Real Time Driver Drowsiness Detection System for Road Safety

Gokulraj A P[1], Senthil Kumar K L[2]

[1]PG Scholar, M.E Industrial Safety Engineering, Department of Mechanical Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode, India
[2]Professor, Department of Mechatronics, Bannari Amman Institute of Technology, Sathyamangalam, Erode, India

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Abstract - *Every year, road accidents caused by human error result in an increasing number of deaths and injuries around the world. Drowsy driving has been identified as a significant cause to vehicle accidents. It was demonstrated that driving performance deteriorates with increased drowsiness with resulting crashes constituting more than 20% of all vehicle accidents. Risky driving behaviours can lead to accidents, which can result in significant financial and moral damages. This paper indicates the driver's drowsiness and prevents them from the fatal accidents. Basically sleeping can be identified from several factors like eye blinking level, yawning, gripping force on the steering, brainwave (EEG) or heartrate (ECG) and so on. This work provides the WEB camera for eye blink and mouth yawn monitoring system and it also gives buzzer to alert the driver during drowsiness and stop the vehicle by applying the brake and clutch with the help of a relay. The system is based on processing the driver's eyes using Raspberry pi 4 by using a WEB camera that is affixed at the dashboard of the vehicle. This system is capable of detecting facial landmarks, we have utilized the face detection process to detect the iris point and mouth to find the threshold by computing the Eye Aspect Ratio (EAR), Eye Closure Ratio (ECR), Mouth Aspect Ratio (MAR) and Mouth Closure Ratio (MCR) to detect driver's drowsiness based on adaptive thresholding. In case the observed threshold is met then the brakes of the vehicle are applied and the driver is woken up.*

Key Words: **Eye blink monitoring system, drowsiness, relay, yawning, Raspberry pi 4, iris point.**

1. INTRODUCTION

According to available statistics, over 1.3 million people die in road accidents each year, while 20 to 50 million people suffer non-fatal injuries. The National Highway Traffic Safety Administration (NHTSA) conservatively estimated that 1,00,000 vehicle crashes occur each year as a result of driver drowsiness, with approximately 1,550 deaths [1]. According to Indian enforcement agents patrolling the motorways and major roads, sleep-deprived drivers are still responsible for roughly 40% of all traffic accidents [3]. According to the National Sleep Foundation of the United States, 54 percent of deaths are caused by adults driving a vehicle while tired, with the remaining 28 percent falling asleep [4].Especially in India drowsy driving is the major problem. And the drowsy driving is the dangerous condition of driving , sleepiness and fatigue. Sleep difficulties, certain types of drugs, and even boredom, such as driving for long periods of time, can cause drowsiness in situations of stress and exhaustion in an unexpected and inconvenient way. The feeling of sleeping lowers one's degree of alertness, resulting in dangerous conditions and an increased risk of an accident [2]. As a result, the following strategies for detecting sleepiness have been widely employed to prevent catastrophic accidents. They were also divided into three groups. Vehicle-based measures were continually monitored, including lane position, steering wheel movement, and acceleration pedal pressure. And the driver's behaviour is measured, such as yawning, eye closure, eye blinking, and head position. Electrocardiogram (ECG), electromyogram (EMG), electrooculogram (EoG), and electroencephalogram (EEG) are among the physiological measurements [1]. In this system the drowsiness of the driver is detected by using behaviour measures by monitoring the condition of eyes and movement of the mouth were determined by using the raspberry pi and USB camera which is used to recognize the drivers drowsiness state based on threshold value. If suppose the driver eyes enclosed for more than 2 seconds the buzzer is activated and it alerts the driver and also if it continued for three times within five minutes then it will stop the vehicle. Hence this project will help in saving the precious life of driver and road accidents will be decreased.

2. METHODOLOGY

This section explains the proposed method for detecting tiredness in drivers, which consists of five steps:

2.1 Capturing

Eye camera is mounted on the dashboard of the vehicle and it will continuously capturing the facial image of the driver.

