e-ISSN: 2583-4819
Volume-2, Issue-1 (January-April, 2023)

Accident Prevention: Driver's Drowsiness DetectionSystem Using AI Techniques

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Received Date: April 14,2023 *Published Date:*

ABSTRACT

One of the main causes of traffic accidents is driver fatigue and drowsiness. Globally, they are increasing the number of fatalities and injuries each year. In this paper main module focuses on how to recognize tiredness, which will assist to decrease accidents and improve road safety. This system gathers photos from a live webcam feed, applies machine learning to the image, and determines whether or not the driver is sleepy. Many facial expressions and bodily movements, including yawning and sleepy eyes, are seen as indicators of sleepiness. The EAR (Eye Aspect Ratio) measures the ratio of distances between the horizontal and vertical eye landmarks to identify sleepiness. The distance between the lower and upper lips is used to produce a YAWN value for yawn detection, and the result is compared to a threshold value. We have used a play sound library, which will give appropriate voice alert messages when the driver is in a drowsy state. A time limit is applied for driving, if the driver exceeds the time limit then the also system gives the alert message. The proposed system is made to decrease the rate of accidents.

Keywords- Alert, Drowsiness, Drowsy, Eye Aspect Ratio (EAR), MAR, Open CV, Yawn detection

INTRODUCTION

Sleep is an important factor for the well-functioning of every part of your body. It affects our physical as well as mental health. Healthy sleep recharges our minds and keeps us refreshed for the entire day. For a well-functioning brain, enough sleep is needed.

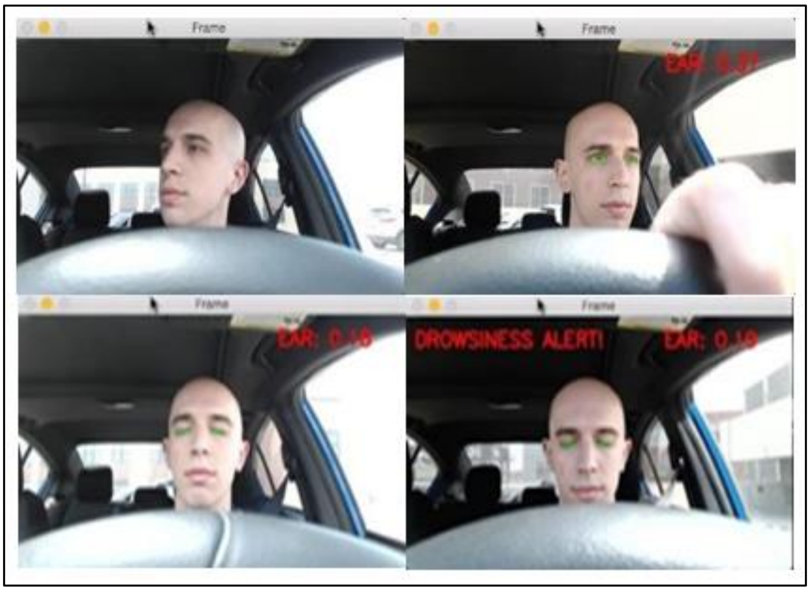

Figure 1: *Driver drowsiness.*

Urbanization has grown significantly over the past ten years, which has caused an exponential rise in the number of automobiles on the road. Due to the increased traffic, there has been a significant increase in traffic accidents, which has led to a record number of transportation-related fatalities. As a result, road safety is one of the most highly focused areas in the field of transport. Speeding, drunk driving, distracted driving, and other risk factors have been identified by the World Health Organization (WHO) as contributing to accidents [1].

While driving a lot of activities need to be performed and their judgment should be perfect. Lack of sleep can affect coordination, and judgment making you less alert and also loss of concentration. Driving for too long without sleep and also drinking alcohol affects your driving ability and makes you drowsy. Drowsy driving significantly leads to accidents. Every year, drowsy driving leads to 100,000 crashes, 71,000 injuries and 1,550 fatalities. Another study revealed that more than 23% of truck drivers are in sleep deprivation. So to avoid accidents due to drowsy driving, drowsiness detection system have been developed. It detects the overall facial expression of the driver i.e., detects eye blinking rate, yawning, and drowsiness and using CNN model and image processing. Assessing overall expression sends an alert message to the driver [2].

RELATED WORKS

Some work has been done on the development of a drowsiness detection system.

