Drowsiness Detection for Advanced Driver Assistance System using facial landmarks

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Abstract: This paper presents the development of a solution to detect a driver's drowsiness in real-time and issue alerts to avoid possible traffic accidents. In particular, the methods used for drowsiness detection by computer vision is performed, focusing on the use of facial reference points. Distraction, drowsiness, tiredness, speeding, and fatigue are the main causes of accidents, and advanced driver assistance systems ADAS help reduce these serious human errors.

Keywords – Facial landmark; OpenCV; Dlib; Drowsiness Detection.

I. INTRODUCTION

Long distances and motorway driving can be tiring and monotonous. In recent years, drowsiness and fatigue have become the supreme reasons for causing severe road accidents in India and worldwide as well. The significant increment in the percentage of road accidents due to drowsiness and fatigue seized the researcher's attention. It has also been observed that drivers' performance also deteriorates with an increase in drowsiness [1], [2]. In NHAI's study at the midnight, 90% of accidents are due to the drivers' drowsiness and fatigue. With this view, the creation of intelligent vehicles has exponentially increased. Autonomous cars can prove to be a great way to deal with drowsy driving [3].

Drowsiness detection by considering various parameters of driver exhaustion be an integral part of future Smart Vehicle System (SVS) which consider eye-blinking rate, eye closure time, eyebrows shape, yawning, drivers gesture other than the speed of the vehicle, movement of steering, brake and accelerator pattern and continuous driving duration. Numbers of techniques are in use to detect drowsiness and fatigue. Other parameters for this can be medical parameters like heart rate, pulse rate, etc. In SVS, high vision cameras are embedded to capture run-time images of the drivers and generate alerts accordingly.

With respect to the aforementioned concern, various researchers have proposed distinct ways to automate the system of measuring the drowsiness of a driver. Based on the vision, Malla et al. [4] proposed a light-insensitive system employing Haar algorithms [5] [6] to detect objects and faces. The level of eye closure was taken as a measure to detect the drowsiness of the driver. Later, Vitabile et al. [7] presented a drowsiness detection system that recognized the symptoms of a drowsy driver using an infrared camera. The researchers used the concept of bright pupils to deduce an algorithm for eye detection and tracking. The system is used to alarm the driver upon detecting drowsiness. On similar grounds, Bhowmick et al. [8] used the conventional Otsu threshold method [9]. The complete detection model used eye localization and segmentation as the core concepts. Ultimately, a non-linear Support Vector Machine (SVM) was used to train the model in order to detect drowsy eyes. Considering, transport as an integral part of routine activities, Alshaqaqi et al. [10] proposed a driver drowsiness detection system known as the Advanced Driver Assistance System (ADAS). They proposed an algorithm that helped in locating, tracking, and analyzing both the driver's face and eyes to measure PERCLOS, which is a supported measure of drowsiness associated with slow eye closure.

All the above existing approaches employed complicated methods to detect the drowsiness of a driver. This article proposed an uncomplicated method for the same. The proposed article is arranged as Section II, which describes the proposed methodology followed by Section III in which experimental results encompassing the accuracies are mentioned. Finally, Section IV lists the conclusion, and Section V, the future scope of the proposed work.

II. PROPOSED METHOD

The proposed system enables overcoming, and some of them addressed the drawbacks of an existing system. The system provides a non-intrusive method, night-based detection, and less false-positive detection with high accuracy. This system consists of four parts: video Capturing, preprocessing, facial landmarks and cues extraction, and drowsiness detection. In the first section, real-time video of the driver records using a digital camera. Using some image processing techniques, the face of the driver is detected in each frame of the video. The facial landmark point in the driver's face is localized using one shape predictor and calculating eye aspect ratio, mouth opening ratio, and yawning frequency. Based on the values of these parameters' drowsiness is detected. Facial landmarks at the detected face are pointed and ultimately the eye aspect ratio, mouth opening ratio, and yawning frequency are computed. Depending on their values, drowsiness is detected based on developed adaptive thresholding.

Software Requirements Specifications

1. Python:
   - Python 3
2. Libraries
   - Numpy
   - Play sound
   - Scipy
   - Dlib
   - Imutils

- OpenCV, etc.