2.2 Creating a Region of Interest (ROI)

After receiving video input from the camera, we must first convert the image to greyscale, as the OpenCV object detection algorithm requires grey images as input. To detect the faces, all of the colour information is not required. It generates an array of detections with x, y coordinates and height, which is the width of the face.

2.3 Detection of eyes and mouth

The procedure for detecting eyes and mouths is the same as for detecting the face. First, we set the cascade classifier for each eyes and mouth to extract the eyes and mouth boundary box, and then we can extract the eyes and mouth image from the frame.

2.4 Classification

In this step, the extracted boundary of the eyes and mouth are feeded into the classifier. Then the classifier will categorize whether eyes and mouth are open or closed.

2.5 Calculation

Finally, the algorithm determines whether or not the person is sleepy by calculating a score. The score is essentially a number that will be used to determine how long the individual has remained closed-eyed. The automobile will be halted and the driver will be warned if the score exceeds the threshold. The experiment's process flow is depicted in Figure 1.

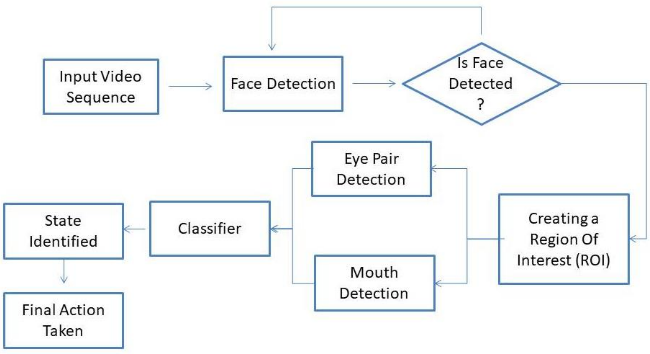

Fig -1: Flow diagram of the proposed algorithm

3. DRIVER FATIGUE AND ROAD SAFETY

Drowsy drivers may be responsible for nearly a third of all fatal car accidents. Many people are unaware that falling asleep at the wheel causes more serious vehicle accidents than drinking. While we have all heard of drunk driving, we haven't heard much about sleepy driving, despite the fact that it's a big health and safety issue. While distracted driving has received a lot of attention lately, sleepy driving continues to be a major cause of car accidents. In addition, drivers between the ages of 16 and 24 are nearly twice as likely to be involved in a sleepy driving accident as drivers between the ages of 40 and 59. Men (52%) are also more likely than women (30%) to admit to falling asleep behind the wheel at some point [12]. Long-distance driving has the difficulty that many individuals are unaware of, or prefer to ignore, how much driving is too much. On prolonged journeys, take a 15-minute rest outside the vehicle every two hours or 160 kilometres. There is no set guideline for how far you should drive at any particular moment, but no destination is worth putting your life in danger to get. Don't put too much pressure on yourself. Determine a safe distance ahead of time and pull over when you reach it.

4. FACIAL LANDMARK MARKING

The Dlib package was imported and utilised to extract driver face landmarks in this proposed study [13]. The package includes a pre-trained face detector that employs a linear SVM (support vector machine) approach to recognise faces and is based on a variation of the directed gradients histogram. The application's face landmarks were then utilised to measure distance between places, and the real facial landmark predictor was built up. The EAR and MAR values were calculated using these distances [14]. Equation 1 was used to calculate EAR, which is defined as the ratio of the eye's height and breadth. The MAR was calculated using equation 2 and is defined as the ratio of the mouth's height and breadth. The numerator represents the eye and mouth height, whereas the denominator represents the breadth of the eye and the mouth a shown in the figure 2.

$$EAR = \frac{||p_2 - p_6|| + ||p_3 - p_5||}{2||p_1 - p_4||} \quad \text{--- (1)}$$

$$MAR = \frac{||q_2 - q_8|| + ||q_4 - q_6||}{2||q_1 - q_5||} \quad \text{--- (2)}$$

(A) (B)

