean distance. These traits make it easier to detect driver fatigue, inform him right away by voice speaker, and send an alert to the vehicle owner who can awake him. IoT modules, which rely on wireless transmission, are used to send alerts to their destinations.

However, the proposed system incorporates a credit card-sized computer known as Node MCU and a webcam that can track eye movements in order to monitor the intensity of collision effects that occur at the time of an accident and notify owners or emergency departments that are close to the accident site along with GPS location of the accident.

2. Literature Review

2.1 Driver Fatigue Detection System.

The strategy for spotting the early warning indicators of weariness or drowsiness while driving is presented in this study. It is feasible to identify the decrease of attention before the driver nods off by analysing a few biological and environmental characteristics. The system will assess if the person is qualified to drive because of this study. The driver's level of fatigue can be inferred indirectly using heart rate variability (HRV), steering-wheel grip pressure, and temperature differences between the inside and outside of the car. A hardware device has been designed to collect and process these variables, and an algorithm has been created to find beats and compute the HRV while accounting for the other previously mentioned factors.

2.2 Driver Monitoring Based on Low-Cost 3-D Sensors.

In this paper, a method for driver monitoring and event detection based on 3-D data from a range camera was given. To estimate head posture and identify regions-of-interest (ROI), the system utilized 2-D and 3-D approaches. The 3-D point cloud from the sensor was collected, and after examining the 2-D projection, the points belonging to the head were identified and removed for additional examination. Later, the iterative nearest points approach was used to estimate head position estimation with three degrees of freedom (Euler angles). Eventually, pertinent areas of the face were located and used for additional research, such as behaviour analysis and event detection. A 3-D driver monitoring system based on inexpensive sensors was the end product. It was a useful tool for studies on human factors since it enabled the automatic analysis of certain variables and the identification of unique driver-related occurrences, such as sleepiness, inattention, or head posture.

2.3 Fundamental Concepts of Driver Drowsiness Detection.

According to the authors of this publication, the biggest difficulty with modern technology is to rapidly identify the driver's tiredness; otherwise, a dangerous road collision is always a possibility. As a result, establishing a new method to cope with such an unfortunate catastrophe and its aftermath becomes necessary. The goal of this research is to create a pattern for a sleepiness recognition system that aids in the widespread prevention of traffic accidents.

The technology measures the driver's level of weariness while they are operating the car. It uses online and in-vehicle categorisation systems. Many bio-behavioural characteristics, including the face, eyes, heart, reaction time in the head, etc., are employed in categories, and information is recorded and exploited. Many researchers today have created driving assistance systems that can gauge a motorist's level of weariness. To discover the driver's inattention, a variety of methodologies are applied, with the major focus being on the driver's level of weariness.

2.4 Driver drowsiness recognition based on computer vision technology.

This research presents an eye tracking and image processing-based non-intrusive sleepiness identification approach. To solve the issues brought on by variations in lighting and driver location, an eye-tracking/detection technique is presented. Calculated metrics include the percentage of closed eyelids, longest time closed, frequency of blinking, level of average eye opening, speed of eye opening, and speed of eye closing. Fisher's linear discriminated functions were used to integrate these measurements in order to lessen correlations and derive an independent index. Findings with six people in driving simulator tests showed the viability of this technology for detecting tiredness based on videos, which had an accuracy rate of 86%.

2.5 Development of a Drowsiness Warning System based on the Fuzzy Logic.

In this paper, the authors stress on the fact that driving assistance systems, including automotive navigation systems, are becoming more popular in modern times and help drivers in a variety of ways. The ability to gauge the driver's level of consciousness is crucial for driving support systems. In particular, drowsy driving collisions may be avoided if drivers' tiredness was detected. In this research, we discuss a system and a technique for detecting driver drowsiness that makes use of fuzzy logic and image processing.

