REAL TIME FATIGUE LEVEL MONITORING SYSTEM OF DRIVER USING IMAGE PROCESSING

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Abstract

Accident counts because of Driver’s drowsiness has increased lately in the recent times. A large count of traffic accidents occur due to drivers falling asleep while driving, causing the vehicle to lose control. Early indicators of exhaustion and drowsiness could be noticed before a problem emerges. An immediate method for estimating driver's fatigue is estimating the condition of the driver i.e., his/her drowsiness. To save the driver's life and property, it is critical to recognize drowsiness. Such accidents could be avoided using an automated system that can detect the Fatigue level of driver. This can be made easier by using python implemented in RaspberryPi which will be able to trigger an alert/alarm so the Driver can be alerted before any damage/accident has been caused. The project mainly aims to achieve the highest level of predictable accuracy of a Driver’s fatigue level. The proposed system is highly beneficial in automobile business industry markets.

Keywords: Deep Learning; Drowsiness; Python; RaspberryPi; Image Processing; Fatigue detection; Facial landmark detection; Real time video surveillance.

1. INTRODUCTION

In today's technologically advanced automobiles, the driver's and passengers' safety is paramount. Automobile companies are under a lot of pressure in today's environment to establish a competitive advantage in order to achieve business goals and stay competitive.

This Proposed system can be used in automobile organizations to detect drowsiness of drivers and alert them in prevention of severe damage, to them or their surroundings, hence serving the organizations & their customers an advantage towards safety. The basic and foremost technique used in this detection system is the Deep Learning methods, which is well known as the most suitable method for facial detections. DLIB & OpenCV’s DNN module make the system more user friendly. The suggested system is a real-time system that continuously records images. It uses the openCV and dlib libraries in the Python IDE to measure the status of the eye and mouth according to the defined algorithm.

In this project, the facial spots are utilized to identify the eye closure and yawn detection. The face is marked into 68 co-ordinates. Eye closure is distinguished by assessing the EAR value. At the point when EAR value goes under a specific threshold (0.2) eye closure will be identified. The yawn is recognized by assessing the MAR (Mouth Aspect Ratio) value. At the point when the MAR value goes over the limit (0.5) threshold, yawn will be identified. To differentiate b/w the eye blink and slight sleep, EAR value should be lower than the threshold for specific period which is set as 20 frames. The contrast between eye blink and light sleep can be found by plotting the EAR graph. The model can work when the eye and mouth are found and works in enveloping lighting conditions as well.

The identification of driver fatigue has become a popular study area in recent years. Subjective and objective detection are the two types of detecting methods. A motorist should take part in the subjective detection method's evaluation. Huge amounts of data about the driver are acquired using the objective detection method. These data are used to calculate the drowsiness of drivers, which aids drivers in planning their schedules appropriately.

II. LITERATURE SURVEY

As indicated by ongoing figures, drowsiness related impacts/collisions result about 1,200 deaths and 76,000 wounds each year [5]. In the subject of accident-prevention systems, creating answers for recognizing and avoiding drowsiness is a challenge on a serious note.

There is a discussion on drowsiness systems studies. The results of a routine check of driver collision avoidance systems that monitor the length of eye blinks were provided [1]. This innovation utilizes a webcam mounted straightforwardly before the driver's seat to recognize the blinking of the eyes and matches them to a specific EAR (Eye Aspect Ratio). The investigation in [2] was done to see what variables were connected with sleepiness. data was trained in numerous layers, and the system vigorously depended on mouth arrangement. The development is seen in [3]. The development of a synchronized system for detecting tiredness began. The faces of the drivers along the detecting path were targeted by the image from the video. Predefined procedures were used to identify the targeted points on the face, including eye operations. Random Forest has an 84% success rate with empirical results. Reference [4] inspected how to characterize a driver's alert positions, which are for the most part sleepy, by consolidating vehicle data, responses, and tangible pointers with examination, and afterward executing these recognizable pieces of proof in the acknowledgment framework. The level of sleepiness of the driver was determined by demonstration of drivers physical behaviors. Using a data set, the algorithm accurately predicted drowsy driving acquired over ten seconds. In [5], a mobile driver sleepiness estimation arrangement was used. The electrocardiogram (ECG) was constrained to a specific printed circuit board (PCB) configuration throughout development. The PCB was put in place and a 2-channel solution was used.

