

# Intelligent Driver-Monitoring System for Driver Drowsiness and Accident Prevention

Suvarna Hanumante<sup>1</sup>, Sakshi Borade<sup>2</sup>, Tanaya Deotale<sup>3</sup>, Hemant Nawale<sup>4</sup>, Shailesh Mitnapure<sup>5</sup>, Shashank Moon<sup>6</sup>, Dr. S. W. Mohod<sup>7</sup>, Prof. F. N. Mawale<sup>8</sup>

<sup>1,2,3,4,5,6,7,8</sup>Department of Computer Engineering Bapurao Deshmukh College of Engineering Sewagram, Maharashtra, India.

Email: <sup>1</sup>kisanhanumante00@gmail.com, <sup>2</sup>sakshiborade5929@gmail.com, <sup>3</sup>tanayadeotale7@gmail.com, <sup>4</sup>hemantnawale3072000@gmail.com, <sup>5</sup>mitnapure11102000@gmail.com, <sup>6</sup>shashankmoon15@gmail.com

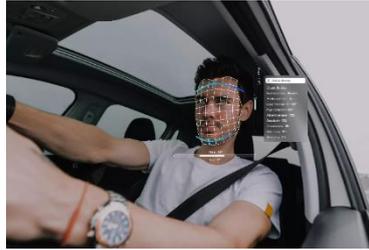
**Abstract:** *The main goal of this project is to develop an intelligent driver monitoring system for driver drowsiness and accident prevention by monitoring eyes and facial expressions. It is believed that the signs of driver fatigue can be detected early enough to prevent traffic accidents. In such cases, if the system detects drowsiness, it issues a warning signal to warn the driver and send a message to the people around. This detection system provides a non-contact technology to determine different levels of driver attention and facilitates early detection of lapses in attention while driving. In such cases, if fatigue is detected, a warning signal will be emitted to warn the driver, and the system will send a message as a warning to nearby drivers several times.*

**Keywords:** *Driver's Safety, Drowsiness, Image Based Measures, Video Stream, Volume Analyser, Yawning.*

## 1. INTRODUCTION

Car accidents are the leading cause of death, killing about 1.3 million people each year. Most of these accidents are caused by driver inattention or drowsiness. Drowsiness reduces the driver's concentration, activity, alertness and causes the driver to make slow decisions and sometimes not make decisions at all. Drowsiness affects mental alertness and reduces a driver's ability to drive safely and increases the risk of human error, which can lead to death and injury. The error rate for the driver was reduced. Countless people drive long distances on roads day and night. Lack of sleep or distractions like talking on the phone, talking to a passenger, etc. can cause an accident. To avoid these accidents, we have proposed a system that will alert the driver if they are distracted or drowsy.

The goal of this research is the detection of the indication of this fatigue of the driver. The acquisition system, processing system and warning system are the three blocks that are present in the detection system. The video of the driver's front face is captured by the acquisition system and it is transferred to the next stage i.e., processing block. We perform image editing here.



OpenCV and dlib open source libraries are used, associate degree infrared camera is used to endlessly track the driving force' facial markings and eye movements. This project mainly focuses on the driver's eye markings. Driver's eye characteristics are continuously tracked to detect drowsiness. Images are captured by the camera, these images are forwarded to an image processing module that performs face recognition to detect distraction and drowsiness of the driver. The following use cases are covered in this project. If the driver's eyes are closed for a limited period of time, the driver is considered drowsy and the corresponding audible alarm is used to warn the driver.

## 2. LITERATURE SURVEY

In the paper “ Facial features monitoring for real time drowsiness detection ” the authors Manu B N, the main objective of this paper is to detect the face and track the eyes. It acquires the video from the camera and detects fatigue, that is eyes open or close if the eyes are closed the alarm is turned on.

In the paper “ Intelligent Driver Drowsiness Detection through Fusion of Yawning and Eye Closure ” the authors M. Omidyeganeh, A. Javadtalab, S. Shirmohammadi, Drowsy driving is a key component in the majority of car accidents. We describe a robust and clever approach for detecting driver tiredness in this study, which combines eye closure and yawning detection methods. A camera fitted in the automobile captures the driver's face look in this method. The eye and mouth portions of the face are then removed and examined for symptoms of driver tiredness. Finally, during the fusion phase, the driver's condition is assessed, and if sleepiness is identified, a warning message is issued to the driver. Our tests show that the proposed approach is quite effective.

