



# FATIGUE DETECTION SYSTEM BASED ON BEHAVIOURAL CHARACTERISTICS OF DRIVER

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**Abstract:** Driver fatigue is a significant contributor to road accidents, leading to severe injuries and fatalities. This research proposes a real-time fatigue detection system that utilizes computer vision techniques to monitor and analyses the driver's behavioral characteristics. By tracking facial features such as eye closure, eyelid movement, and head pose, the system can accurately assess the driver's alertness level. In this task, we propose a machine, which detects the motive force's fatigue fame, which include yawning, blinking, yawn counts, EAR AND MAR ratio and so forth., the use of video images and real time video streaming without equipping their bodies with devices. In this examine, we advise a technique to come across motive force's drowsiness from a video taken via a digicam or webcam. This technique attempts to recognize the face and the detecting the eye and mouth in every frame. Further, we designed a new detection method for facial areas based on 68 key factors, referred to as facial landmarks. If the motive force shows any signs and symptoms of drowsiness, alert message will be displayed to prompt the driver to take necessary breaks or rest. This system aims to enhance road safety by reducing accidents caused by driver fatigue and promoting responsible driving habits.

## I. Introduction

Driver drowsiness is a serious hazard to avenue protection due to fatal accidents. Had tried several times in current years to create structures which can without delay pick out driver drowsiness. Analyzing the driver's steering behavior, watching the motive force's facial capabilities, and monitoring the driver's physiological parameters are a number of the various strategies those structures appoint to decide the diploma of drowsiness. For driving force drowsiness detection, facial features are a popular choice due to the fact they may be non-invasive and may be without difficulty incorporated into the vehicle. A driving force drowsiness detection system based totally at the HAAR Cascade Classifier is proposed. The driver's eyes and face are detected by way of the machine the use of the HAAR Cascade Classifier algorithm, and the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) values are used to indicate driving force's stage of drowsiness. The ratio among the vertical and horizontal distances among the eyes and the mouth, respectively, used for calculation of EAR and MAR values. A real-time stimulus sleep detection has been proposed using computer cognition and a prediction method. A driving force drowsiness detection device that makes use of the HAAR Cascade Classifier set of rules to determine the driving force's eye and face aspect ratios is the concern of this paper. In actual time, the device can as it should be locating driving force drowsiness and prevent injuries caused by drowsy riding.

## II. LITERATURE REVIEW

In different fields, it is essential to find target objects and tracking them effectively when handling obstructions and other complex aspects the system. Different techniques for tracking things have been attempted by researchers. This technology depends mainly on the domain of application.

**Shreya A Kulkarni et. Al**, [1], in today's years driving pressure weakness is one of the massive motives for car mishaps. A direct approach for estimating riding force weak point is estimating the situation of the reason pressure for example drowsiness. So, it is critical to perceive the drowsiness of the driving force to spare existence and belongings. This task is pointed inside the path of building up a model of drowsiness identity framework. In this framework it collects the image persistently and measures the situation of the attention, mouth ratio and head node price as consistent with the predetermined calculation and gives cautioning whenever required. For actualizing this framework some OpenCV libraries are utilized together with Haar-cascade. Drowsiness is described as a reduced diploma of interest portrayed with the aid of sleepiness and hassle in staying alarm however the character awakes with easy pleasure through stimuli. It is probably because of a scarcity of relaxation, medicine, substance misuse, or a cerebral difficulty. It is on the entire the end result of fatigue which can be both highbrow and bodily. Physical fatigue, or muscle weariness, is the temporary physical failure of a muscle to perform preferably.

**Yuvraj Suryawanshi et. Al, [2]**, Drowsiness is one of the main motives for road injuries in the previous couple of years. With the development in generation, various accident prevention technologies are evolving. The primary objective of avoidance of road accidents can be accomplished via actual-time drowsiness detection of a motive force the use of video taking pictures with face detection. After taking pictures and detecting the drowsiness by way of the usage of a camera, the alarm will buzz. The function of head and blinking of eyes are used as the capabilities to hit upon whether the driving force is drowsy or now not. The digicam captures the actual-time drowsiness via using Local Binary Pattern to discover the face and Haar cascade to detect the eyes. A custom eye blinking document has been advanced for eye blinking detection and AdaBoost is used to recognition on eye movements on the same immediately of time.

**Ioana-Raluca Adochiei et. Al, [3]**, Road site visitors' accidents, because of riding pressure fatigue, have a propensity to inflict high mortality charges comparing with accidents related to rested drivers. Currently there may be a growing car corporation style within the course of equipping automobiles with diverse motive force-assist technology. Third events also began producing complementary structures, which includes ones that would encounter the motive force's diploma of fatigue; however, this growing situation requires further studies and development. A tool like that is expected to make the motive force aware about the assumed risk at the same time as his diploma of the use of and taking decisions are reduced and is indicating a snooze damage because the vital approach. By monitoring the dominion of the human eyes, it's far assumed that the signs and symptoms of driving force fatigue can be detected early sufficient to prevent a possible road twist of destiny, which could bring about excessive accidents or in the end, in fatalities.

**Sinchana N Rao et. Al, [4]**, Accidents in roads have grown to be truly a main chance in towns. The prime cause for accidents in road is irresponsible driving. Main cause for accident is motive force drowsiness, alcoholism and careless using. This paper pursuits to increase an answer that could stumble on drivers' exhaustion and to trouble a timely warning, subsequently growing the transportation safety. Snooze breaker (SB) is proposed to locate driving force's drowsiness and gives alarm notification primarily based on Haar cascade set of rules for face and dlib's facial landmarks to effectively map the regions like mouth and eye at the face. The measures that may be used for drowsiness detection are eye closures, frequency of yawing, and so forth. SB is built the usage of Arduino Uno hardware, video camera, open-supply pc vision library (OpenCV), ultrasonic sensor (UV), gasoline sensor and corresponding alert device within the shape of buzzer.

**Vedant Kaushish et. Al, [5]**, Several studies have referred to indicating that riding force drowsiness has brought about a couple of wide variety of accidents during the last years. So, that permits you to save you such injuries, measures are to be implemented. One such degree is a Driver Drowsiness Detection software; the software program will prompt an alarm as soon as the riding pressure keeps his/her eyes closed for a positive quantity of time. This paper proposes to come across whether the reason pressure is sleepy or now not with the useful resource of the use of OpenCV with eyelid associated parameters. The information consists of around 9723 snap shots of eyes beneath terrific optical situations. The used dataset is divided into 3 elements for the sake of consolation i.e. Frontal face detection, left eye detection and right eye detection. With all the capabilities, an OpenCV and keras a reason force's fatigue or drowsiness version is constructed. The validation outcomes suggest the precision and accuracy of the proposed version. The creation of software program so that it will save you such accidents is one among the largest demanding situations in field of twist of fate-avoidance structures. The motive of the proposed paper is to expand a system with the intention to hit upon fatigue based on openCV, keras and Tensorflow. This paper works through first organising the vicinity containing the eyes, if you want to accomplish that first the complete face is searched and installed then a Region of Interest is chosen i.e. The location containing the eyes. Then the gadget determines whether or not the eyes are closed or open.