An automatic appearance was utilized to detect driver weariness in [6]. To forecast tiredness, a camera followed the driver's eye. Each time the driver fell asleep, he was awoken by a signal. It suggested that one is sleeping after failing twenty frames. A convolutional neural network was used in [7] to detect targeted eyes with next to mouth features. They employed the proportion of the eyes as well as the function of the lips to discover weariness. Reference [8] looked studied variables such uninterrupted driving time, uninterrupted rest, and a sleep before driving to predict driver drowsiness. Through particular indicators of fatigue reactions, the researcher was able to acquire the truth about the driver's attitude through physical engagement.

III. COMPONENTS

HARDWARE REQUIREMENTS:

- Internet connection-Not required
- Operating system-Windows7 or later
- RaspberryPi Board
- Web camera
- Alarm beeper

SOFTWARE REQUIREMENTS:

- Python
- PyCharm
- RaspberryPi Stimulator

IV. METHODOLOGY

Eye closure detection and yawn detection are fully covered by the proposed Fatigue detection model. The project uses the dlib facial landmark detector in an OpenCV context. The driver's face is constantly observed, and frames are collected using a webcam. The OpenCV environment is used to process the collected image. The initial step in detecting drowsiness is to use a webcam to detect the face. The Facial landmark detection concept then detects facial expressions such as eye closure, yawning, speaking, eating, and head posture. The system receives the image captured and processes it. It uses OpenCV to convert the incoming image into a digital signal. Estimating EAR is used to identify eye closure (Eye Aspect Ratio). Drowsiness is confirmed when EAR falls below the threshold value, and the driver is notified. The yawning is found by estimating the Mouth Aspect Ratio (MAR). Yawning is confirmed when the MAR value exceeds the threshold value.

A. Facial Landmarks detection:

Face alignment, head pose estimation, face switching, blink detection, and many other applications use facial landmarks successfully. ROI detection uses an input image to locate important areas of interest along the shape.

Facial landmark detection is a two-step procedure:

Step 1: Determine the location of the face in the image.

Step 2: ROI detection is used to identify the important facial structures on the face.

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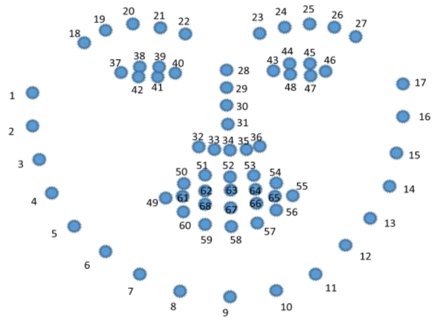

Fig 4.1.1. Visualization of the 68 facial landmark co-ordinates

The facial detection is done in the Python IDE using the dlib python library module and OpenCV. Dlib is a pre-trained library in python that is used to detect facial landmark. Dlib estimates the placement of 68 coordinates (x, y) which map the facial points on a person's face.

B. Eye Closure Detection:

The face is captured continuously with a webcam, and the captured frames are analyzed in an OpenCV environment. Using the dlib facial landmark detector, the face is identified and essential facial features are retrieved. In the frame, the landmark indices for both eye areas are emphasized. The Eye Aspect Ratio (EAR) is calculated in real time and is shown in the frame. The EAR value will be high after the eyes are opened. As the eyes close, the EAR levels decrease. Eye closure is detected when the EAR value falls below a specific threshold. The driver is notified by the alarm when the driver's eyes are closed.

C. Eye Aspect Ratio (EAR):

The aspect ratio of the eye region is referred to as EAR, and it is commonly used to measure the temporal consistency and speed of left and right eye blinks, as well as to detect drowsiness. These coordinates are needed to calculate EAR's value. [36,37,38,39,40,41] Landmark indices for the right eye [42,43,44,45,46,47] Landmark indices for the left eye.