In the paper “ Monitoring Driver's Drowsiness Status at Night Based on Computer Vision ” the authors Vidhu Valsan A, Paul P Mathai, Lerin Babu, This research describes a real-time tiredness driving detection system that operates at night. The location of facial landmarks on the driver's face is determined by employing one shape predictor and then computing eye aspect ratio, mouth opening ratio, and yawning frequency. The values of these parameters are used to identify drowsiness. The thresholds are established using an adaptive thresholding approach. Offline implementation of machine learning techniques was also done. The proposed approach was tested in both real-time and on the Face Dataset. The system's accuracy and robustness are demonstrated by the experimental findings.

In the paper “ Design of Real-time Drowsiness Detection System using Dlib ” the author Shruti Mohanty, Shruti Hegde, Drowsy driver detection system is designed using Python and Dlib model. This model is trained to identify 64 facial landmarks. As shown in Figure 5, the drowsiness features are extracted and the driver is alerted in case of drowsiness. Dlib library is used to detect and localize facial landmarks using Dlib's pre-trained facial landmark detector

called Histogram of Oriented Gradients (HOG). In this method, frequencies of gradient direction of an image in localized regions are used to form histograms. It is used to map the coordinates of the facial landmarks of the input video and drowsiness detected by monitoring aspect ratios of eyes and mouth.

In the paper “ Driver Drowsiness Detection using Percentage Eye Closure method ” the author K. Sakthidasan, One of the main reasons for accidents is drowsiness or fatigue in driver. Preventing the drowsiness prevents accidents and it employs road safety. There are many types of analysis done regarding the drowsiness which are seen in driver such as yawning, eye closure and head movement. The proposed system focuses on eye closure by the effective method named Percentage Eye Closure (PERCLOS). The PERCLOS establishes a parameter level to detect the drowsiness. The detection is carried out by Viola-Jones detector, which segments the driver face and image of the eye from the detector. The main concept of this method is that it rejects the non-face quickly and spends time on the face region.

### **3. OBJECTIVE**

The main idea of this project is to plan a system to distinguish driver’s sluggishness by persistently checking the facial expressions of the driver by facial landmark detection concept. The objectives of the project are as follows:

- [1] To develop a technology that can identify signs of driver’s drowsiness.
- [2] To alert the driver upon identifying the drowsiness.
- [3] To prevent accidents and damage of vehicles caused by drowsy driving using drowsiness detection system.

### **4. METHODOLOGY**

The Machine Learning is an approach of getting the effect automatically. ML is the concept which is linked with many complex and advanced Algorithms, and it can be easily used with the Python programming language. The two libraries which contains the machine learning algorithms are :

1. SciPy Library
2. Ctypes Library
3. Pygame Library

The SVM algorithm used in this project is present in the library scikit-learn. It represents humans as machines. In order to gain high accuracy and high efficiency, it is necessary to implement Machine Learning algorithms.

#### **A. Machine Learning with Python :**

The Python properties are Platform Independence, Object Oriented and Robust Language. It has the machine learning algorithms in pandas and scikit-learn library and is an Open-source language.

#### **B. Libraries :**

1. **NumPy:** NumPy stands for Numerical Python. It basically includes all types of mathematical operations in the code. It performs linear algebra as well as matrices.

2. **SciPy:** SciPy are green libraries in Python Languages. These are imported and used for managing the datasets. In order to teach the device the usage of a dataset, dataset must be stored in a variable.
3. **Imutils:** Imutils is used for styling the pictorial representation along with bar graphs, curves and many others. by way of using this library, the difference between the attributes is determined with the colors i.e., every attribute is outstanding with unique coloration.
4. **Pygame:** Pygame is the most used library for implementing machine learning techniques and algorithms. It is open and free.