In [3] developed a system capable of detecting drowsiness by monitoring the eyes and mouth. Facial landmark detection is used to detect the face. By using shape prediction methods important features of the face are detected. For face detection, they employed Open CV's built-in HAAR cascades. To detect sleepiness, the EAR function computes the ratio of distances between the horizontal and vertical eye landmarks. The e-Speak module is used to notify drivers when they are about to nod off or yawn with the necessary voice notifications. The system's drawback is that the accuracy of the model suffers if the eye frames are not accurately recorded because of any obstructions, such as goggles or spectacles reflection.

The paper [4] implemented a system for drowsiness detection using the dlib library, Open CV library and EAR function. Dlib library contains the pre-trained facial landmark detector, which calculates 68 facial coordinates. These coordinates help to detect overall features of the face like positions of the eyes, eyebrows, nose, mouth, jaw and shape of the head. Draw Contours command extracted from the Open CV library is used to draw eye region data helps to detect the drowsiness level of the driver. The ear function equation used, whenever the value of the EAR function decreases, tells us whether eyes are closed or partially closed as the distance between both vertical axes will be decreased, the person's closing eyes. The alert system used is a vital help in reducing the total number of crashes. This system can detect the drowsiness of the same driver and the triggering of the alarm may vary from person to person.

Multiple Convolutional Neural Networks algorithm for face-tracking. After that, he combined CNN with the KCF algorithm, which gives better performance in a complex environment such as low light. CNN is also used to determine the condition of the eyes. And Dricare was applied to increase its precision. To assess whether an eye is closed, it measures the angle of an opening eye. DriCare measures how long the mouth is open and helps to detect whether the driver is yawning or not. This system measures driver drowsiness level using three different criteria: the blinking frequency, duration of the eyes closing, and yawning. If the result surpasses the threshold, then it alerts the driver [5].

In [6] proposed a technique for detecting sleepiness that makes use of face and eye recognition. For real-time image processing of live video coming from the camera, the author used OpenCV. The open-source Dib library was utilized by the author to implement CNN. To identify facial characteristics, the author uses detectors of previously acquired face shapes and highly tuned prediction algorithms. We employ the EAR function to determine if our eyes are open or closed. The eye is open if its aspect ratio remains constant.

In paper [7] V B Navya Kiran created a non-intrusive technology that can recognize weariness and promptly deliver a warning. Computer vision is the foundation of this system. It makes use of the PERCLOS, Viola Jones, AdaBoost, and CAMSHIFT algorithms. The PERCLOS algorithm aids in detecting

e-ISSN: 2583-4819
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sleepy driving. Eye and facial detection is done through image processing. For face detection, a cascade classifier based on HAAR is utilized. This methodology was discovered to be a reliable and timely method. This system uses a camera to take input, a Raspberry Pi module to interpret it, and a buzzer to warn the driver as shown in Fig.2.

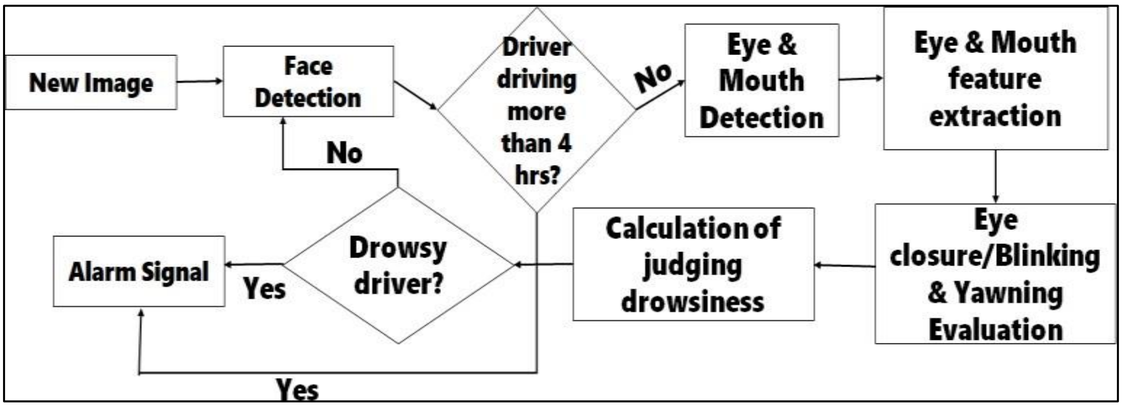

Figure 2: *System flow.*

A system implemented for detecting drowsiness based on vision. This system uses an IR camera and infrared illumination system that works both during the day and at night. First, symmetry is used to perform face detection in digital images. It is then subjected to the white balance algorithm. The SAD (Sum of Absolute Differences) technique is used for tracking. The Hough transform is used to ascertain eye conditions. PERCLOS measurement is used to assess driver conditions [8].