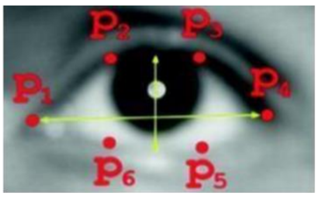

Fig 4.3.1 Landmarks when eyes opened

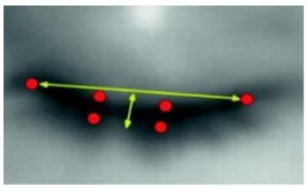

Fig 4.3.2 landmarks when eyes closed

The formula used to calculate the Eye Aspect Ratio (EAR) is given below:

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

As the eyes close, the EAR value decreases.

D. Yawn Detection :

A webcam is used to capture the face, which is then analyzed in the OpenCV environment. The indicators of mouth landmarks are identified and highlighted. The MAR (Mouth Aspect Ratio) is calculated. The MAR value is decreased while the mouth is closed. When the driver yawns, the MAR value rises. Yawning will be identified when the MAR value rises above the threshold value. The driver is triggered by an alarm when the yawning is detected.

E. Mouth Aspect Ratio(MAR):

The Mouth Aspect Ratio is the proportion of the mouth's vertical to horizontal distance. In MAR estimation, 3 vertical distances and 1 horizontal distance are taken into account. When the driver yawns, the vertical distances increase, while the horizontal distance decreases slightly. For a successful detection, the MAR value for a yawning person is considered to be more than 0.43, whereas MAR values less than the threshold are omitted.

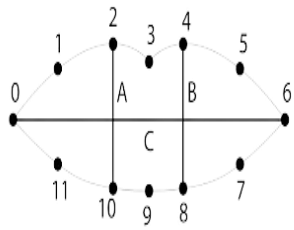

Fig 4.5.1 & Fig 4.5.2. Landmark indices for mouth region

The formula to estimate the Mouth Aspect Ratio (MAR) is given below:

$$MAR = \frac{|CD|+|EF|+|GH|}{3*|AB|}$$

The MAR value will increase upon yawning.

2. SYSTEM DESIGN

2.1. *Facial landmark Detection Design:*

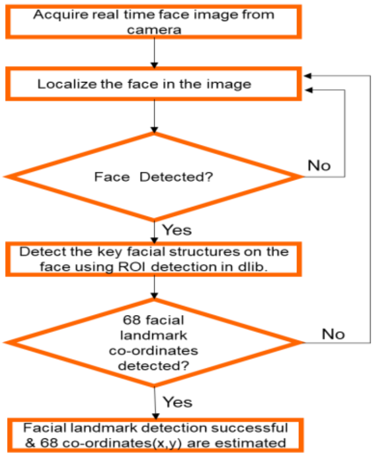

Fig 5.1.1 Process flow of facial landmark detection design

2.2. *Eye Closure Detection Design:*

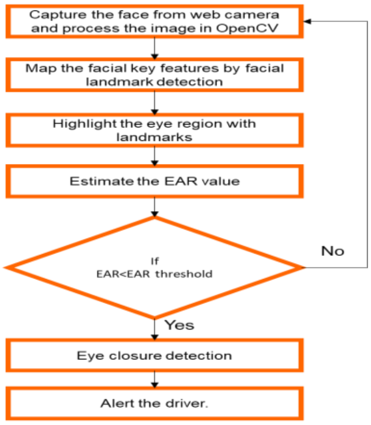

Fig 5.2.1 Process flow of Eye closure detection design.

2.3. *Mouth Closure Detection Design:*

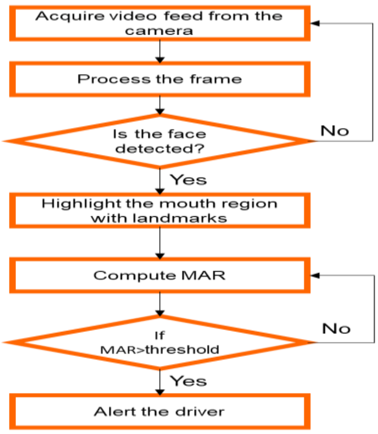

Fig 5.3.1 Process flow of Mouth closure detection design.