Machine learning library. It is also used for performing Regression, Clustering, and Statistical Modeling. Everyone can access and use it, and Pygame is reusable in various contexts. Pygame has many Machine Learning algorithms, and this library is also called as inbuilt Machine Learning technique. Pygame has Logistic Regression, RF algorithm, feature extraction, classification report, and confusion matrix. These packages are inbuilt such that these can be accessed directly and can be used for the classification and prediction projects.

### Proposed Approach

Almost all drivers have experienced this drowsiness problem while driving. Youngsters and professional drivers are mostly affected by this drowsy driving because of continuous hours of driving without any rest. In many cities, auto drivers and cab drivers drive continuously overtime sometimes to complete their targets or at times to get bonus profit. Many of the poor workers in order to meet their daily expenses and for the sake of their loved families tend to work in night shifts for long time, this can be one of the main reasons for accidents taking place because of drowsy driving. Therefore, a driver drowsiness monitoring system has been developed in this paper. The block diagram of the proposed method for drowsiness monitoring is shown in figure 1. A webcam has been used to record the video of the driver. The webcam is arranged in such a way that it captures the front facial image of the driver. Once the video capturing is done, the recorded frames are then pulled out to get the 2-Dimensional images. The object (Face) in the frames is detected by HOG and SVM algorithm.

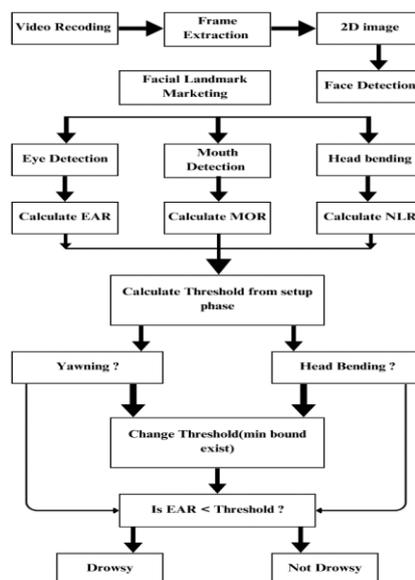


Fig. 1 The block diagram of intelligent DMS for drowsy drivers

## Implementation

### 1. Acquiring Data:

Initially, the video is captured and recorded by using a laptop webcam and then the frames are released and proposed in a laptop. Thereafter, the picture implementation techniques are proposed on the 2-dimensional picture of the recorded video. Now, the required driver information is produced. The volunteers are asked to look towards the laptop webcam and perform activities like continual eye blinking, eye closing, mouth yawning, and head bending.

### 2. Face Identification:

The driver's face is identified first after the frames have been extracted. In this paper, HOG & SVM algorithms are being used for face extraction. In this detection, only positive examples of the stable window size are taken for photographs and histogram of oriented gradients (HOG) descriptors and are calculated on them. Next, a negative sample of the same size for the HOG descriptor is considered and the results are evaluated. In general, there are more negative examples than positive examples. Then, after obtaining the features of the two groups, the SVM algorithm is directly used to classify the required problem. For the SVM algorithm, strong negatives are used for better detection and accuracy. In this definition, after training, the SVM classifier is analyzed on the labeled data and the characteristic values of the false positive samples are reused for training purposes. To test the image, the window used for the positive sample is displayed in the image, and then the desired result or output is grouped according to the location of each window. Then, based on the results obtained and considering the results of different samples, the high value sample is considered to determine sleep and the boundary of the surface is drawn.

### 3. Locating Face Points:

After the face is detected, the next step is to draw the eyes, mouth, nose, etc. on the person's face. is to find such a point. The images used for face detection must then be normalized to reduce the distance factor between the camera and the driver. So the face photo is converted into a gray scale image with a width of 500 pixels. Normalization is done for the regression tree. It will approximate the location point position on the surface of the pixel intensity. In this process, the squared error loss is reduced by using gradient boost learning. Different structures are used to open different structures. Because of this procedure, the location of the boundary of the eyes, mouth, and nose is shown and illustrated in Table 1. The location points on the surface of the water are then marked and shown in Figure 2. The red dots in the image are used for clarity

Table. 1 The location points on face

PARTS	LANDMARK POINTS
Mouth	49-68
Right Eye	38-42
Left Eye	43-48
Nose	28-36

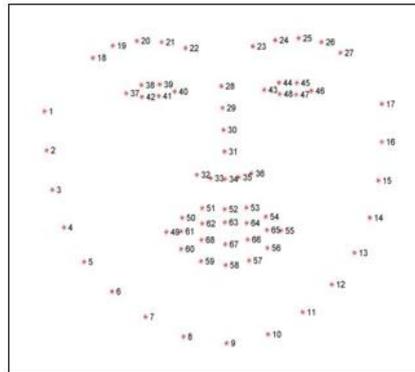


Fig. 2 Facial landmarks

### 1. Feature Extraction:

After marking the points on face, the drowsiness features are calculated as given below.

