# Drowsiness Detection Using Machine Learning

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***Abstract— The number of road accidents are increasing rapidly over the years. Therefore, driver drowsiness and fatigue detection are major possible area to prevent a large number of sleeps induced road accidents. Several techniques have been studied and analysed to conclude the best technique with the highest accuracy to detect driver drowsiness. Nowadays, there are many theories about driving drowsiness detection technique. However, most of the work is finding the general solution for all drivers. The paper is proposing a real-time driving drowsiness detection algorithm that is driver specific. The work shows real-time system that utilizes camera to automatically track and process driver's eye using Python, dlib and OpenCV. The eye region and the mouth region of the driver is measured continuously to check the drowsiness of the driver. According to the face's landmarks, new parameters, called Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR), is introduced to evaluate the drowsiness of driver in the current frame. Through experiments, we demonstrate this algorithm with respect to current driving drowsiness detection approaches in both accuracy and speed. we show this algorithm with respect to current system in terms of speed and accuracy.***

***Indexed Terms— Drowsiness, Eye aspect ratio (EAR), Mouth aspect ratio (MAR), OpenCV, Eye-blinked detection, Dlib***

## I. INTRODUCTION

Nearly 1.35 million drivers die due to road accidents every year as per the World Health Organisation(WHO) [1] statistics and 90 percent of them are due to drowsiness of the driver. One of the main reasons is due to that the driver sleeps during driving. This can happen due to insufficient sleep, tiresomeness, consumption of alcohol, and also due to medication taken by the drivers. Recently, along with the development of road transport and advancements, it has become for the government to handle the traffic and also the accidents caused. It should also be a primary concern to develop safety warning system along with developing traffic management system to handle traffic so that they can ensure less number of accidents.

The amount of accidents happening can be lessened by determining the drive time and also the state of driver to some extent. However, it is not useful to determine the drowsiness and tiresomeness in a driver. This will give birth to the implementation of a driver's drowsiness detection system which can act as an alternate to solve the problem .

Drowsiness Detection System should be a typical system developed in order to alert the drowsy drivers. The systems can be built by analysing human behaviours, physiological conditions and vehicular parameters[2]. Human behaviours include yawning, eye blink rate, head position and movements. And physiological conditions include heartbeat rate, blood pressure and temperature of the body. The vehicular parameters include motions of the vehicles on the road along with its behaviour. The approach proposed in this paper concentrates on two parameters namely eyes status and mouth status detection and prediction with two statuses: open and closed status. Depending on whether the eyes status is lesser than the given threshold and mouth status being bigger than the threshold, one can determine whether the driver is drowsy or not in order to alert him.

Due to the non-invasive and reduced cost, the research on drowsiness detection based on the behaviour of the driver has become active in recent years. Even though, the performance of these systems might not be effective and accurate considering the algorithms and the parameters considered in designing it. [3], [4].
Following are the contributions of the paper:

1. To effectively improve the performance, the design implements a new OpenCV based system to determine the face of the driver.
2. In order to assess the eyes and mouth whether they are open or closed, dlib toolkit is considered.

3. 3.In order to improve the system's significant performance in terms of both speed and accuracy, experiments are conducted extensively to determine how EAR and MAR works in different drivers.
4. The results from the conducted experiments show that the proposed system is more efficient, accurate and reliable.

## II. LITERATURE SURVEY

There are many approaches through which we can detect object, landmarks on the face and other methods for detecting drowsiness of the driver.It depends what application we are trying to build accordingly we can decide what technique we want for our system. Many researchers have tried to use various available methods for detecting drowsiness like behavioural parameters-based techniques, vehicular parameter-based techniques and various physiological parameters-based techniques etc.

Researchers have been trying to find the most efficient method with very high accuracy but they are trying to find universal approaches to it rather than looking into individual differences.The research works which made it possible to develop this proposed work are:

### A. Recognizing Landmarks on Face

The One of the most crucial thing in using behavioural parameters-based techniques is detecting the face of the driver then only the a decision can be made on the behaviour of the driver by extracting his facial features.

In [4] Facial key points are extracted using convolutional networks at three design levels. The two benefits from this proposal are: firstly, the eyebrows,the data of texture context over the complete face to find every single key point is applied. Secondly, because the reason that all key points are predicted by the networks. This research work mainly focuses on reducing the anomaly and ambiguity in case of occlusions or if the image gets corrupted. For Robust detection of facial points the CNN architecture has been utilised to get the most accurate result as possible. This work provides the result in three levels of CNN architecture and hence help in improving the overall accuracy.It has one of the main disadvantage that it is using colored image instead of using grayscale and colored images occupies almost three times of the system space as compared to grayscale because in colored image each pixel is converted in to number using RGB color Model. And in grayscale each image has a number ranging from 0(black) to 255(white). Another big drawback is it uses Rasberry pi which is not that good for real time detection and CNN based face detector which is although very fast and accurate but require very high speed Nvidia GPU.