3. RESULTS

In comparison with the model in [4] which has better empirical results than the other references, our real time fatigue level monitoring system of driver using image processing gives us an output with up to 94.66% for eye blink prediction and 95.99% for yawn detection, while the real time model predicts an average of 93.5% accuracy. Below mentioned is the empirical results of our real time system.

A. *Facial landmark detection output:*

The proposed work begins with the detection of facial landmarks in the face. To separate the landmark spots from the facial attributes in the face. Figure 6.1.1 depicts the detected output. As illustrated in the figure, the entire face is marked with 68 landmark co-ordinates.

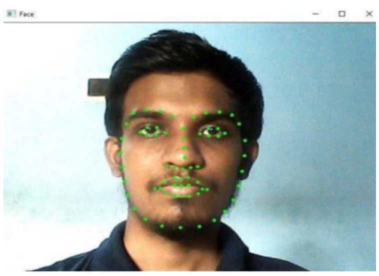

Fig 6.1.1 Facial Landmarks Detection

B. *Eye closure detection outputs:*

When the eyes are opened, the EAR value will be higher, as shown in Fig. 6.2.1. When the eye is closed, the EAR value begins to decrease. The EAR threshold has been set to 0.2. When the EAR is less than 0.2, it is assured that the eyes are closed. It could be an eye blink or a light nap. To prove the driver's drowsiness, the EAR value must fall below the threshold for 20 consecutive frames. The system will trigger an alarm if drowsiness is detected, as shown in Fig. 6.2.2.

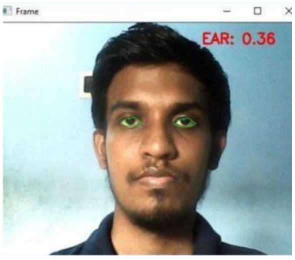

Fig 6.2.1 Output when eyes are open   Fig 6.2.2 Output when eyes are closed

C. *Eye Aspect ratio Response :*

The graph is drawn b/w the frames and the value of EAR at each frame. The plot's response is depicted in Fig 6.3.1. matplot library was used to create the graph. A new list is created, which is empty. In that list, the EAR value for each frame is appended. Finally, the list includes the EAR values for each frame. The graphic depicts the distinction between blink and light sleep. For drowsiness confirmation, the EAR value must remain low for 20 consecutive frames in a row.

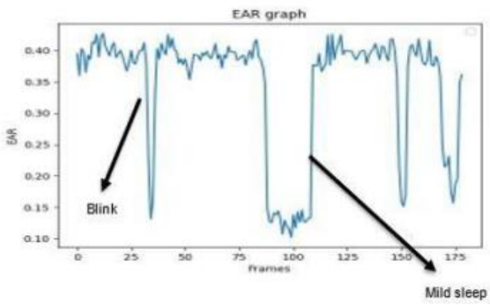

Fig 6.3.1. EAR plot.

D. *Yawn Detection:*

The MAR will result in lesser value when the mouth is closed. Whenever mouth is opened MAR will result in incremented values. The threshold limit of MAR is set to 0.5. At the point when MAR goes over 0.5, yawning is assured, and alarm is sent to the sleepy driver. The results when mouth is closed and opened are displayed in the Fig 6.4.1 and Fig 6.4.2 individually.

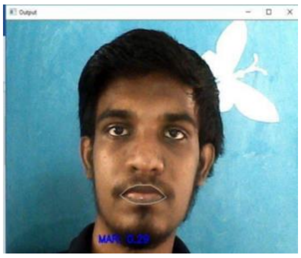

Fig 6.4.1 Output when

mouth is closed

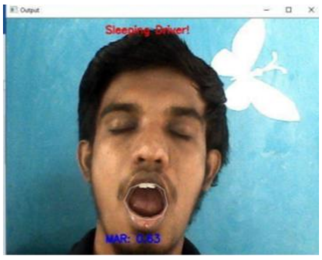

Fig 6.4.2 Output when

mouth is open

E. MAR Response:

A graph with frames and MAR values at each frame is displayed. The graph's response is depicted in Fig. 6.5.1. As seen in Fig, the MAR threshold value is set to 0.5.