#### Eye Aspect Ratio (EAR):

From the boundary points on the eyes, the EAR is evaluated as inverse ratio of width of eyes to the height of eyes. The mathematical formula for EAR is given as,

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

where  $i$  is the point marked as  $i$  in facial landmarking ( $i - j$ ) gives the distance between the points  $i$  and  $j$ . When the eyes are open EAR is max and when the eyes are closed, the EAR is approximated to zero. So, the decreasing value of EAR indicates the closing of eyes and identifies the drowsy behavior of the driver.

#### Mouth Opening Ratio (MOR):

Mouth Opening Ratio is defined as the identification of yawning of the driver and ultimately drowsiness detection is done. The mathematical formula for calculating the MOR is given as,

$$MOR = \frac{(p_{15} - p_{23}) + (p_{16} - p_{22}) + (p_{17} - p_{21})}{3(p_{19} - p_{13})}$$

The MOR ratio is maximum when the mouth of driver is open and if it remains same for some time, then yawning condition is indicated. And if it decreases towards zero, then the condition is considered as normal, and not yawning.

#### Nose Length Ratio (NLR):

Drowsy alarm is detected using the head tilt angle when the driver's head is down along the vertical axis. Webcam focal plane is directly proportional to head tilt and is calculated by head tilt. Usually the nose makes a sharp angle with the webcam. The angle of the head increases as it moves up and down. Therefore, the length of the nose is given as the length of the nose, which measures the tilt of the head. The mathematical formula for NLR is

$$NLR = \frac{\text{nose length } (p_{28} - p_{25})}{\text{average nose length}}$$

The facial points for nose length ratio and head bending are shown in figure.2.

## 2. Classification:

After obtaining the eye, mouth, and nose values, the next step is to detect sleep from the SVM frame. A flexible threshold value for insomnia is needed. Then, algorithms such as SVM are used to classify the data.

The driver's initial position is normalized to obtain eye, mouth, and nose threshold values. This step is known as the setup phase. EAR 100 to 300 frames will be recorded, and the average value of 150 to 200 above will be known as the hard limit value for ear. The values which are high i.e., in which eyes are not closed is considered. If the threshold is greater than the test value, then it is defined as blinding. Each person's eye size will be different; thus, this has the effect of reducing person-to-person adjustment. To calculate the MOR value, the threshold value of the frame is calculated based on the condition that the mouth is not opened. If the threshold is less than the test value, shock is detected when the mouth is opened. Using the Tilt head feature, the nose between the inlet and the head can be defined in terms of the length of the nose. The NLR value ranges from 0.8 to 1 in the normal head position and varies with the head tilted up and down. The average shape of NLR is measured by the length of the nose, assuming that the head is not tilted. It is tested after receiving the asylum value. Then, if at least one of the eye, mouth, and nose detectors is not satisfied, a sleep warning is displayed. In practice, for example, at least 70 frames out of 75 frames meet the sleep condition for one or more features, then the entire system detects sleep and the driver is alerted by an audible alarm.

A single threshold value is considered to address the refugee problem and this threshold value depends on the EAR. A value of 150 EAR above 300 frames is considered to receive an average EAR value. If the threshold value is greater than the EAR value, the driver is at risk. Considering bending and tilting of the head, this EAR threshold will increase and spread over more frames. Frame Tilt and Tilt are combined to obtain a flexible threshold value. If the EAR value is higher than the threshold value, it is considered as a sleep state and displays this alarm. In the case of tilting the head, if your head is down, the frame is considered a sleep warning. Table II shows the calculated parameters.