Fig -2: (A) Landmarks of Eye in EAR, (B) Landmarks of Mouth in MAR

EAR and MAR function in the same way. The distance between the upper and lower eyelids is estimated using the numerator of equation 1. The denominator represents the horizontal distance between the eyes. When the eyes are open, the numerator value rises, raising the EAR value; when the eyes are closed, the numerator value falls, lowering the EAR value. EAR readings are employed in this scenario to identify tiredness of the driver. The average of the left and right eyes EAR values is calculated. In our drowsiness detector, the Eye Aspect Ratio is monitored to check whether it falls below the threshold value and does not rise over it in the next frame. As shown by the aforementioned event, the person has closed his or her eyes and is sleeping. If the EAR value increases again, however, it indicates that the person has just blinked their eye and is not sleepy. Figure 3 depicts a set of facial landmark points developed using the Dlib tool and used to determine EAR. The facial landmark points for the left eye, right eye and mouth that were employed in the computation are listed in Table 1.

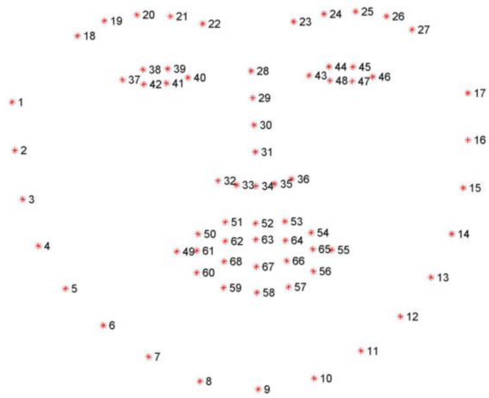

Fig -3: Facial Landmark Points according to Dlib library

Table -1: Facial Landmarks points

Parts	Landmark points
Left eye	[37 – 42]
Right eye	[43 – 48]
Mouth	[49 – 68]

5. CLASSIFICATION

Following the capture of facial landmark points, the Raspberry Pi controller receives the EAR and MAR values computed by the server, which are compared to the threshold value of 0.2(eye) and 0.37(mouth). The counter value is incremented if the value is less than the threshold. else, the counter value is reset to zero. An alert is sounded if the counter value exceeds three. In addition, another variable (Sleep Counter) is kept track of how many times the EAR value falls below the threshold. The variable (Total

Counter) is used to calculate the ECR by storing the total number of responses received from the system (Eye Closure Ratio). The ratio of the Sleep Counter and Total Counter values was determined using equation 3 and is defined as the ratio of the Sleep Counter and Total Counter values. Every 15 successive frames, the ECR value was determined (captured from camera). The total counter value becomes one when the frame number reaches 16, and the sleep counter value becomes zero. A notification is generated in the Raspberry pi display whenever the ECR value exceeds the threshold value of 0.5, indicating that the driver is drowsy and if the ECR exceed four times within three minutes then the control signal is send to the relay circuit to stop the vehicle.

$$ECR = \frac{Sleep\ Counter}{Total\ Counter} \quad \text{--- (3)}$$

6. EVALUATION OF PERFORMANCE WITH EXPERIMENTAL RESULTS AND DISCUSSION

This section provides an empirical analysis of the acquired results as well as a performance evaluation of the suggested strategy. The system begins by collecting real-time data from the drivers. It then determines the drivers tiredness by calculating the EAR and MAR values based on the video collected by the user and the raspberry pi response. ECR and MCR levels are also used to identify tiredness. When the face detection algorithm determines that the driver is sleepy, it transmits information to the Raspberry Pi through the camera, which activates the buzzer for around 3 seconds to alert the driver and the raspberry pi display will also show the alert message on the screen which is shown in the figures 4,5,6 and 7. The system will also applies brakes with the use of a relay if the driver was not respond to the buzzer for a certain period of time so that the motor can be set to forward or backward bias to work in both clockwise and anticlockwise directions with 20% efficiency for roughly 7 seconds to reduce the vehicle's speed.