3. Operating System
   - Windows

Hardware Requirements Specifications

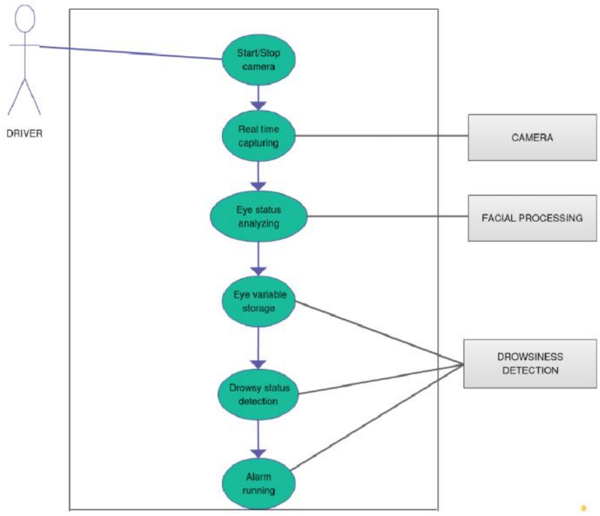
1. Laptop with basic hardware.
2. Webcam

Requirement Analysis

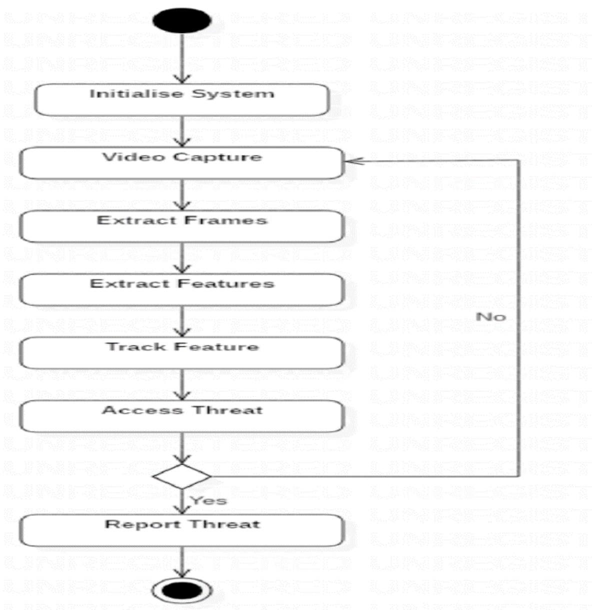
1. Python: Python is the basis of the program that we wrote. It utilizes many of the python libraries.
2. Libraries:
   - Numpy: Pre-requisite for Dlib
   - Scipy: Used for calculating Euclidean distance between the eyelids.
   - Play sound: Used for sounding the alarm
   - Dlib: This program is used to find the frontal human face and
   - estimate its pose using 68 face landmarks.
   - Imutils: Convenient functions written for OpenCV.
   - OpenCV: Used to get the video stream from the webcam, etc.
3. Laptop: Used to run our code.
4. Webcam: Used to get the video feed.

System Design

1. Use a case diagram

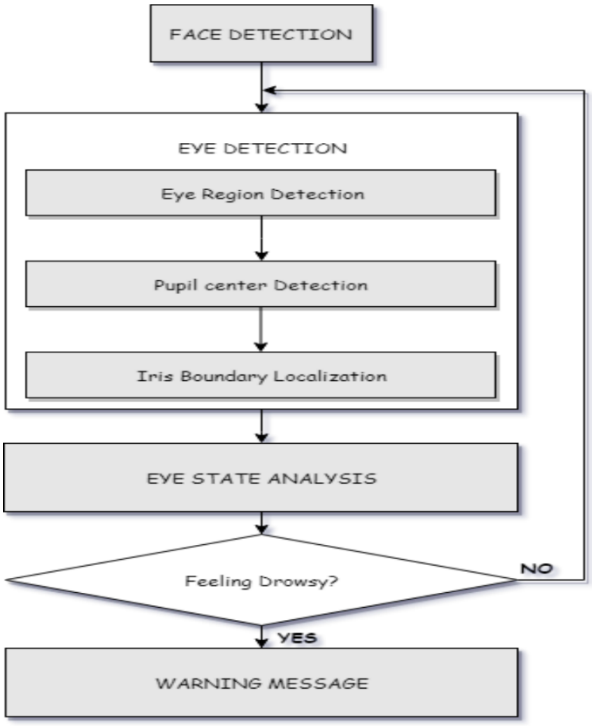


2. Activity diagram



System model

The framework is created utilizing the incremental model. The center model of the framework is first created and afterward augmented in this way in the wake of testing at each turn. The underlying undertaking skeleton was refined into expanding levels of ability. At the following incremental level, it might incorporate new execution backing and improvement.



Implementation

In our program, we used Dlib, a pre-trained program trained on the HELEN dataset to detect human faces using the pre-defined 68 landmarks. After passing the video feed to the dlib frame by frame, then able to detect the left eye and right eye features of the face. Now, drew contours around it using OpenCV.

• By Using Scipy's Euclidean function, the calculated sum of both eyes' aspect ratio is the sum of 2 distinct vertical distances between the eyelids divided by their horizontal distance. then check if the aspect ratio value is less than 0.27. If it is less an alarm is sounded and warned by the user.