**Athira Babu et. Al, [6]**, or humans, sleep is a key requirement. The mystery of humankind's physical properly-being is sleep. In a take a look at on sleep, researchers have proved that adults from the age of eighteen and above need to get seven to nine hours of sleep an afternoon. Drowsiness is the basis reason of the unsafe road accidents. If drivers are notified as drowsy at the perfect on the spot of time, we will prevent the majority of street injuries that happened in the global. New strategies are brought through manner of the researchers to locate the drowsiness of the using pressure and every era has its personal gain and demerit. This paper makes use of Python and Dlib models to build a drowsiness identity version. We intention to combine both face detection and head pose detection which makes this an ideal detection technique. In the proposed system, a laptop is used, the usage of which actual-time video is recorded. Head-pose detection in conjunction with face detection helps to growth accuracy. For dataset video enter, the proposed gadget gives a most accuracy fee of 94.Fifty one%.

**Yaman Albadawi et. Al, [7]**, Continuous improvements in computing era and synthetic intelligence in the past decade have led to enhancements in motive force monitoring systems. Numerous experimental studies have gathered real driver drowsiness facts and implemented various synthetic intelligence algorithms and feature combinations with the goal of considerably improving the performance of those systems in actual-time. This paper presents an updated review of the driver drowsiness detection structures carried out over the past decade. The paper illustrates and opinions current systems the usage of exclusive measures to track and detect drowsiness. Each device falls beneath one among four possible categories, primarily based at the statistics used. Drowsiness can be triggered either through riding for lengthy hours without sleep, or by using using at a time while the driving force of the car might usually be asleep. In these cases, the fundamental trouble is that a drowsy motive force is unable to pay attention and has slower response to any street occasion. Luckily, early degree detection of driver drowsiness may be hired as an application to prevent any mishap situations.

**Mohammad Liton Hossain et. Al, [8]**, Driver in-alertness is an critical reason for max injuries related to the car's crashes. Driver fatigue because of sleep deprivation or sleep problems is an essential issue inside the growing sort of the injuries on these day's roads. Drowsy cause pressure warning device can form the basis of the device to in all likelihood reduce the injuries associated with motive force's drowsiness. The motive of this type of machine is to carry out detection of riding pressure fatigue.

By putting the camera within the vehicle, we are capable to show the face of the motive force and look for the eye-actions which imply that the riding force is not in circumstance to reason force is no longer in condition to energy. In one of these instances, a caution sign wants to be issued. This paper describes the manner to locate and tune the eyes. We additionally describe a method which could determine if the eyes are open or closed. The fundamental criterion of this device is that it ought to be quite non-intrusive and it need to start at the same time as the ignition is becoming on at the same time as not having at the purpose force initiate the gadget.

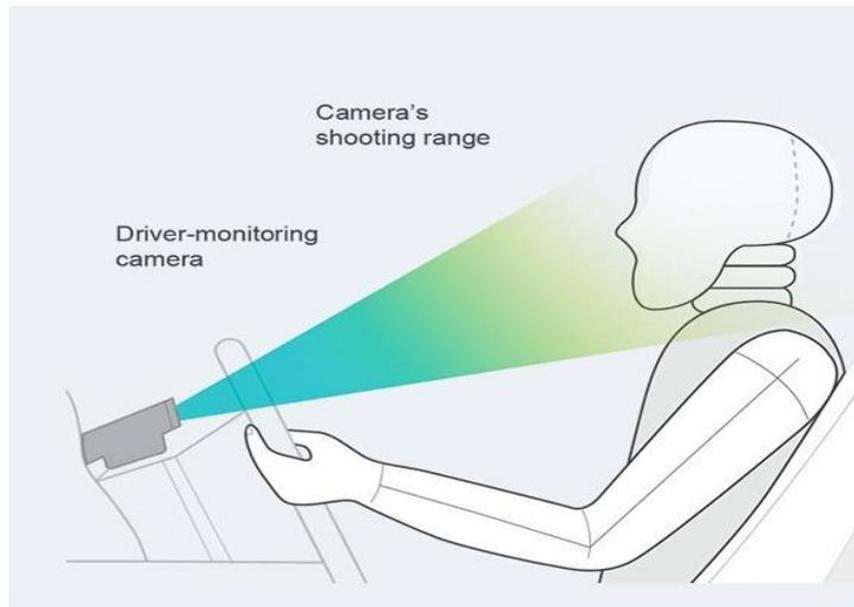
**Ruben Florez et. Al, [9]**, Drowsiness detection is an essential project in avenue protection and other regions that require sustained interest. In this article, an approach to discover drowsiness in drivers is offered, that specialize in the attention location, given that eye fatigue is one of the first symptoms of drowsiness. The method used for the extraction of the attention place is Mediapipe, selected for its excessive accuracy and robustness. Three neural networks were analysed based on InceptionV3, VGG16 and ResNet50V2, which implement deep mastering. The database used is NITYMED, which contains motion pictures of drivers with distinct stages of drowsiness. The three networks have been evaluated in terms of accuracy, precision and don't forget in detecting drowsiness in the attention location. This paper gives an method to determining driver drowsiness with the aid of virtual photo evaluation, exploring the use of a of the eyes (open or closed) using strategies that put into effect deep getting to know which encompass convolutional neural networks (CNNs). For the selection of the location of hobby, a method for the correction of factors close to the eyes is proposed. The proposed approach makes use of the technique, which includes six tiers: acquisition of the facts (video), pre-processing of the pix captured from the movies, creation of the dataset, training of the CNN architectures, trying out of the skilled fashions and subsequent prediction of driving force drowsiness.

**Sonia Diaz-Santos et. Al, [10]**, this paper introduces a cutting-edge method that mixes facial reputation and drowsiness detection technologies with Internet of Things capabilities, consisting of 5G/6G connectivity, aimed toward bolstering car security and driving force protection. The delineated -phase venture is tailored to reinforce security measures and address accidents stemming from motive force distraction and fatigue. The preliminary section is centered on facial reputation for driver authentication earlier than car initiation. Following successful authentication, the following section harnesses non-stop eye tracking functions, leveraging edge computing for actual-time processing to perceive symptoms of drowsiness at some stage in the journey. Emphasis is located on video-primarily based identity and evaluation to make sure robust drowsiness detection. Finally, the observe highlights the capacity of those improvements to revolutionize automobile safety and twist of fate prevention in the context of wise delivery structures. Traffic bruises are chargeable for about 1.3 million deaths global every yr, with young humans being the maximum affected organization. Distracted riding and fatigue rank the various leading reasons of these accidents, emphasizing the necessity of mitigating those elements to lessen the wide variety of patients. Presently, advanced automobile fashions incorporate driver drowsiness and interest warning (DDR-AW) as certainly one of their safety technologies, integrating the smart additives of clever delivery systems (ITSs) to save you injuries caused by driving force inattention.

### III. Image Capture and Face Recognition

A digicam is setup that appears for faces in the enter video circulate and monitors frames of faces. In the occasion that a face is diagnosed, facial milestone identity is hooked up and the attention district is removed from the earge of video circulation. The driving force's face is captured through a digicam inside the proposed system. The HAAR Cascade Classifier set of rules is used to system the photos and pick out the driver's face and eyes. A photo object detection algorithm primarily based on gadget studying referred to as the HAAR Cascade Classifier uses a fixed of features. A classifier that had been educated on a dataset of every effective and terrible photographs is used inside the set of rules. The classifier needs to discover the objects within the high-quality photos; however, those aren't present within the bad photographs. By comparing the traits of the advantageous and bad pics, the classifier acquires the capability to perceive items. The driving force's face and eyes are detected through the system, which then calculates the EAR and MAR values. Driver-monitoring camera, this camera is typically mounted on the dashboard, usually near the rearview mirror. Camera's shooting range, the image indicates the area that the camera can effectively monitor. This range is typically designed to cover the driver's face and upper body.