2.6 New Automotive Electronics Technologies.

Nowadays, a growing variety of professions demand long-term focus. Drivers need to be aware of the road so they can react quickly to unforeseen events. Certain auto incidents frequently have driver fatigue as the immediate cause. In order to reduce the number of accidents involving fatigue, it is necessary to develop the frameworks that will recognise and alert drivers to their terrible psychophysical conditions. Yet, there are many obstacles to the development of such frameworks that are related to the prompt and suitable identification of a driver's weakening effects. Adapting the vision-based approach is one of the technical options for implementing driver sleepiness detection systems. The systems used to detect driver drowsiness are discussed in this article. By assessing the driver's vision system, we can here identify tiredness.

2.7 Review of on-road driver fatigue monitoring devices.

We are becoming more and more aware that driving while fatigued may be a factor in a sizable number of crashes on NSW roadways. According to current statistics, fatigue is thought to be a significant contributing factor in about 20% of fatal fatalities on NSW roads, but experts agree that this figure likely underestimates the impact of fatigue because many accidents with other causes may also have fatigue as a contributing element. The creation of tiredness detection tools has gained popularity over the past ten years, and some automakers are now integrating tools in their vehicles that are promoted as fatigue warning systems (e.g., Citroen). A variety of methods are being used to combat the issue of fatigue detection. This paper provides a concise summary of the research on tiredness monitoring systems and discusses their potential utility in reducing driver weariness.

2.8 Eye tracking based driver fatigue monitoring and warning system.

The major goal of this research is to create a non-intrusive system that can recognise driver weariness and deliver a prompt warning. Because driver fatigue is a major factor in many traffic incidents. As a result, this approach will help avoid numerous accidents, which will save money and lessen personal suffering. With the help of a camera, this system will keep track on the driver's eyes, and by creating an algorithm, we can identify signs of driver drowsiness early enough to prevent accidents. So, this project will be useful in anticipating driver fatigue and will provide warning output information by sound and seat belt vibration, whose frequency will range from 100 to 300 Hzs. Additionally, if the driver is feeling sleepy, there is a chance of sudden acceleration or deceleration. We can determine this by plotting a time-domain graph, and when all three input variables indicate that the driver may be feeling tired at once, a warning signal is displayed in the form of text or a red circle. This will immediately indicate drowsiness or exhaustion, which can then be used as a record of the driver's performance.

2.9 Facial landmarks, real-time detection with dlib, OpenCV, and Python; Detect eyes and other facial features & Eye blink detection.

This paper presents a blink detector implementation utilising OpenCV, Python, and dlib. To locate the eyes in a particular frame from a video stream, facial landmark detection is the first stage in creating a blink detector. After we know the face landmarks for both eyes, we can compute the eye aspect ratio for each eye, which provides us a single value that connects the vertical and horizontal landmark distances for the eyes. Once we know the eye aspect ratio, we can threshold it to see if someone is blinking. The eye aspect ratio will be roughly constant when the eyes are open, quickly decrease during a blink, then rise again when the eye opens.

2.10 Real time sleep/drowsiness detection.

The major goal of this research is to create a non-intrusive system that can recognise human weariness and send an alert when it occurs. Long-distance drivers who do not take frequent rests have a greater risk of becoming sleepy, a condition that they frequently fail to identify in time. According to the expert's studies, drowsy driving causes more traffic accidents than drunk driving, with almost one-fourth of all serious motorway accidents being caused by sleepy drivers who need to rest. The technology will use a camera to track the driver's eyes, and by creating an algorithm, we can identify signs of driver fatigue early enough to prevent the individual from falling asleep. So, this project will aid in anticipating driver weariness and provide warning output in the form of alert and pop-ups. Additionally, rather than being turned off automatically, the warning will be turned off manually. To accomplish this, a deactivation dialogue will be created, which will include a few straightforward mathematical operations that, when correctly completed, will turn off the alert. Also, if the driver is sleepy, it is possible that they will respond to the dialogue incorrectly. By creating a time-domain graph, we can evaluate this. A Warning signal is issued in the form of text and sound if all three input variables point to the likelihood of weariness simultaneously. This will immediately indicate drowsiness or exhaustion and serve as a record of the driver's performance.