A technique for spotting sleepy drivers was devised. After the video has been recorded, it is sent frame by frame to dlib, which can identify characteristics of the left and right eyes. Then, using OpenCV, outlines were drawn around it. The sum of both eyes' aspect ratio was determined using Scipy's Euclidean function. 0.25 was selected as the basic case, and the driver is alerted if the EAR value falls below it.

PROPOSED SYSTEM

The main motive to develop the system is to detect the drowsiness level of the driver while driving and it should give a proper alert message to the driver. The system should detect the face region and extract the eye region and mouth region from it. It should detect drowsiness levels by monitoring the eyes, especially the blinking rate. The system should give an alert voice when the driver is yawning frequently or eyes are closed for a few seconds. The system must work even if the driver is wearingspectacles.

Firstly, the system detects the face region of the driver using face landmark detection. Then, the timer is set to the system using the Time library. If the driver is driving for more than 4 hrs, then the system will give a voice alert, otherwise, it will start detecting a face. The significant aspects of the face are found using shape predictions. OpenCV's built-in HAAR cascades, which have already been trained, do face detection. Using a facial landmark detector that is pre-trained and part of the dlib library, in the following stage, the location of 68 (x, y)-coordinates that correspond to facial structures are calculated. The EAR is calculated using the ratio of the distances between the horizontal and vertical ocular landmarks for drowsiness detection. The distance between the upper and lower lips will be used to produce a MAR value for yawn detection, and the value will be tested against a threshold value. Play sound library is used to give appropriate voice alert messages when the driver is in a drowsy state [9].

METHODS USED

Open CV

A well-known computer vision library is Open CV (Open Source Computer Vision). Real-time image processing is the main emphasis of the cross-platform library, which also has patent-free versions of the most recent computer vision techniques. It provides you with a framework for working with images and videos as you want, whether using Open CV methods or your own, without having to worry

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about allocating and reallocating RAM for your images. It may also be used for real-time video and image processing. To create this system, the highly efficient HAAR Cascade algorithm of OpenCV was employed for real-time image processing of live video streaming from the camera [10].

DLIB

Dlib is a cutting-edge C toolkit that includes algorithms and machine learning tools for building sophisticated C ++ applications to address real-world issues. It is employed in a broad range of industries and academic settings, including robots, embedded technology, mobile phones, and massively parallel computer systems. You may utilize Lib without charge in any application thanks to its open-source licensing. Using the CNN (Neural Networks) implementation of the free source Dib library. Detecting facial characteristics also makes use of highly tuned prediction methods and detectors of previously learnt face shapes [11].

Face Landmark

To determine the exact location of the 68-(x,y) coordinates (Fig. 2) that correspond to the facial structure of the face, the pre-trained facial landmark detector included inside the dlib package is employed. The key facial features, including the mouth, left eyebrow, right eyebrow, left eye, right eye, nose, and jaw, are represented by these 68-(x,y) coordinates. Only the left eye, right eye, and mouth's (x,y) coordinates are required of these [12].

The denominator of this equation (1) signifies while the numerator calculates the separation between the vertical landmarks of the eye. The denominator is weighted appropriately as there is only one horizontal eye reference point for calculating the distance between them. As the eye is open, the aspect ratio of the eye is essentially constant, but when you blink, it rapidly decreases. The aspect ratio of the eyes substantially decreases when the person blinks. As seen in Fig.3, when EAR abruptly decreases and then increases again, indicating that a single blink has occurred, the condition of the eye is identified.