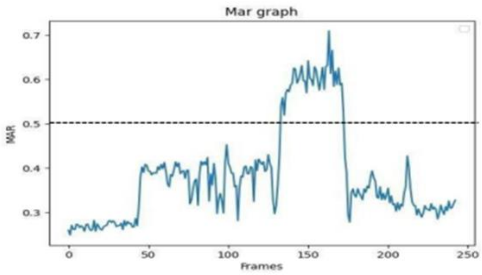

Fig 6.5.1. MAR plot

4. CONCLUSION

The suggested "Driver Fatigue Detector" system is a real-time device with a fast response time. According to the results of the experiment, the system is applicable in a variety of situations and provides consistent performance. When a drivers fatigue level exceeds a particular threshold, this real-time driver fatigue monitoring technology triggers an alarm so the driver can slow down. It continuously analyses the driver's level of drowsiness, and when that level surpasses a specified threshold, an alarm is triggered to notify the driver.

The accuracy of sleepiness detection is determined by counting the number of times individual samples' eyes blink and yawn. The results of eye blink detection and yawn detection are tabulated. Eye blink detection accuracy is predicted to be 94.66 percent. The yawn detection accuracy is predicted to be as follows 95.99 per cent. Most of the time, the system accurately detects eye blinks and yawns. The technology also performs well in low-light situations. The system is quick, and once it starts taking pictures, it continues to recognize faces and do detection until it is stopped.

5. REFERENCES

[1] Wanghua Deng , Ruoxue Wu , “Real time driver- drowsiness detection system using facial features”,IEEE Access , vol.7 , pp. 227-238 , August 2019

[2] Shruti Mohanty , Shruti V Hegde , Supriya Prasad , “Design of Real-time Drowsiness Detection System using Dlib” , 7th IEEE International Conference on Electrical and Computer Engineering ,IEEE , 2020.

[3] Sai Sandeep Raju, V.T., Belwal, M. (2021). Driver Drowsiness Detection. In: Smys, S., Palanisamy, R., Rocha, Á., Beligiannis, G.N. (eds) Computer Networks and Inventive Communication Technologies. Lecture Notes on Data Engineering and Communications Technologies, vol 58. Springer, Singapore.

[4] A. M. Al-madani, A. T. Gaikwad, V. Mahale, Z. A. T. Ahmed and A. A. A. Shareef, "Real-time Driver Drowsiness Detection based on Eye Movement and Yawning using Facial Landmark," 2021 International Conference on Computer Communication and Informatics (ICCCI), 2021

[5] Basha, S. M., Poluru, R. K., & Ahmed, S. T. (2022, April). A Comprehensive Study on Learning Strategies of Optimization Algorithms and its Applications. In *2022 8th International Conference on Smart Structures and Systems (ICSSS)* (pp. 1-4). IEEE.

[6] S. Sathasivam, A. K. Mahamad, S. Saon, A. Sidek, M. M. Som and H. A. Ameen, "Drowsiness Detection System using Eye Aspect Ratio Technique," 2020 IEEE Student Conference on Research and Development (SCOReD), 2020.

[7] Mehta, Sukrit and Dadhich, Sharad and Gumber, Sahil and Jadhav Bhatt, Arpita, Real-Time Driver Drowsiness Detection System Using Eye Aspect Ratio and Eye Closure Ratio (March 20, 2019). Proceedings of International Conference on Sustainable Computing in Science, Technology and Management (SUSCOM), Amity University Rajasthan, Jaipur - India, February 26-28, 2019.

[8] Reza Ghoddoosian, Marnim Galib, Vassilis Athitsos; Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2019.