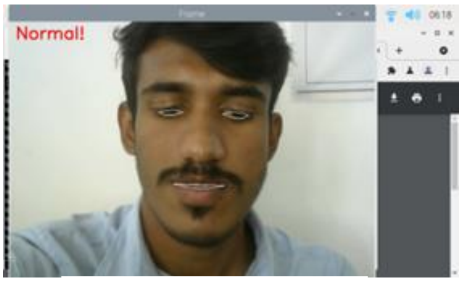

Fig - 4: Normal state

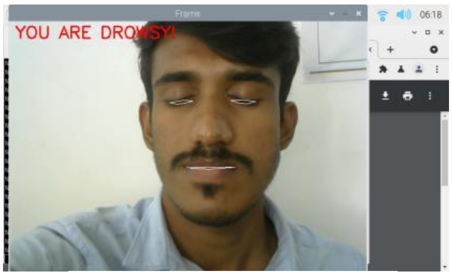

Fig - 5: Drowsiness state

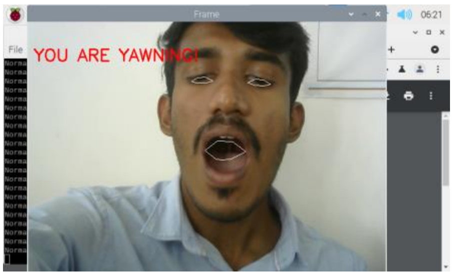

Fig – 6: Yawning state

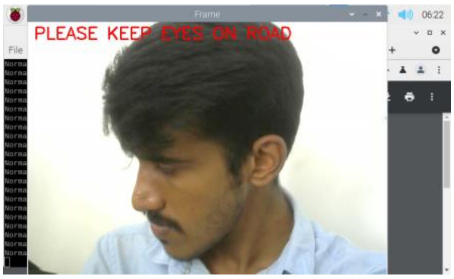

Fig – 7: Distracted state

7. RESULT AND DISCUSSION

We used the EAR (Eye Aspect Ratio) and MAR (Mouth Aspect Ratio) and proposed a method for calculating the ECR (Eye Closure Ratio) and MCR (Mouth Closure Ratio). When compared to previous approaches in the literature, our suggested algorithm improves accuracy and minimizes the time it takes to compute the values in the Raspberry Pi, resulting in superior consciousness outcomes as soon as the driver feels tired. Other invasive methods, on the other hand, necessitated the attachment of a variety of equipment and gadgets to the driver's body, making it impossible for the driver to focus on his driving. Furthermore, with earlier techniques, the driver had to do a setup every time before the ride began. However, the cost of measuring pulse rate, heartbeats, and other bodily functions is high with these intrusive methods. Here a Raspberry Pi 4 and a WEBCAM are used to detect sleepiness, eliminating the expenditures of machinery and disruptions in the driver's focus. And the suggested algorithm performed admirably under favourable lighting circumstances. It also works for individuals who wear glasses and the hardware attachment was also more cost efficient and easily replaceable as shown in the figure 8.

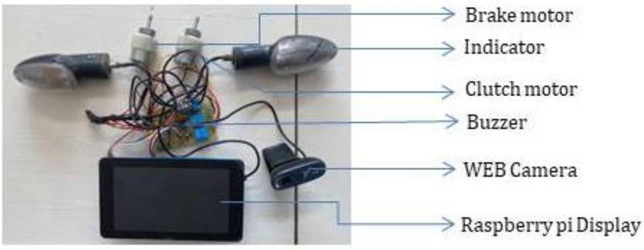

Fig – 8: Proposed Hardware system

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8. CONCLUSIONS

The goal of this project is to create a real-time system that monitors and detects the driver's sleepiness, alerts the driver with an alarm, and applies the brakes to stop the vehicle. Non-invasive tactics were favoured over intrusive ones to minimize the driver from being distracted by the sensors linked to driver's body when compared to other systems. When drivers are used to severe workloads and driving for long periods of time, this method works well. This is the most effective strategy to avert accidents and save people's lives. The technology will be able to determine if the eyes and lips are open or closed while monitoring. A warning signal in the form of a buzzer will be delivered when the eyes are closed for an extended period of time and the mouth is kept opened for an extended period of time. At the same time, when the driver is distracted by some external diversion this system will alert them to keep their eye on road and also if the driver still not responds to the buzzer sound then the clutch and brake are activated to stop the vehicle slowly. Before this the left and right indicator will be switched on to alert the other vehicles before stopping the vehicle.

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