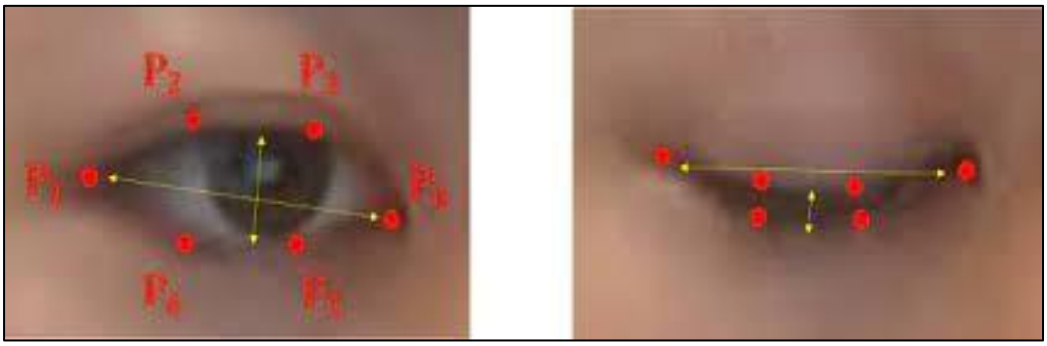

Figure 3: *Open and closed eye landmarks.*

MAR

The mouth aspect ratio is used to detect yawning, using the equation, the calculation (2). The mouth is represented by a set of 20-(x,y) coordinates, as is well known. So, using the same coordinates as the EAR Calculation, we calculated the distance between them using coordinates 62, 64, 66, and 68 shown in Fig. 4.

$$MAR = \frac{||p2-p8||+||p3-p7||+||p4-p6||}{2||p1-p5||} \quad (1)$$

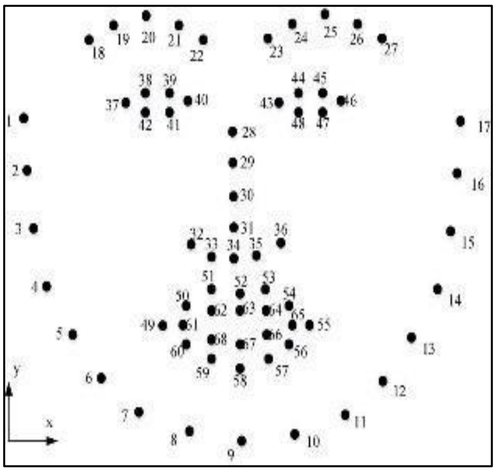

Figure 4: *68 coordinates (Face Landmarks).*

e-ISSN: 2583-4819
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EAR

Based on the facial landmark (in Fig. 1), the driver's face was identified, and the sleepiness level was then calculated. Equation number is used to compute eye aspect ratio (1). Now, each eye is represented by a set of six (x,y) coordinates , with the left corner of the eye (where you would look if you were gazing at the person) as the beginning point and the rest of the area moving clockwise from there [13,14].

To determine whether an employee in a manufacturing facility is yawning, there will be a noticeable difference in the mouth aspect ratio. An increase in mouth aspect ratio causes a rise in "yawn count." This algorithm reported a mouth aspect ratio of 0.20. The operator is yawning if the Euclidean distance calculation yields a ratio greater than 0.20. There will be a count for each time the operator sighs. The programming to specify the condition and cumulative of the yawning operator.

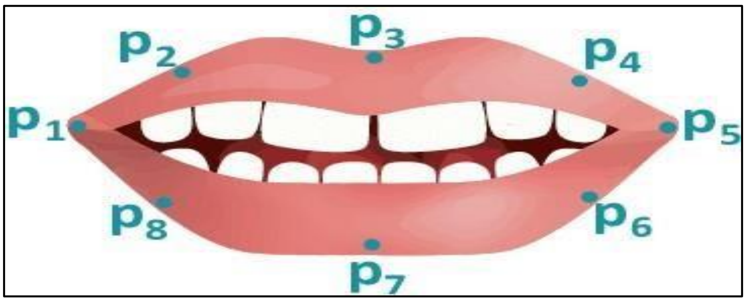

Figure 5: *Mouth landmarks.*

Algorithm Steps

$$EAR = \frac{\|p2 - p6\| + \|p3 - p5\|}{2\|p1 - p4\|} \quad (2)$$

Step 1: Take an image as input from a live webcam.
Step 2: Checking time limit, if exceeds buzzer the alarm otherwise go for face recognition.
Step 3: First create a zone of interest around the face in the picture (ROI).
Step 4: Then send the ROI's region corresponding to the eyes and mouth to the classifier for identification.
Step 5: Calculation of EAR and MAR.
Step 6: Then the classifier compares EAR and MAR with the threshold value.
Step 7: Then the classifier classifies whether the eyes are open or closed as well as detects whether the driver is yawning or not and gives an alert message accordingly.