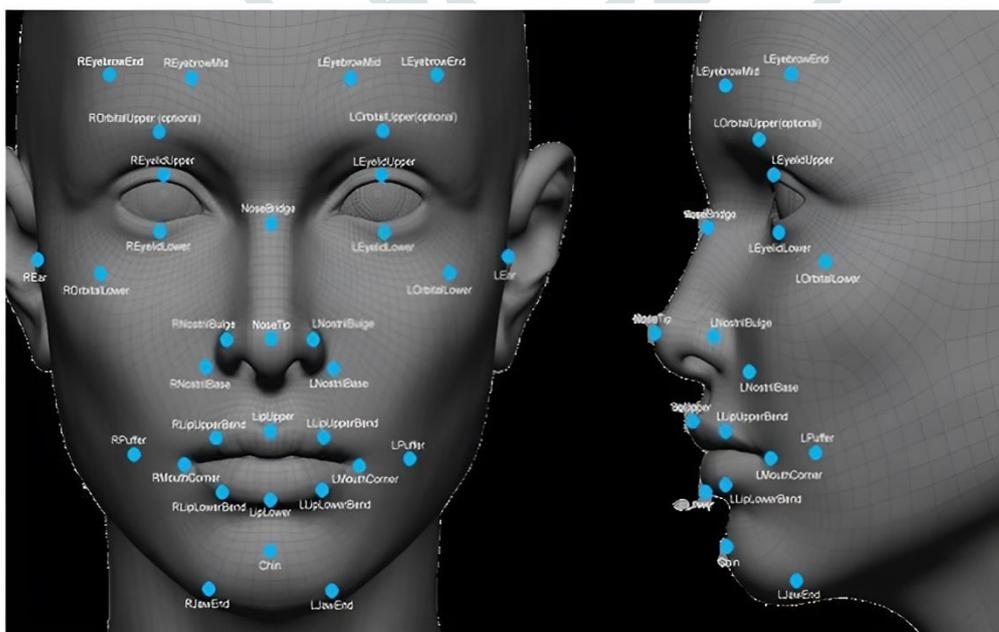
The camera is used to monitor the driver's behavior and detect signs of fatigue or drowsiness. It can analyze facial expressions, eye movements, and head gestures to assess the driver's alertness. If the system detects signs of fatigue or drowsiness, it can trigger alerts or activate safety features to prevent accidents. Improved protection, through monitoring the motive force's country, the system can assist prevent accidents caused by fatigue or inattention. Enhanced driving force consolation, the device can offer indicators to remind drivers to take breaks or alter their driving conduct to avoid fatigue.



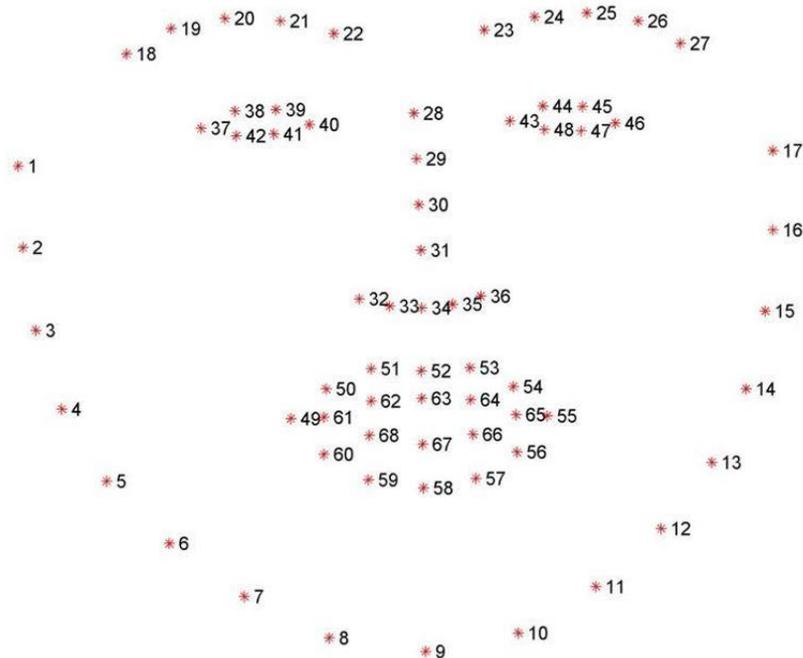
**Figure 1: Practical design of the system**

#### IV. Developing Image Processing solutions using OpenCV & dlib

OpenCV (Open-Source Computer Vision) and Dlib are both effective open-supply libraries widely used in computer imaginative and prescient and gadget mastering applications. They offer a rich set of gear and algorithms for duties which include picture processing, object detection, face popularity, and extra. While they share some similarities, additionally they have awesome strengths and use instances. OpenCV is a complete library designed for a wide variety of computer vision tasks. It presents a tremendous collection of functions and algorithms for photo processing, object detection, function extraction, and more. OpenCV offers a numerous set of equipment, together with photo analyzing and writing, filtering, segmentation, monitoring, and stereo imaginative and prescient. It is available for a couple of systems, which includes Windows, macOS, Linux, and Android, making it notably flexible. OpenCV has a big and active community, imparting extensive documentation, tutorials, and forums for aid. Dlib is primarily a machine learning library with a strong emphasis on computer vision applications. It offers a variety of algorithms for functions like face detection, facial landmark detection, and object tracking. Dlib is written in C++11, making it efficient and well-suited for modern programming practices. Dlib is known for its performance and efficiency, especially in computationally intensive tasks. Dlib often provides state-of-the-art algorithms and achieves high accuracy in its target applications.



**Figure 2: Facial landmarks by OpenCV**



**Figure 3: Facial landmarks set which is detected via dlib (Haar cascade 68 Landmarks pointers)**

Facial Landmark is an inbuilt HOG classifier used to determine the position of 68(x, y) coordinates that map to facial structure on the face. It is specially used for photograph or video processing and additionally evaluation together with object detection, face detection, and many others. Facial Landmarks are used to localize and represent vital areas of the face, which includes mouth, eye, eyebrows.

## V. METHODOLOGY

The driver's face is captured by a camera in the proposed tool. The HAAR Cascade Classifier set of rules is used to technique the photographs and select out the cause pressure's face and eyes. An photograph object detection set of rules based totally on device mastering known as the HAAR Cascade Classifier makes use of a difficult and speedy of features. A classifier that has been educated on a dataset of each exceptional and negative pix is used within the set of policies. The classifier wishes to find the gadgets within the high-quality snap shots, but those aren't gift within the terrible photos. By comparing the tendencies of the high-quality and bad snap shots, the classifier acquires the ability to identify gadgets.