### B. Driver Drowsiness Detection

According to the studies there are two methods in terms of categorizing drowsiness detection methods contact as well as non contact method.The non contact method include behavioural parameters based techniques and contact method include physiological parameters based techniques that include sensors in contact with the body of the driver.

A research work using electrodes on the car wheel of steering. This research is performed by [7].In this signals are transferred to the remote place with the help of sensors but there is one major setback it can have sensor aging or sensor delay resulting in the tempering of result.

Another research work based on physiological signals which can be heart rate, rate of breathing of drivers these are directly related to drowsiness is brain reflected is performed [8] by Electroencephalographic (EEG) signals.

A wireless sensor that can be a wearable by [9] is done to build a drowsiness detection system. Design of the drowsiness detection system has to be done in two phases: first we have collect the physiological parameters-based data using the sensor and then we analyse the data. Then in the second stage based on the heart rate and breathing rate they designed a Mobile app that will notify by alarm.

Another research[10] that captures the facial expression by dlib facial detector using HOG and linear Support vector machine and dlib shape predictor using 68 landmarks. But there are some limitation of this system i.e lighting conditions, and the dlib facial detector used is not as good as CNN based detector which can detect face at any angle .

Through our work we have tried to overcome all these drawbacks.

## III. METHODOLOGY

In our work we have used pre-trained facial landmark detector using dlib library to extract the facial features like eye and mouth. By extracting these features we are going to decide the state of the driver. This process is carried out as"

- First the image is detected by live image capturing and then the face is detected using OpenCV inbuilt Haar cascade method which works on the Viola Jones algorithm.
- Then the landmarks are predicted by dlib shape predictor.
- The required features are extracted as per there coordinates.
- If there is any change in the extracted features state accordingly drowsiness state is detected.

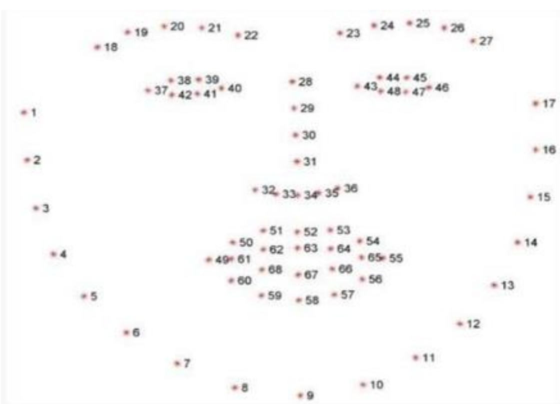

Fig. 1. Marking the 68 facial landmark coordinates using Dlib.

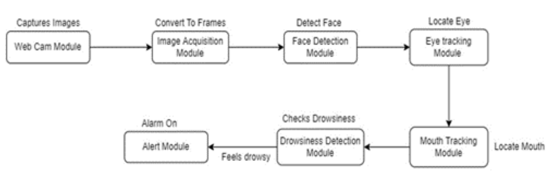


Fig. 2. Design Module Flow.

### A. Workflow

With the help of digital camera live video capturing is done to extract every frames one by one for each instant. Each frame is analysed using openCV inbuilt Haar Cascade Classifiers, for each frame if EAR value is lesser than their threshold value, then at that instant of time a blink is considered.Similarly if the MAR value is greater then the threshold value then yawn is considered. When the blink or yawn is detected for fixed frames then driver’s drowsiness is detected and it will trigger the alarm and the alarm will keep on beeping untill the driver comes back to normal state.

### B. Face Detection

1) Frame capturing: First the frames are captured by videostream object from the immutils of python library.
2) Detection of Face: Face is detected by viola jones algorithm and each and every frame is stored in an array of frames.

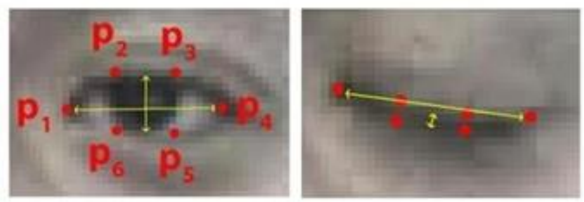


Fig. 3. Calculation of EAR.

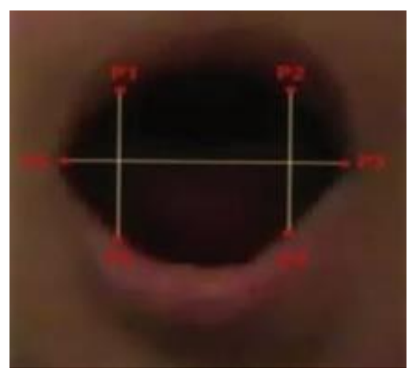

Fig. 4. Calculation of MAR.

### C. Monitoring Eye Closure:

Eye Aspect Ratio is defined as the ratio of average of distance between upper and lower eyelid to the horizontal distance of the eye. It is used to detect the drowsiness of the driver. Average of vertical distance of eye decreases when the driver blinks. The horizontal distance of eye will remain constant. So when the driver is feeling sleepy and closes his eyes the EAR will decrease as the numerator will decrease and the denominator will be same. When EAR value will be lesser than the threshold value it will trigger the alarm.