ANALYSIS AND RESULT

The ability to build an analysis over long periods, that is, to measure the time spent in each condition, is necessary to detect sleepiness from an eye and mouth analysis. This requires knowledge of the eye's state as well as the mouth's state,that is, whether it is open or closed, in time.Consequently, the following tables might be utilized to analyse the sleepy condition. You can use Table 1 to establish if your eyes are closed, wide open, or in a normal state. Similar to Table 2, which is used to assess if the mouthis in a normal state or open (yawning). To identify a sleepy state using the threshold values, Table 3 is crucial. Drowsiness is determined by comparing the EAR & MAR values with temporal variation to respected threshold values.

Table 1: *Threshold values and status of eyes based on EAR.*

Range	Status
< 0.25	Close
0.27-0.30	Normal
>0.32	Wide open eyes

Table 2: *Threshold values and status of mouth based on MAR.*

Range	Status
0-0.0.15	Normal
>0.15	Mouth open

Table 3: *Comparison of threshold values with EAR and MAR.*

EAR < threshold(0.25)	Drowsy (Eyes close)
MAR > threshold(0.20)	Drowsy (Mouth open)

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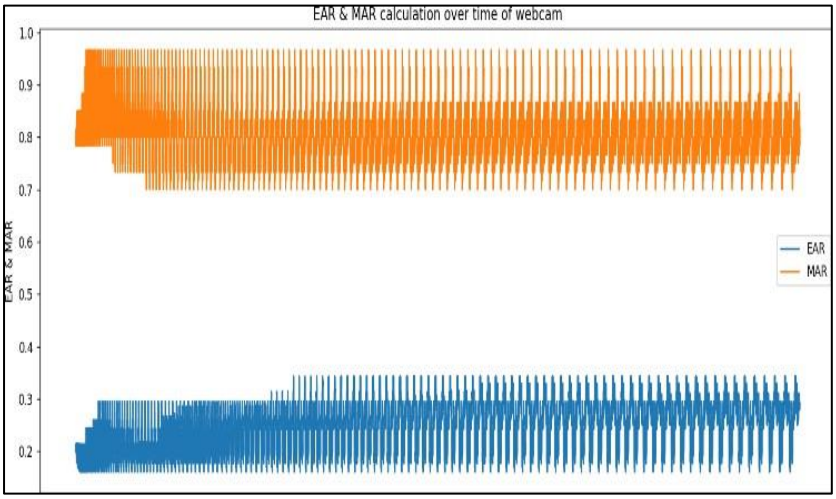

Figure 6: *EAR and MAR graph with time variation.*

Fig. 6 shows the time variation graph with EAR and MAR values.