Fig. 1. 68 landmarks detected

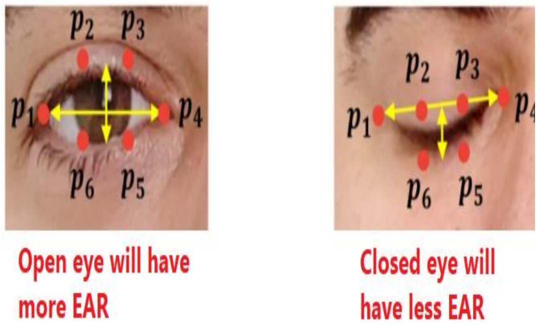


fig. 2. Eye aspect ratio

III. EXPERIMENTAL RESULTS

According to the proposed system, the live feed is first converted into frames, the average mouth and eye detection time of which is computed. After the detection of the mouth, the eyes are tracked and identified. The algorithm is able to detect the eyes even in the presence of glasses. Once the mouth is detected and the eyes are tracked, drowsiness detection starts. The states of eyes are checked for; accordingly, the driver is prompted with an alert or warning. The results of the same are illustrated below.

Fig. 3 Face and Eye Detection

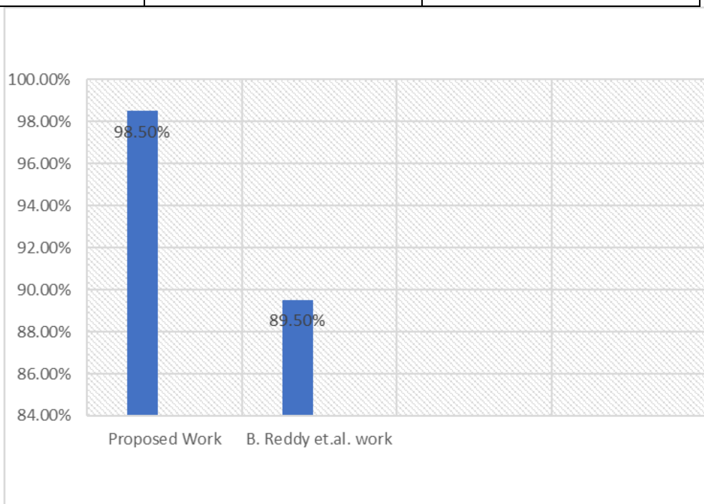
The Drowsiness system uses Eye Aspect Ratio (EAR) which works more efficiently in comparison to Mouth Aspect Ratio (MAR) to detect the yawn. The combined EAR and MAR features work more appropriately for determining the fatigue level and the state of sleepiness in the driver.

Table-1 shows combined features of eye blinking and yawn shows 98% accuracy in the result

Input	EAR	MAR	Drowsiness Detected	Actual yawn	Background Condition
Sample-1	0.36	0.39	No	No	Day
Sample-2	0.16	0.25	Yes	Yes	Day
Sample-3	0.30	0.36	No	No	Day
Sample-4	0.31	0.32	No	No	Day
Sample-5	0.13	0.74	Yes	Yes	Day
Sample-6	0.32	0.42	No	No	Night
Sample-7	0.16	0.29	No	No	Night
Sample-8	0.35	0.41	No	No	Night
Sample-9	0.17	0.32	No	No	Night
Sample-10	0.13	0.69	No	No	Night

Table 2 shows the comparative result with B. Reddy et al. work

	B. Reddy et al. work	Proposed work
Metric	Eye state and mouth	Eye state and mouth
Technique	CNN	CNN
S/W & H/W	PC, GTX 1080 GPU & NVIDIA embedded board	Laptop with basic hardware & Python
Accuracy	89.5 %	98.5%



We can observe that the proposed work for drowsiness detection based on EAR and MAR by using python is better than the available work for the same. The proposed work is more reliable than the previous work.

IV. CONCLUSION

It completely meets the objectives and requirements of the system. The framework has achieved an unfaltering state where all the bugs have been disposed of. The framework cognizant clients who are familiar with the framework and comprehend its focal points and the fact that it takes care of the issue of stressing out for individuals having fatigue-related issues to inform them about the drowsiness level while driving. Proposed work can be absolutely used to detect drowsiness and thus help drastically reduce road accidents.

V. FUTURE PROSPECTS

Researchers are working day in and day out to get better results than the previous times. The field of Artificial Intelligence and Digital Image Processing is growing exponentially, so the future prospective is really very bright. Many algorithms and techniques have been already proposed but the better versions of them are on their way. Letting the machine decide what actions are needed to be taken in certain circumstances is as simple as it sounds, but the work to be done behind it is extremely complex. Training machines to think like humans can be an extremely difficult task but the way the research and other related work that has been carried out till now is fantastic.

VI. REFERENCES

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