2.11 Driver Alertness Monitoring Using Fusion of Facial Features and Bio-Signals.

One of the main contributing causes of traffic accidents that happen everywhere is driver intoxication. The system described in this research uses two independent techniques—eye movement monitoring and bio-signal processing—to analyse data on fatigue and monitor driver safety. A monitoring system is built into Android-based smartphones, which uses a wireless sensor network to collect sensory data and further process it to determine the driver's current level of driving skill. In order to assess the behaviour of the driver in a way that is more realistically, it is essential that several sensors be combined and timed. A video sensor and a bio-signal sensor have been used to collect the driver's photoplethysmography signal and image, respectively. The framework for evaluating driver weariness is a dynamic Bayesian network. If a certain level of driver weariness is thought to have been reached, a warning alarm is activated. The system's extensive testing proves the usefulness of various aspects, especially when combined with discrete approaches, and their integration makes fatigue detection more accurate and comprehensive.

3. Methodology

3.1.1 Existing Methodology

The existing system uses eye or facial movements, deep learning, Electrocardiography (ECG), Electroencephalography (EEG), or Electrooculogram (EOG), vehicle steering movement, etc. to calculate the driver's level of weariness.

- The various deep learning algorithms are used for face and eye detection to monitor a driver’s drowsiness.
- The EEG technique analyses the state of sleepiness using the brain indicator signal, camera, and sensors that are activated with the help of machine learning method to alert drowsy driver.
- A method to observe drowsiness through signal of Heart Rate Variability (HRV) is obtained using EEG sensors.
- An intrusive method for measuring eyeball movement using EOG technique to construct a fatigue alert system is embedded with an Arduino controller board with K Nearest Neighbors (KNN) classifier to improve the percentage of accuracy.
- Vehicle steering movement technique primarily uses steering input from electric power steering system. Monitoring a driver this way only works as long as a driver actually steers a vehicle actively instead of using an automatic lane-keeping system.

3.1.2 Demerits of Existing System

The main demerits of the existing system are:

- The body sensors are required to measure parameters like heart rate, muscle activity etc in case of physiological measurement, which can make the driver uncomfortable.
- The usage of vehicle-based measurements such as steering movement, lane monitoring system, etc. is highly influenced by the structure of the road, type of vehicle and the driving skill. If driver is not so skilled, then these measurements can lead to ambiguous results.

3.2.1 Proposed Methodology

The image analysis techniques have been greatly accepted and applied. In the proposed method, A Web camera is for taking consecutive facial images of the driver. It then uses program which is written in python code to detect the position of eyes based on the images taken. The algorithm for this system is as shown below:

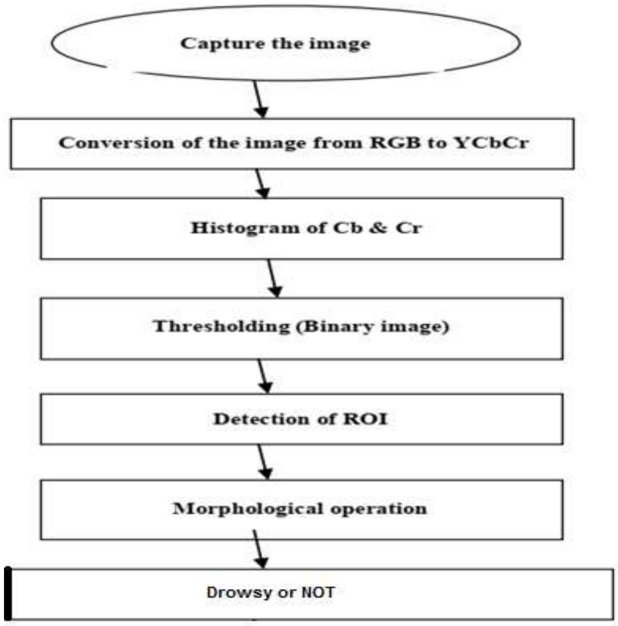

Fig 1: Flow Diagram

3.2.2 Image Processing for the Detection of the Eye

This section explains the various steps involved in the detection of ROI implementing the image processing.