The reason pressure's face and eyes are detected with the useful resource of the system, which then calculates the EAR and MAR values. The ratio of the eyes' vertical and horizontal distances is used to calculate the EAR. The ratio of the mouth's vertical and horizontal distances is used to calculate the MOR. The riding pressure's stage of drowsiness is then assessed the usage of the EAR and MAR values. The following thresholds are used to determine the diploma of drowsiness: The driving pressure is belief to be drowsy if EAR is much less than zero.25. The driving force is deemed to be yawning if the MAR is more than 0. Four. Driver drowsiness can be as it should be detected in real time through the proposed machine. A picture dataset became used to check the system, and it produced an accuracy of ninety-six%. The photos in the dataset depict drivers who are absolutely alert, reasonably drowsy, and significantly drowsy, respectively. In every instance, the gadget became capable of correctly discover driving force drowsiness.

## VI. SYSTEM ARCHITECTURE

The device captures a 2D photo of the driver's face. The digital camera's role and orientation are taken into consideration. The motive force's head position and orientation are analyzed. The eyes' openness or closure is determined. The eye aspect ratio, frequency, and period of blinks are measured. The role of the face within the photograph is diagnosed. The places of these facial capabilities are determined. The role of the iris within the eye is diagnosed. The mouth's openness or closure is decided. The mouth factor ratio and peak are measured. The motive force's head tilt forward or backward is analyzed. The driving force's head rotation left or right is analyzed. The percentage of eyelid closure is calculated. The extracted facial functions and styles are processed to decide the level of drowsiness. This involves studying the mixture of those functions to identify symptoms of fatigue or sleepiness. Based at the processed facial patterns, the gadget makes a judgment about the driving force's level of drowsiness. These statistics may be used to cause signs or prompt safety measures to prevent accidents. Overall, the photograph illustrates the procedure of the use of facial capabilities to locate driving force drowsiness, that's a critical protection situation within the car enterprise.

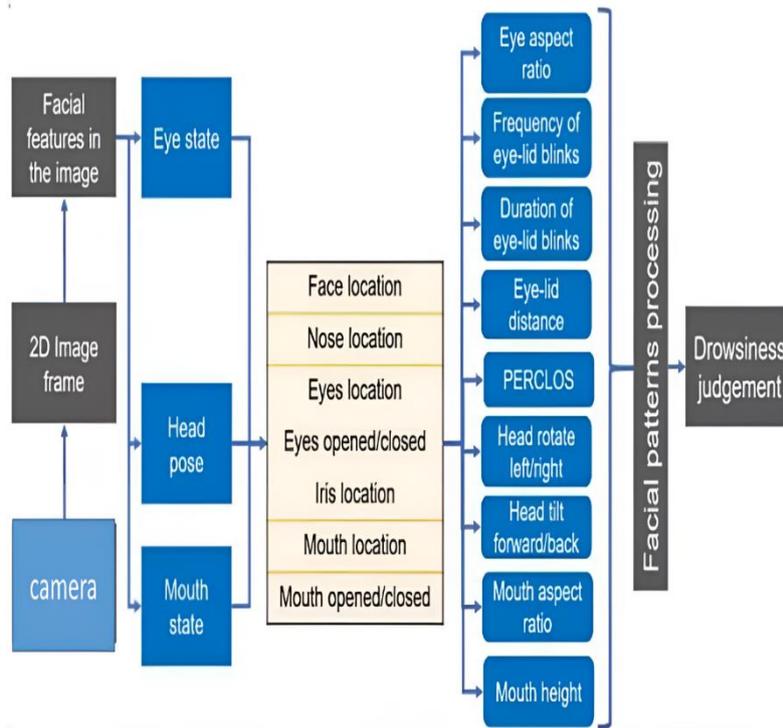


Figure 4: SYSTEM ARCHITECTURE

VII. Implementation

HAAR CASCADE CLASSIFIER:

Haar Cascade Classifier is a device gaining knowledge of item detection set of rules and object detection model that has been extensively utilized in laptop vision applications. A photo object detection set of rules based totally on device learning is the HAAR Cascade Classifier algorithm. The calculation works by means of dissecting the factors of the item to be identified and figuring out the way to comprehend it from specific articles inside the photo. The differences in intensity among the object and the history are what supply rise to these capabilities. The algorithm is frequently utilized in pc vision programs like face detection, pedestrian detection, and item tracking due to the fact it can identify multiple objects in a photograph. Positive and bad snap shots are used to educate the HAAR Cascade Classifier algorithm. Negative images do not contain the item that desires to be observed, whereas advantageous photographs do. In order to learn how to as it should be pick out the object, the set of rules examines the traits of both styles of photographs. HAAR functions, which are of rectangular styles or shapes of contrast version within the photograph, are the capabilities used in the set of rules. Integral pix, that are a method of representing the image to hurry up the function computation, may be used to efficaciously compute those capabilities.

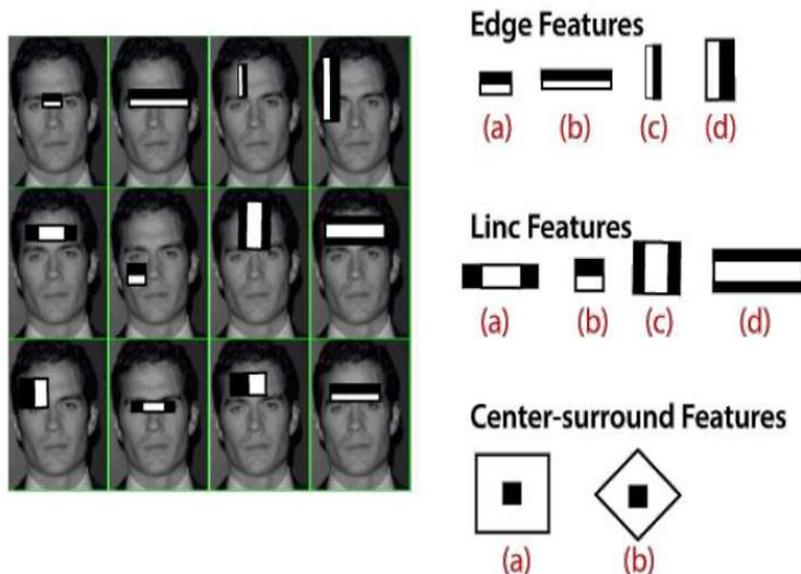
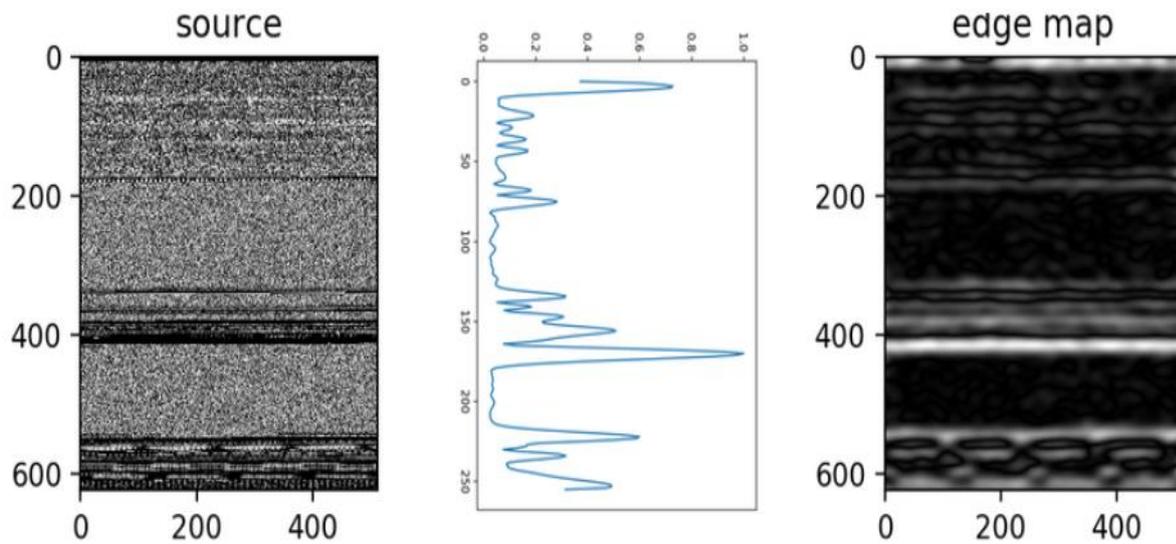