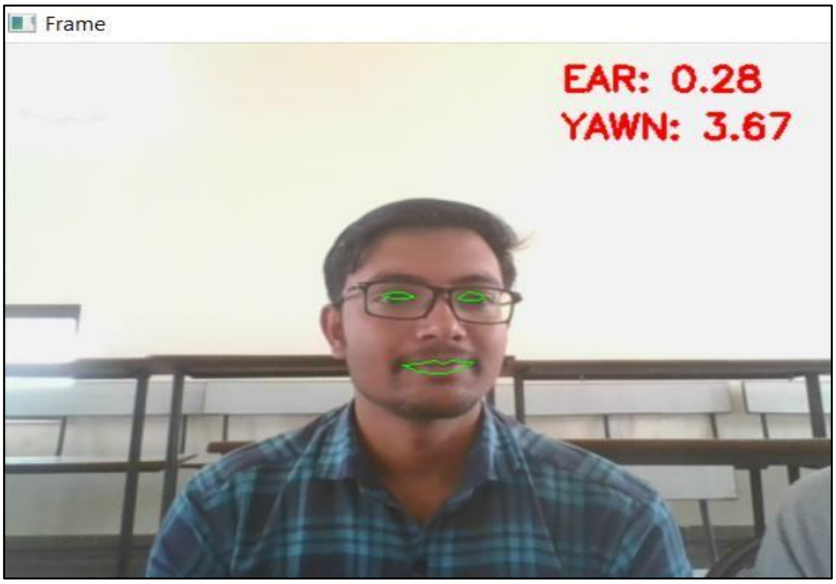

Figure 7: *EYE and mouth extraction.*

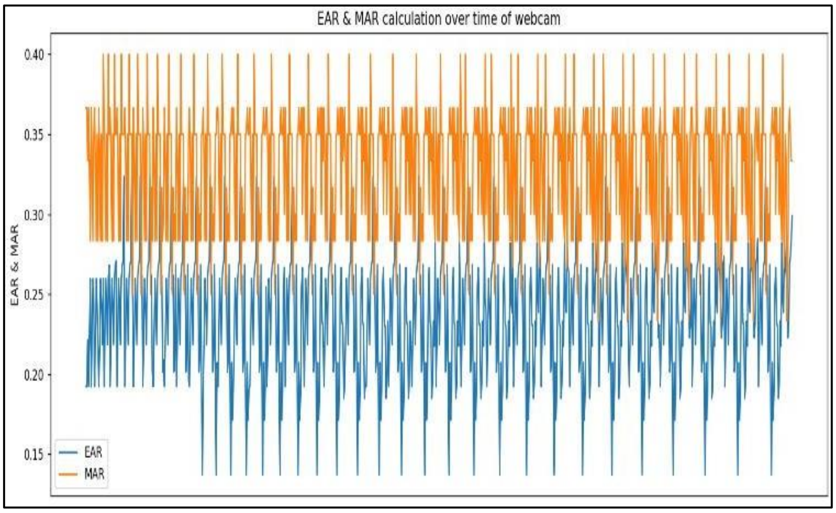

Figure 8: *EAR and MAR for the normal position.*

The method effectively retrieved the eye and mouth region from the driver's face in Fig. 7 and discovered the individual in their natural posture. Fig. 8 depicts the changes in EAR and MAR values over time for the diver's typical position.

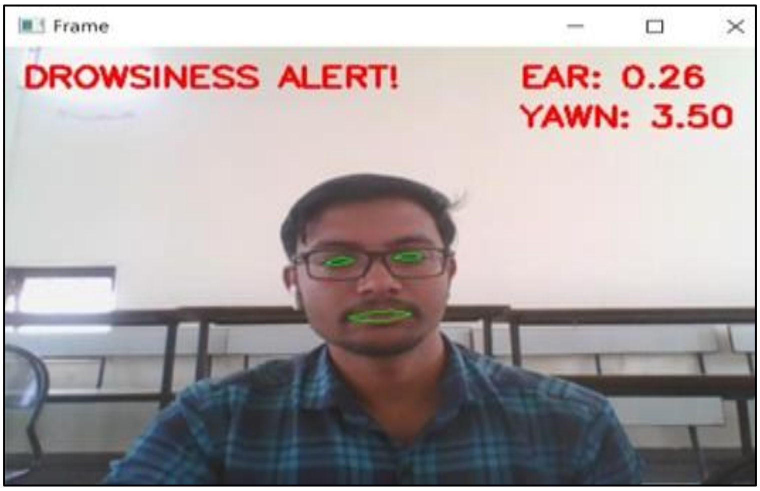

Figure 9: *Drowsiness alert (eye closed).*

Fig. 9 showed that the driver found a drowsy and triggered an alarm, its EAR value is less than the threshold value.