Machine learning algorithms and thresholding factors are used to determine driver drowsiness from values derived from EAR, MOR and NLR. Previously, this feature was used to analyze the individual classification of the feature space. However, here it is used for principal component analysis.

After converting the values obtained from threshold, whether the features are significant for classes or not is tested. If three factors give five percent significance, this classification based on Bayesian Classifier and SVM algorithm is used.

Table. 2 Calculated parameter values of threshold

EAR from setup phase (average of 150 max values out of 300 frames)	0.34
Threshold = EAR – offset	$0.34 - .045 = 0.295$
At Yawning, (MOR > 0.6)	Threshold = Threshold + 0.002 *max bound exist
At Head Bending, (NLR < 0.7 OR NLR > 1..2)	Threshold = Threshold + 0.001 *max bound exist

## 5. RESULTS AND DISCUSSION

The laptop webcam is opened and the driver's face is recorded and captured. The captured video is passed to the processing team for sleep detection. If an error is detected, an alarm will sound to alert the driver. The initial state of the driver is given in Figure 3. The values for this frame are given as follows

EAR= 0.350, MOR= 0.341, NLR= 1.030

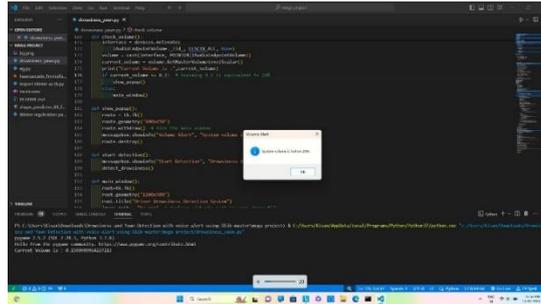


Fig no. 3 Initial Volume Detector Window of DMS

The initial step of the project will be to check if the volume is lower than 20% or not. If so, it will popup above window

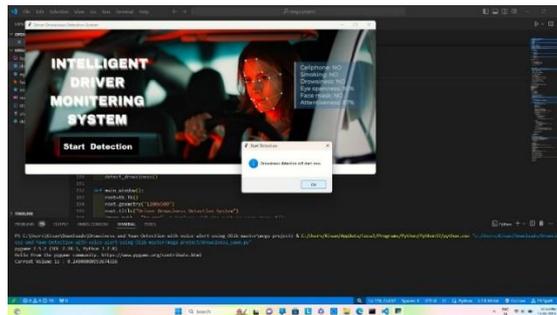


Fig. 4 Home window of intelligent DMS

On running the program after the initial window, home window will look like fig.4 If we click on ok button, face detection will be started.

Below are some of screenshots of different stages of face and its output that, on which condition how the system will behave:

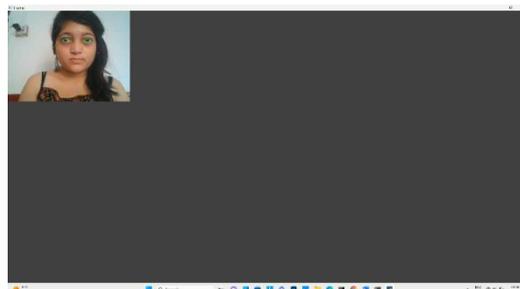


Fig. 5 Initial condition of driver

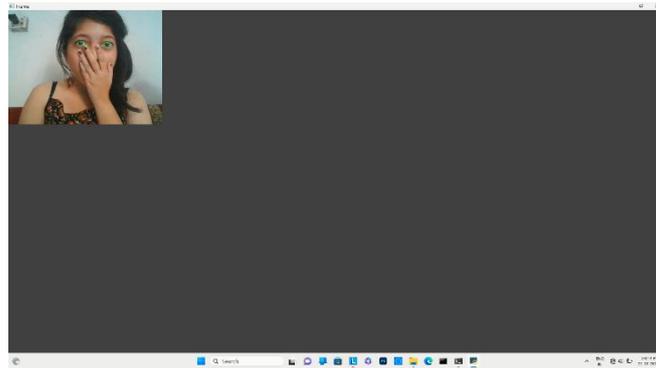


Fig. 5.1 Drowsy identification based on yawning

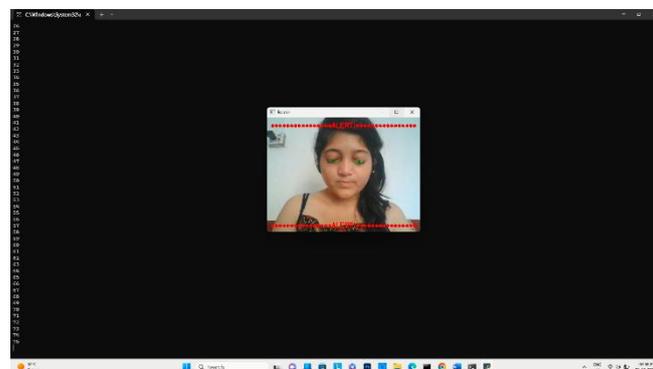


Fig. 5.2 Drowsy identification based on closed eyes

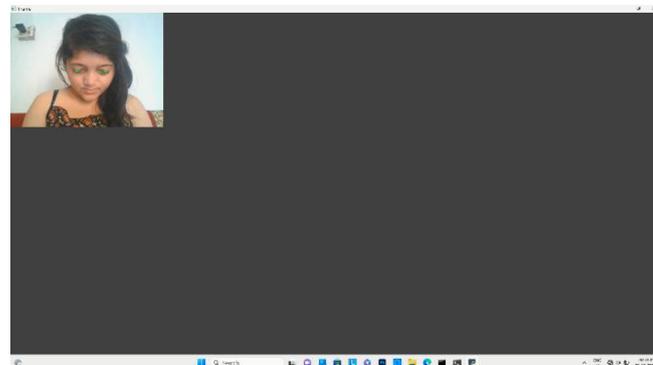


Fig. 5.3 Drowsy identification based on bent head

Various drowsiness situations are shown in Fig. 5. Figure 5.1 shows the example of alert for drowsiness due to yawning and Figure 5.2 shows the example of drowsiness alert due to eye closing. Figure 5.3 shows an example of drowsiness due to head bending. Table 3 shows the sample values of the parameters for various states.

Table. 3 Sample values of distinct parameters and states

State	EAR	MOR	NLR
Normal	0.35	0.34	1.003
Yawning	0.22	0.77	0.76
Eye Closed	0.15	0.419	0.876

Head Bending	0.15	0.577	0.66
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The system can also detect the driver's drowsiness along with spectacles as shown in Fig. 6.

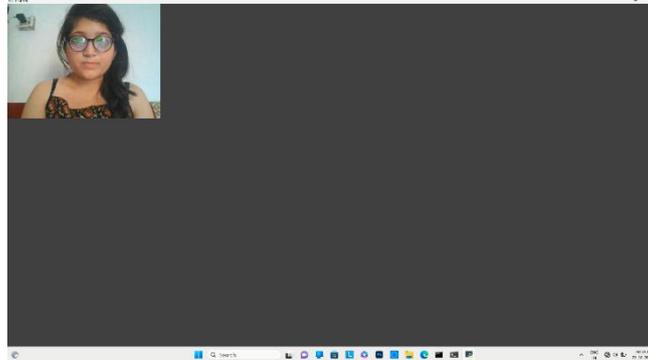


Fig. 6 Identification of eyes with glasses

### Salient Features

- Simple application of Image processing
- Easy to install and used
- Web camera Interfacing
- Image processing based drowsy detection
- Real time video capturing and image processing
- Buzzer for alarm indication

## 6. CONCLUSION

This paper has designed a system for the identification of drowsiness by implementing the machine learning algorithms and visual behavior features like Eye Aspect Ratio, Mouth Opening Ratio and Nose Length Ratio. These features are calculated from threshold values by recording video through a webcam on a laptop. This flexible method is used to determine the threshold value to detect insomnia. The developed system works perfectly with the given data. Then, the threshold value is saved and the machine learning algorithm is applied. Algorithms such as SVM and Bayesian classifier are used here, which performs SVM with a sensitivity of 0.569. SVM algorithm gives more accuracy and system designed using SVM algorithm gives ideal results. In the future, the proposed model can be implemented in real life as a car and bus device to validate advanced systems.

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