Figure 5: Haar Feature detectors



Horizontal edge feature vector and image.

### Horizontal Edge Feature



Figure 6: Horizontal Edge Feature

The diagram shows the results of edge detection in the image. The primary image is shown on the left, the edge map is shown on the right, and a horizontal edge feature vector is shown in the middle.

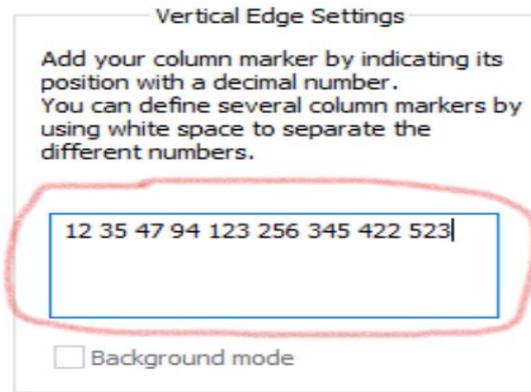
**Original Image:** This will be the provided image to the edge detection process. It appears to be a grayscale image with some horizontal and vertical patterns.

**Edge Map:** This is the output of the edge detection process. It emphasizes the rims inside the authentic photograph. Edges are regions where there may be a sudden alternate in depth.

In this case, the edge map shows parallel and the perpendicular lines, indicating the existence of edges in those directions.

**Horizontal Edge Feature Vector:** This will be the one-dimensional array that represents the energy of the horizontal edges within the picture. The x-axis of the plot represents the horizontal role inside the photograph, and the y-axis represents the power of the horizontal area at that function. The peaks within the plot correspond to areas of the photograph with sturdy horizontal edges. Overall, the diagram shows that the edge detection method has effectively identified the parallel and the perpendicular edges inside the original photograph. edge map and feature vector provide a useful representation of the image's edge information.

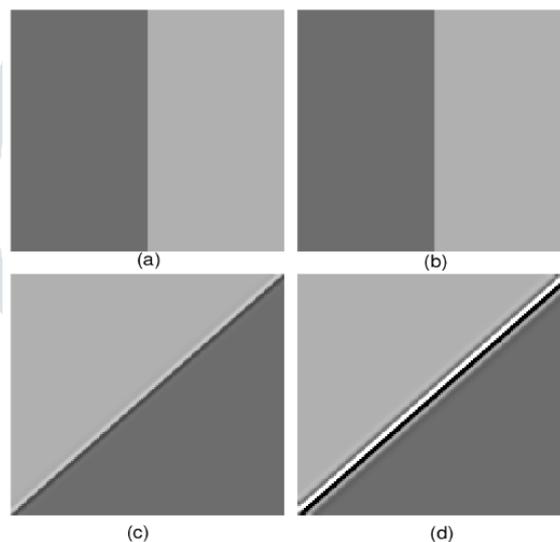
## Vertical Edge Feature



**Figure 7: Vertical Edge Feature**

The image shows a user interface element, likely from a software application, related to vertical edge settings. This UI element allows users to customize the settings for vertical edges, possibly within the context of a document editing, image processing, or layout design application. The column markers defined here are likely used to specify specific vertical positions within a document or image, which can be used for diverse intentions like aligning content, creating divisions, or applying effects.

## Diagonal Edge Feature (45 degrees)



**Figure 8: Diagonal Edge Feature**

These snap shots are regularly used to illustrate the idea of photograph gradients, which can be used in picture processing and laptop imaginative and prescient to hit upon edges and other features in snap shots. Gradients measure the price of exchange of depth in an image, and can be used to become aware of areas of the image with sharp transitions. (a) is a vertical gradient, with the left half being darker than the right half. (b) is a horizontal gradient, with the top half being darker than the bottom half. (c) is a diagonal gradient, with the top-left corner being darker than the bottom-right corner. (d): A diagonal gradient with a sharp edge, with the top-left corner being darker than the bottom-right corner, and a clear boundary between the two regions.

## Eye Aspect Ratio Calculation

It is an estimate of the eye-commencing state. This can be defined through the beneath equation. A system can determine if a person's eyes are shut if the Eye Aspect Ratio falls beneath a positive threshold.

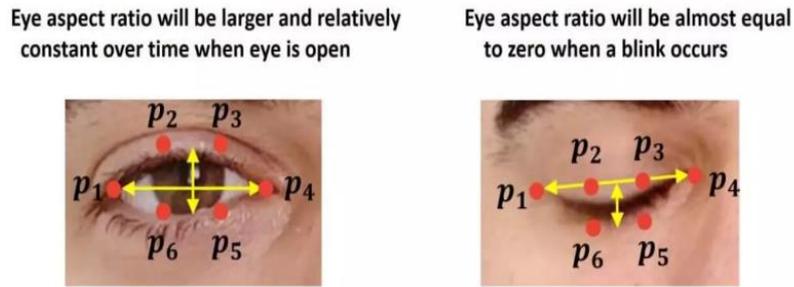


Figure 9: Eye marks when the eye is open and closed respectively

FORMULA

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

The acronym stands for Eye Aspect Ratio.  $||P2-P6||$  represents the Euclidean distance within two factors, P2 and P6. These points likely correspond to specific landmarks on the eye, such as the outer corners of the eyes.  $||P3-P5||$ , similar to the previous term, this represents the Euclidean distance between points P3 and P5. These points might correspond to the inner corners of the eyes.  $||P1-P4||$ , this term calculates the Euclidean distance between points P1 and P4. These points could represent the top and bottom points of the eye, respectively. The EAR formula essentially compares the vertical distance between the top and bottom of the eye ( $||P1-P4||$ ) to the average horizontal distance between the inner and outer corners of the eyes ( $||P2-P6|| + ||P3-P5||$ ). A higher EAR value generally indicates that the eyes are open, while a lower value suggests that the eyes are closed or nearly closed. By accurately calculating the EAR, computer vision could be well briefed choice about a person's state.