3.2.3 Capturing the Image

An image which taken inside a vehicle includes the driver driver's face. Typically, a camera takes images within the RGB model (Red, Green and Blue). However, the RGB model includes brightness in addition to the colours. When it comes to human's eyes, different brightness for the same colour means different colour. When analysing a human face, RGB model is very sensitive in image brightness. Therefore, to remove the brightness from the images is second step. We use the YCbCr space since it is widely used in video compression standards. Since the skin-tone colour depends on luminance, we nonlinearly transform the YCbCr colour space to make the skin cluster luma-independent. This also enables robust detection of dark and light skin tone colours. The main advantage of converting the image to the YCbCr domain is that influence of luminosity can be removed during our image processing. In the RGB domain, each component of the picture (red, green and blue) has a different brightness. However, in the YCbCr domain all information about the brightness is given by the Y component, since the Cb (blue) and Cr (red) components are independent from the luminosity. The following conversions are used to segment the RGB image into Y, Cb and Cr components:

$Cr=0.439 *R-0.368*G-0.071*B+ 128$

$Cb=0.148*R- 0.291*G- 0.439*B+128$

3.2.4 Binary Image Processing and Segmentation of the Image

The Cb and Cr components give a good indication on whether a pixel is a part of the skin or not is to reject regions in the image that are not faces the next step is to use binary image processing to create clearer delineations in these regions. The algorithm was implemented in Python. Faces can be distinguished by applying maximum and minimum threshold values for both Cb and Cr components. The thresholds that were chosen based on the histograms are as following: 130<=Cr<=155 159<=Cb<=230 Narrowing down these thresholds increases the probability that the accepted pixels are part of the skin. Based on the Cb and Cr thresholding, a resulting black and white "mask" is obtained.

3.2.5 Eye Region Detection

Since we are taking only the face area, we know that the region of interest is the region containing the eyes. We divided the face into four quadrants, the region of eyes will be uppermost two quadrants Since blinking of the eyes usually happen concurrently, we can then assume that the right eye will be positioned at the upper left-hand side of the face. Therefore, calculation will be based on only one eye. By taking these assumptions, the search for the eye will be limited to the area this limited area will make the search more efficient. A computer vision system made with the help of opencv that can automatically detect driver drowsiness in a real-time video stream and then play an alarm if the driver appears to be drowsy.

3.2.6 Algorithm

● We utilized a pre trained frontal face detector from Dlib's library which is based on a modification to the Histogram of Oriented Gradients in combination with Linear SVM for classification.

● The pre-trained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face. The 68 landmark output is shown in the figure below. However, we utilized the 70-landmark model.

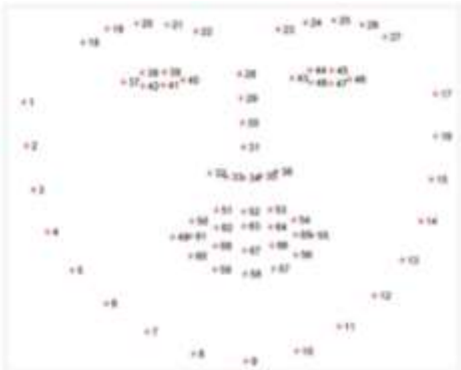

Fig 2: Face Measurements

● We then calculate the aspect ratio to check whether eyes are opened or closed.

● The eye is open if Eye Aspect ratio is greater than threshold. (Around 0.3)

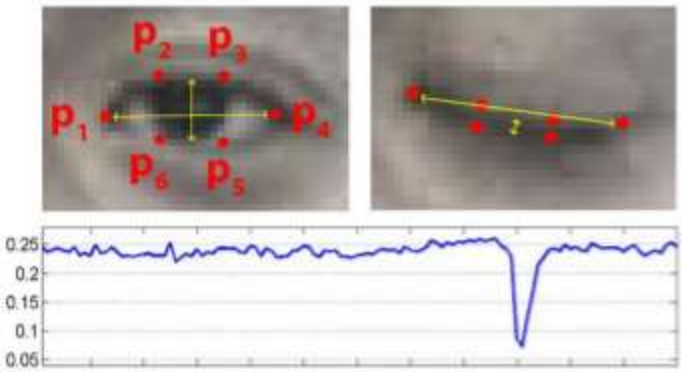

Fig 3: Eye Measurements

- A blink is supposed to last 200-300 milliseconds.
- A drowsy blink would last for 800-900 ms.