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

Fig. 5. Eye Aspect Ratio Formula

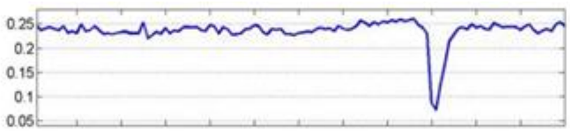


Fig. 6. Mouth Aspect Ratio Graph

D. Monitoring Mouth Activity:

Mouth coordinates are detected by the dlib toolkit. As shown in figure 4 Mouth Aspect Ratio(MAR) will be calculated using 6 points. MAR is defined as the ratio of average vertical distance between the upper lip and lower lip to the horizontal distance of the mouth. Similarly as in the EAR formula here numerator will increase when the driver yawns and denominator will be same. Hence if MAR value is greater than the threshold value it detects the drowsiness of the driver and trigger the alarm.

$$\text{MAR} = \frac{||P1 - P5|| + ||P2 - P4||}{2||P6 - P3||}$$

Fig. 7. Mouth Aspect Ratio Formula

E. Alarm Activation:

Alarm Activation helps in alerting the driver. It depends on EAR and MAR values. If EAR value is lesser than the threshold value for fixed frames and MAR value is greater than the threshold value the alarm will get activated. Activation of alarm shows that the driver is sleepy.

## IV. RESULTS

The system is implemented using Python, OpenCV and dlib toolkit. It is based on two parameters, Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR). Both the parameters are continuously measured and calculated by the algorithm. Threshold value is set for both the parameters. If the calculated EAR value is less than the threshold value of EAR then it means driver is feeling drowsy. And if the calculated value of MAR is more than threshold value of MAR then it means driver is yawning and feeling drowsy. Both methods together helps in identifying drowsiness of driver accurately. Below are some results of the implementation.

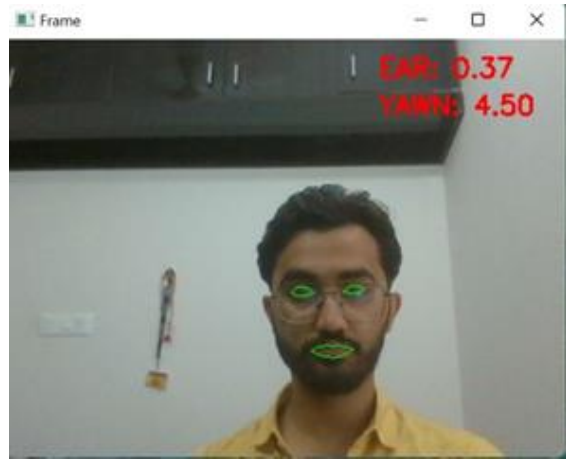


Fig. 8. Open eye and closed mouth


Fig. 9. Closed eye and closed mouth

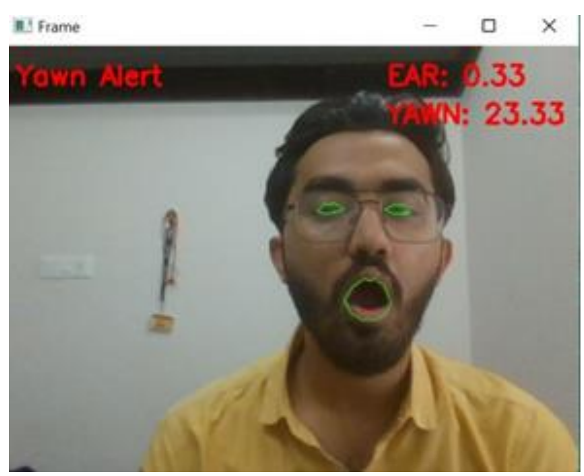


Fig. 10. Open eye and open mouth

## V. CONCLUSION

In conclusion, drowsiness detection technology is a car safety technology to help prevent accidents caused by a drowsy driver. It is important to detect and alert the driver early before any unwanted accidents happen that may possibly lead to death. The proposed system is able to detect the drowsiness through image processing technique that calculates and measures Eye Aspect Ratio (EAR), in other words the size of the driver's eyes. The data on Eye Aspect Ratio has to be gathered to determine the threshold value that indicates whenever a driver is experiencing drowsiness. Alert by alarm system is vital as it helps in reducing the number of accidents caused by drowsy driving hence reducing the total number of car crashes.

As for now [5], the detection system only detects fatigueness of the same driver again and again with bare limitations. The alarm is also working well and able to trigger the alarm sound to alert the driver. However, the threshold frames to trigger the alarm may varies due to different Eye Aspect Ratio (EAR) in every person. First the system should be able to automatically determine the Eye Aspect Ratio when a person is experiencing drowsiness without setting it first to each separate individual after several testing.

A real-time algorithm is presented by the paper. It is based Haar and regression based face landmark detector to give accurate and precise results in real time environment. The two parameters EAR and MAR are enabling the algorithm to work in different conditions.

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