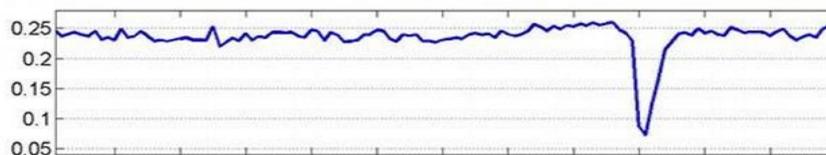


Figure 10: Eye Aspect Ratio plotted over time, the downfall in the graph shows a blink of the vehicle driver

**Mouth Aspect Ratio Calculation**

Mouth Aspect Ratio is calculated by using the face with sixty-eight- (x, y) coordinates. As we can view that the mouth is shown by means of a fixed of 20- (x, y) coordinates. So, we've got to use the coordinates 62, 64, 66 and 68 to calculate the space within them in the identical manner as EAR calculation.

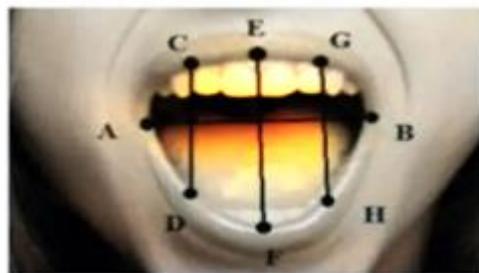


Figure 11: Mouth marks when the mouth is open

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

The image shows a grayscale image of a face with several points labelled from A to H. These points represent specific face landmarks which will be applied in MAR calculation. It includes vertical lines connecting points C and D, E and F, and G and H, respectively. These lines represent the distances between various points on the mouth. CD, EF, and GH represents the lengths of the vertical lines connecting the corresponding points, essentially measuring the distances between different parts of the mouth. AB represents the length of the horizontal line connecting points A and B, which is likely a reference point for normalization. 3, a

constant is used for scaling and normalization purposes. The MAR formula calculates a ratio that indicates the relative openness of the mouth. By dividing the sum of the vertical distances (CD, EF, and GH) by the normalized horizontal distance ( $3 * AB$ ), the formula essentially compares the mouth's vertical "height" to its horizontal "width." Generally, a decrease in MAR indicates that the mouth is closing, which can be a sign of fatigue or drowsiness. By monitoring changes in MAR over time, a system can detect patterns that suggest a driver's attention level is waning. The driving force's degree of drowsiness is then assessed using the EAR and MAR values. The following thresholds are used to decide the diploma of drowsiness: The motive force is concept to be drowsy if EAR is less than 0.25. The motive force is deemed to be yawning if the MAR is extra than 0.4. Driver drowsiness can be as it should be detected in real time by means of the given system. A picture dataset will be applied to check the device, and it produced an accuracy of ninety-six%. The photographs within the dataset depict drivers who are fully alert, fairly drowsy, and severely drowsy, respectively. In every instance, the system become able to as it should be pick out driver drowsiness.

### VIII. USE CASE DIAGRAM

Use case diagram are treasured for visualizing the useful requirements of tool with a view to translate into design choices and improvement priorities. Use case diagrams are treasured UML diagram kind and often used to investigate several systems. They let you visualize the distinctive sorts of roles in a device and the way the ones roles engage with the machine. The diagram illustrates a machine designed to hit upon driver drowsiness. It makes use of a digicam to capture actual-time pictures of the motive force's face and analyses facial cues, in particular the eyes and mouth, to determine their drowsiness state. If the machine detects a excessive level of drowsiness, it triggers an alarm to alert the motive force.

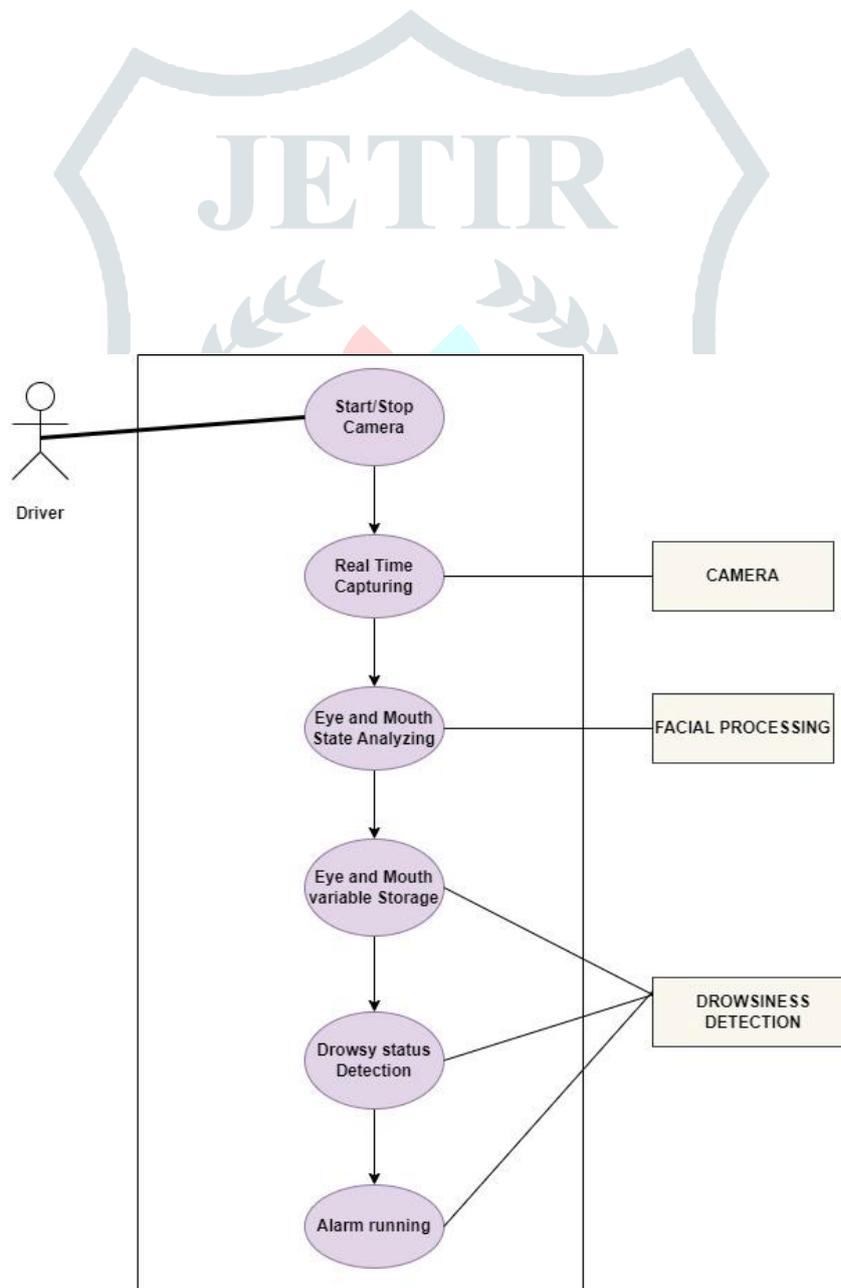
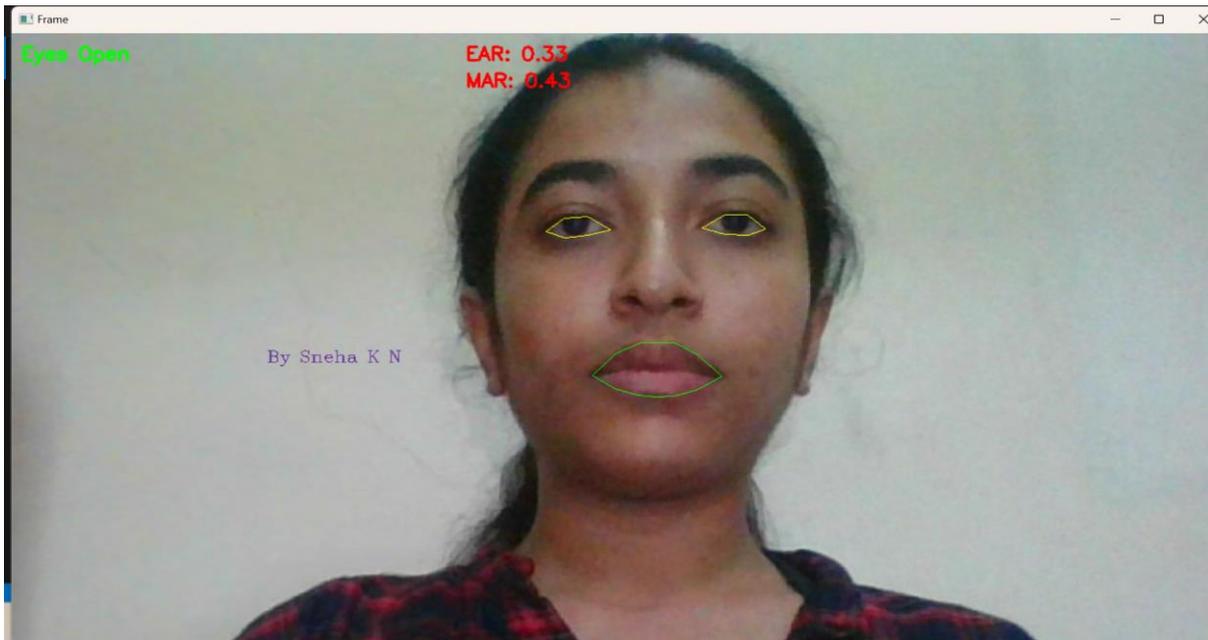