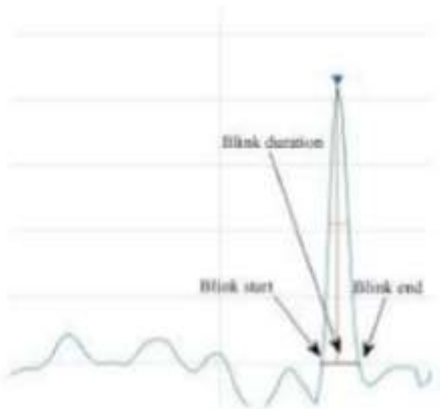

Fig 4: Blink Graph

4. Results

Fig 5: Yawn Alert

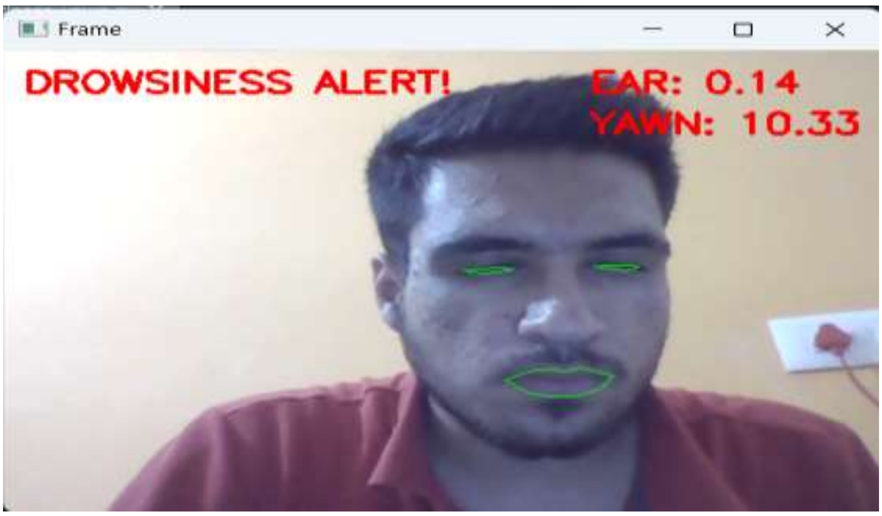

Fig 6: Drowsiness Alert

5. Conclusion and Future Scope

The proposed driver abnormality monitoring system is able to quickly identify drowsy, intoxicated, and hazardous driving behaviours in drivers. The Drowsiness Detection System, which was created based on the driver's eye closure, is able to distinguish between regular eye blinking and tiredness and can identify drowsiness while driving. The proposed system here can halt the mishaps caused by drivers who are feeling sleepy. If the webcam produces better results, the system still functions well even when the driver is wearing eyeglasses and in low light. Many in-house image processing methods are used to gather information about the position of the head and eyes. The monitoring system has the ability to determine whether the eyes of the driver are open or closed. A warning signal is given when the eyes are closed for an extended period of time. Continuous eye closures are used by processing to determine the driver's level of awareness. Additionally, the impact of a collision is measured by the use of sensors and a GPS module to accurately trace the position of the accident and notify a nearby medical facility to provide emergency diagnosis.

The future scope of drowsiness alert systems is that they have the potential to significantly reduce the number of accidents caused by driver fatigue. In the future, these systems are likely to become more advanced and widespread, with the integration of additional sensors and machine learning algorithms to improve their accuracy and reliability. Additionally, there is potential for these systems to be integrated into other modes of transportation, such as trains and airplanes, to improve safety and prevent accidents caused by drowsy operators.

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