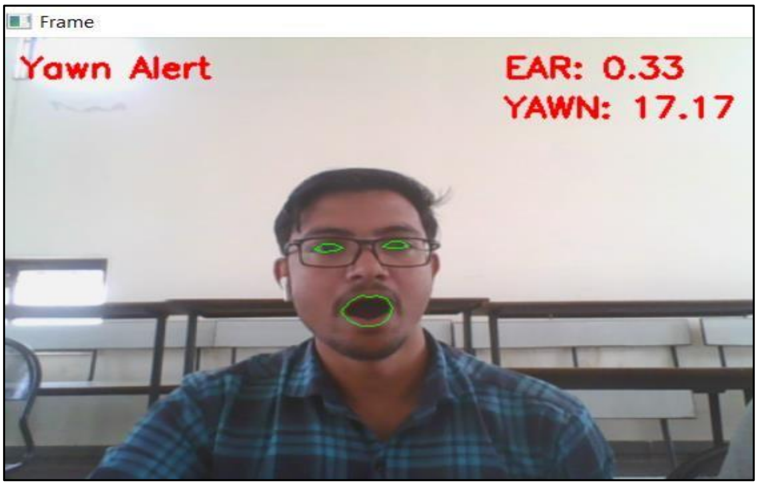

Figure 10: *Drowsiness alert (Yawning).*

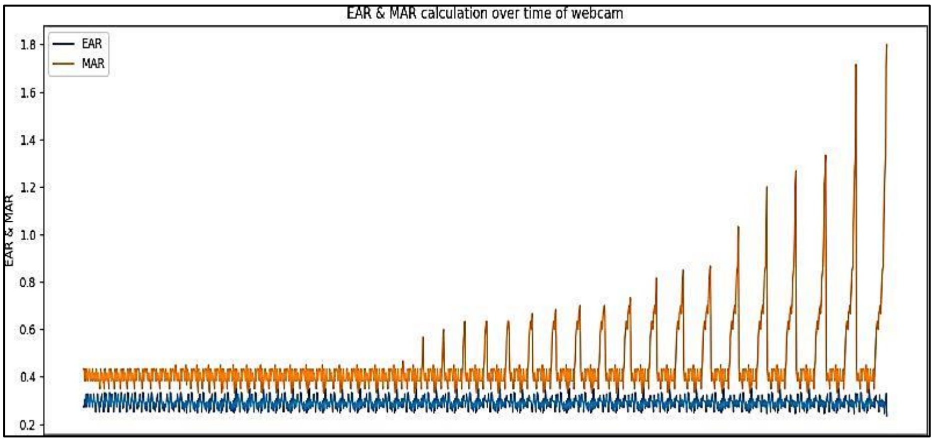

Figure 11: *Constant ear while yawning.*

Driver yawning was observed and an alarm was also triggered, as shown in Fig. 10, and its MAR value was below the threshold. Fig. 11 shows that when the driver is yawning and the MAR value is changing, the EAR value remains constant.

The entire test was conducted on two separate individuals under various environmental situations, such as ambient light, a driver with and without specs, etc. This test was carried out to evaluate the system's precision.

The results of the experiment were impacted by the lighting during testing. Driver A was put through the test in both high and low light. In the intense light, the camera was unable to recognize the driver's face. Due to specifications, it was unable to identify the driver's eye area in bright light for the first time, but in low light, it was able to detect the driver's mouth and eye regions and raised an alarm when the driver was discovered to be sleepy. The same test was performed on Driver B, but this time, the system recognized the driver's mouth and eye regions in both bright and low lighting, with and without glasses, and it also detected whether the driver was feeling sleepy as shown in Table 4.

Table 4: *Result table for different drivers.*

Driver	EAR region	Mouthregion	Light	Drowsiness	Alarm
A	detected	detected	Dim	shown	triggered
A(withglass)	Not detected	detected	Dim	Not shown	Not triggered
A	Not detected	detected	Bright	shown	triggered
A(withglass)	Not detected	Not detected	Bright	Not shown	Not triggered
B	detected	Not detected	Dim	shown	triggered
B(withglass)	detected	detected	Dim	shown	triggered
B	detected	detected	Bright	Not shown	Not triggered
B(withglass)	detected	detected	Bright	shown	triggered

CONCLUSION

The model can identify sleepiness by keeping a watchon the mouth and eyes. Methods for shape prediction are usedto identify significant facial characteristics. These algorithms' inputs are facing landmarks discovered using facial landmark detection. The horizontal to the vertical distance between the ocular landmarks is calculated using the EAR function and MAR function to detect yawning is the subject of this module. Play sound library is used to give appropriate voice alert messages when the driver is drowsy. Also, a time limit is applied for driving; whenever the driver exceeds the system gives an alert message. The goal of the entire initiative is to lower theaccident rate. In addition to working better than cutting-edge techniques, this may be applied to the following situations:

- This system can be used in factories to alert drivers.
- This system can also be used for railway drivers.
- It can be used in Aircraft Also.

This approach does, however, have significant limitations. By concentrating on more features extracted using other feature extraction techniques and using new classification algorithms,the suggested system may potentially be enhanced.