Figure 12: Use case Diagram of Driver Drowsiness Detection

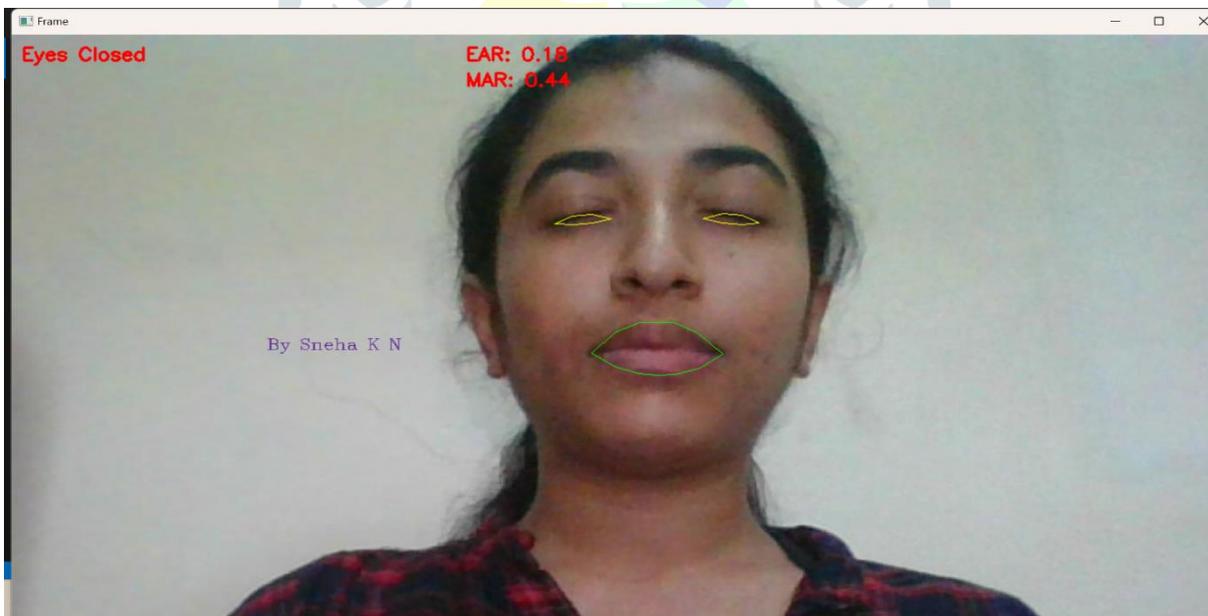
## IX. RESULTS AND DISCUSSION

This section, we describe the different outcomes of our project execution and the system performance as below.



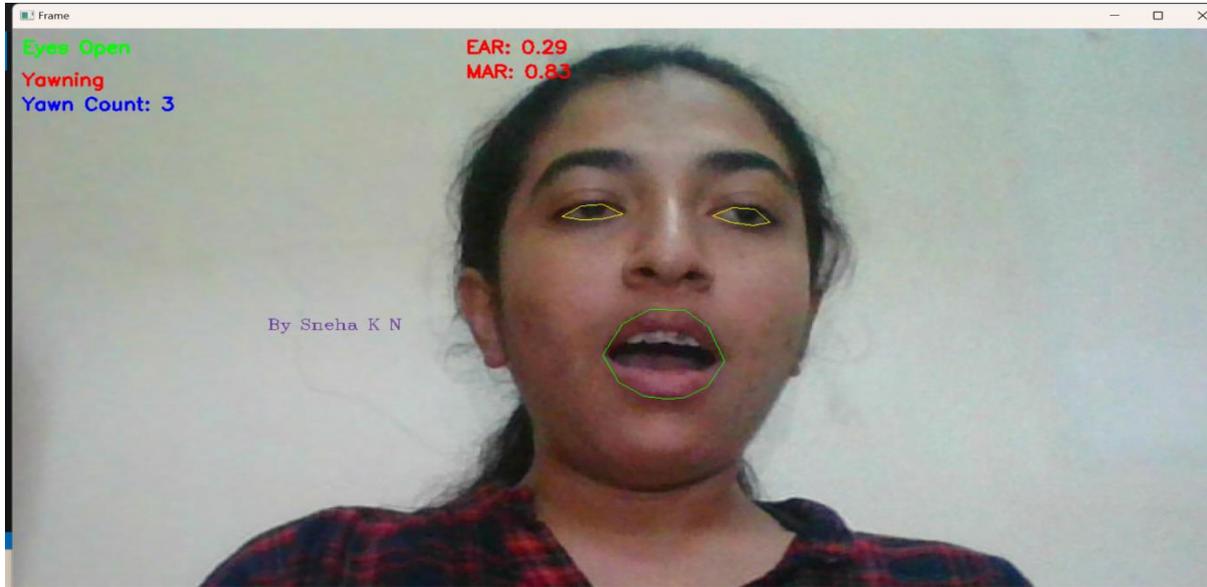
**Figure 13: Eyes open**

When the webcam starts to capture the driver's face, it recognizes the eyes moment and displays whether the eyes are closed or opened. Here the eyes are opened.



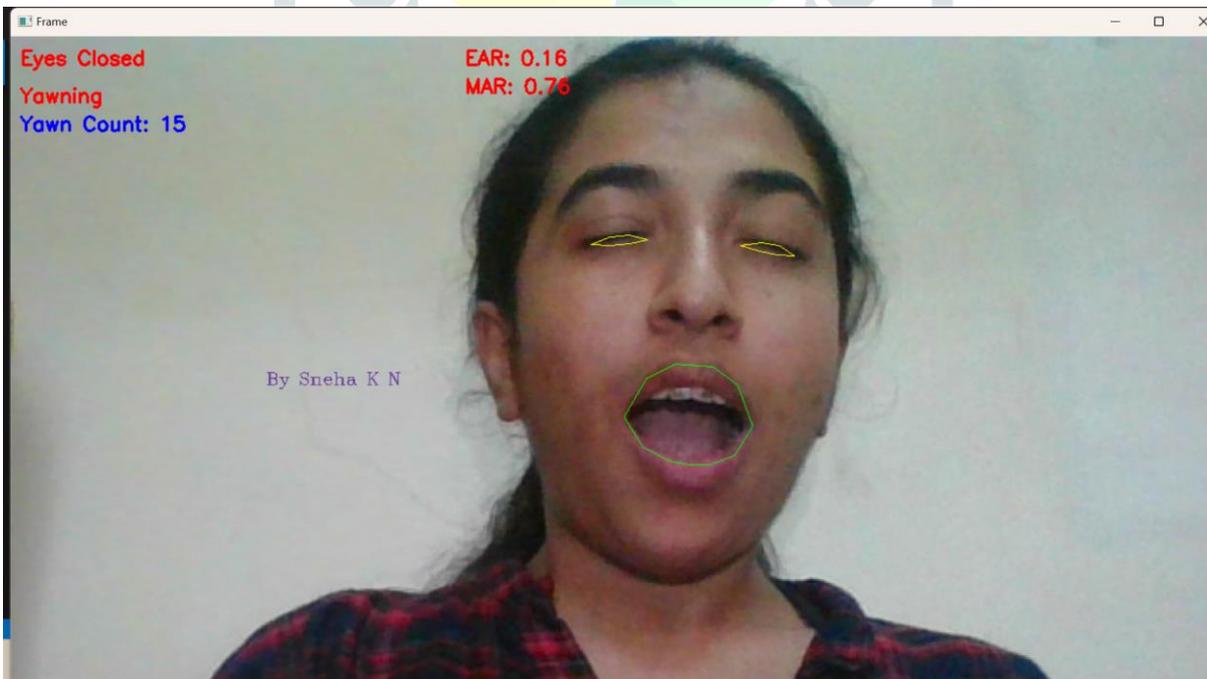
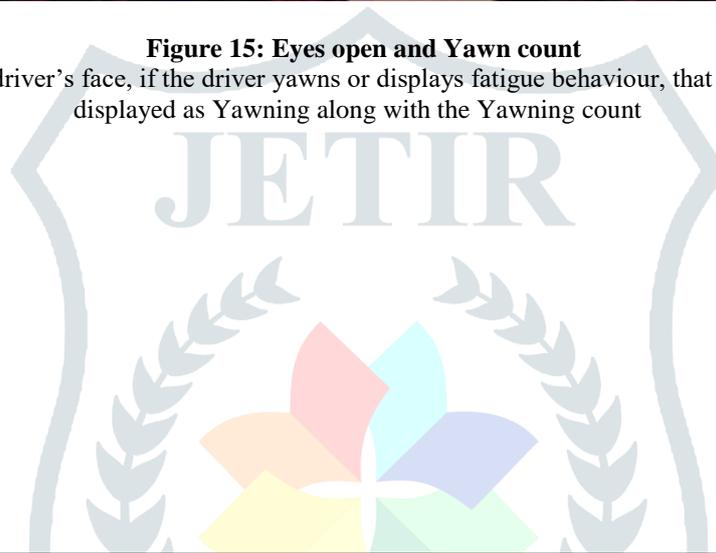
**Figure 14: Eyes closed**

When the webcam starts to capture the driver's face, it recognizes the eyes moment and displays whether the eyes are closed or opened. Here, the eyes are closed.



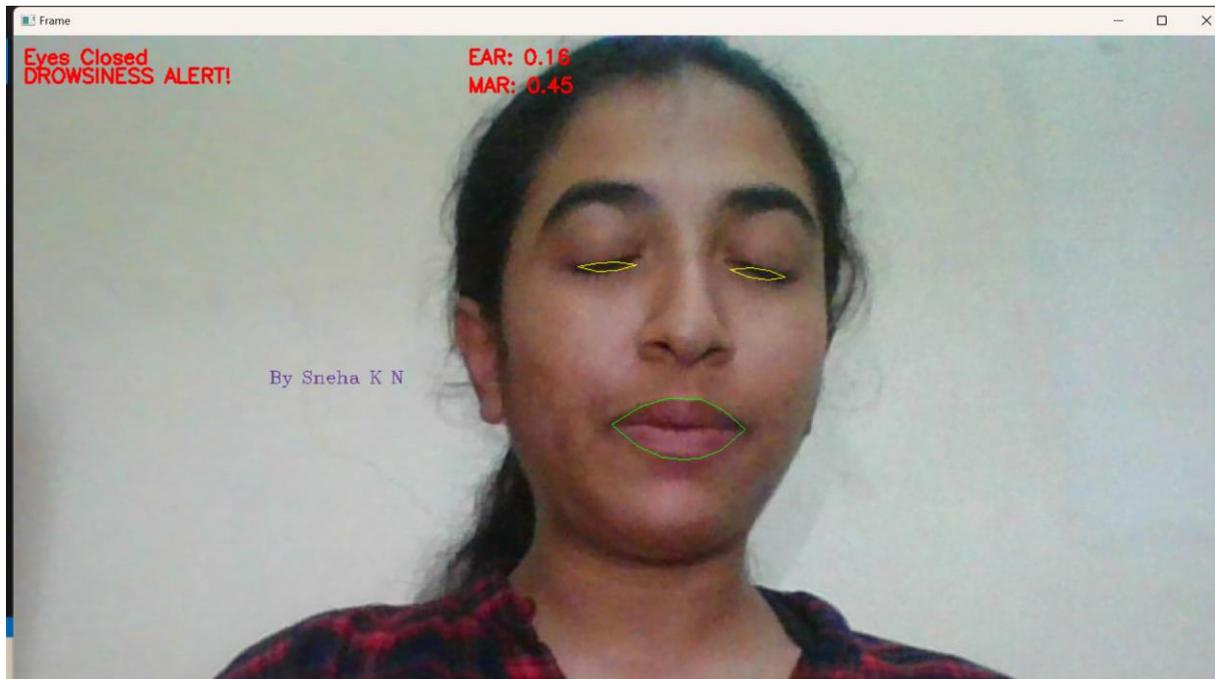
**Figure 15: Eyes open and Yawn count**

After capturing the driver's face, if the driver yawns or displays fatigue behaviour, that can be captured and displayed as Yawning along with the Yawning count



**Figure 16: Eyes closed and Yawn count**

Both the eyes and mouth moment are captured together with the yawn count. The EAR and MAR will be displayed constantly with the values.



**Figure 17: Drowsiness Alert**

If the driver displays the drowsiness action for a certain period of time, then the Alert will be displayed as it detects the drowsiness.

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