REFERENCES

1. P. Manikandan, V. Muneeswaran, G. Ramesh, et al (2021). Drunk and drive controller for vehicles. *2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)*. IEEE, Available at: https://doi.org/10.1109/ICACITE51222.2021.9404713.
2. M Dua, Shakshi, R Singla, et al (2021). Deep CNN models-based ensemble approach to driver drowsiness detection, *Neural Computing and Applications*, 33(8), 3155-3168, Available at: https://doi.org/10.1007/s00521-020-05209-7.

3. Jiwnani, V., Mathur, T., Ameta, S., Khetpaliya, V., & Kavadia, C. (2022). WARNING SYSTEM FOR DRIVERS TO AVOID ACCIDENTS. *International Journal of Advanced Research in Computer Science*, 13, Available at: https://web.p.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=09765697&AN=158577619&h=vJFu%2bp%2b8uhO9TvVmBqHouflAY2oXt7SH88w5fOQTwwAP%2b2
4. S Mohanty, S V Hegde, S Prasad and J. Manikandan (2019). Design of real-time drowsiness detection system using Dlib. *2019 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE)*. IEEE, Available at: https://doi.org/10.1109/WIECON-ECE48653.2019.9019910.
5. Z Lian, S Shao and C Huang (2020). A real time face tracking system based on multiple information fusion, *Multimedia Tools and Applications*, 79, 16751-16769, Available at: https://doi.org/10.1007/s11042-020-08889-4.
6. Devi, M. S., & Bajaj, P. R. (2008, July). Driver fatigue detection based on eye tracking. In 2008 First International Conference on Emerging Trends in Engineering and Technology (pp. 649-652). IEEE, Available at: https://dl.acm.org/doi/10.1109/ICETET.2008.17
7. V B Navya Kiran, R Raksha, A Rahman, et al (2020). Driver drowsiness detection, *International Journal of Engineering Research & Technology*, 8(15), 33-35, Available at: https://www.ijert.org/research/driver-drowsiness-detection-IJERTCONV8IS15008.pdf.
8. A Balasundaram, S Ashokkumar, D Kothandaraman, et al (2020). Computer vision based fatigue detection using facial parameters. *International Conference on Recent Advancements in Engineering and Management*, (pp. 1-9). IOP Publishing, Available at: https://iopscience.iop.org/article/10.1088/1757-899X/981/2/022005/pdf.
9. A Arafat Miah, M Ahmad and K Zannat Mim (2020). Drowsiness detection using eye-blink pattern and mean eye landmarks' distance. *Proceedings of International Joint Conference on Computational Intelligence*, (pp. 111-121). Springer, Available at: https://link.springer.com/chapter/10.1007/978-981-13-7564-4_10#citeas.
10. M Khan, S Chakraborty, R Astya and S Khepra (2019). Face detection and recognition using OpenCV. *2019 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS)*. IEEE, Available at: https://doi.org/10.1109/ICCCIS48478.2019.8974493.
11. A Squalli Houssaini, M Abdelouahed Sabri, H Qjidaa and A Aarab (2019). Real-time driver's hypovigilance detection using facial landmarks. *2019 International Conference on Wireless Technologies, Embedded and Intelligent Systems (WITS)*. IEEE, Available at: https://doi.org/10.1109/WITS.2019.8723768.
12. Thulasimani, L., & SP, P. (2021). Real time driver drowsiness detection using opencv and facial landmarks. Int. J. of Aquatic Science, 12(2), 4297- 4314, Available at: https://www.semanticscholar.org/paper/Real-Time-Driver-Drowsiness-Detection-using-OpenCV-Thulasimani-Poojeevan/4dec68ec8164f2acbbf7a3243e789f4811759b2e
13. H Garg (2020). Drowsiness detection of a driver using conventional computer vision application. *2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC)*. IEEE, Available at: https://doi.org/10.1109/PARC49193.2020.236556.
14. A Ghourabi, H Ghazouani and W Barhoumi (2020). Driver drowsiness detection based on joint monitoring of yawning, blinking and nodding. *2020 IEEE 16th International Conference on Intelligent Computer Communication and Processing (ICCP)*. IEEE, Available at: https://doi.org/10.1109/ICCP51029.2020.9266160.

CITE THIS ARTICLE

Sagar Jadhav et al.(2023).Accident Prevention: Driver's Drowsiness Detection System Using AI Techniques, Recent Trends in Artificial Intelligence & Its Applications, 2(1), 41-49.