Driver Fatigue Detection in Vehicles using Computer Vision.

Project Plan

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Introduction

- Fatigue and distraction are among the major risk factors associated with commercial motor vehicle (CMV) crashes.
- The effects of fatigue on drivers include impaired performance, loss of attentiveness, slower reaction times, impaired judgment, and increased probability of falling asleep.
- Excessive driver fatigue leads to drowsiness, a major cause of crashes, and can lead to severe physical injuries, deaths, and significant economic losses.
- A distracted driver (e.g., a driver who is texting, talking on phone, eating while drivin g, etc.) may not be paying attention even when looking toward the road. Head pose, and gaze estimations are the critical measurement of driver distraction for most cases.

Objectives of the Project

The aim of this project is to develop a prototype for driver fatigue and drowsiness detection system and in order to achieve it below are the following objectives:

- To be able to detect a face from video feed or input image.
- To be able to detect the region of interests i.e., multiple facial features.
- To accurately classify the state of eye i.e., open or closed.
- To classify various classes of the driver's state based on multiple parameters of facial features.
- To provide a warning alarm to the driver based on the classification classes.

Scope

Areas to Include/ Exclude

Include

- Computer vision
- Open cv
- Classifier
- Image recognition
- Image detection
- Machine learning

Exclude

- Artificial intelligence
- Hardware deliverable

System Interface

The proposed system has the following steps:

Step 1: Read the input image from a video feed obtained through webcam.

Step 2: Extraction of the region of interests (facial features).

Detecting facial landmarks is a two-step process:

- Localize the face in the image. (Face Detection)
- Detect the key facial structures on the face ROI.

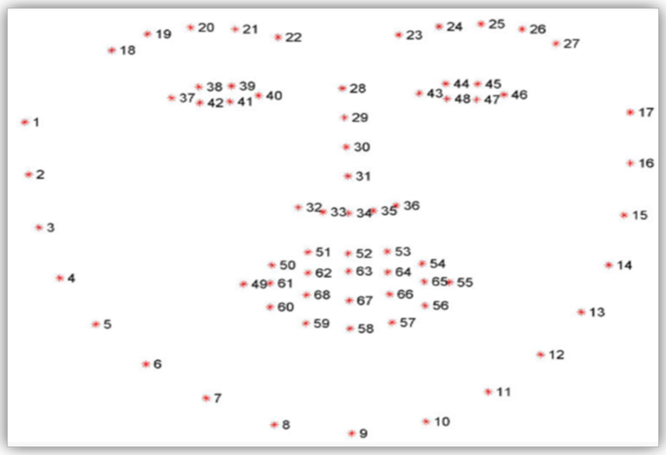


Fig.1: Visualizing the 68 facial landmark coordinates from the iBUG 300-W dataset

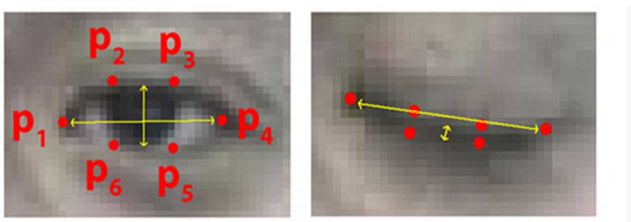
For the face Detection through OpenCV, HAAR feature based cascade classifiers is used.

The pretrained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face.

Eye Detection:

- For every video frame, the eye landmarks are detected.
- The eye aspect ratio (EAR) between height and width of the eye is computed.

$$EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2||p1 - p4||}$$



- The EAR is mostly constant when an eye is open and gets close to zero while closing of eye.
- The drowsiness of the driver is detected by measuring the EAR against a set threshold value.

Yawn detection:

- A person’s yawning is a symptom for drowsiness.
- Yawn can be detected by calculating mouth aspect ratio using the facial landmarks with dlib similar to the calculation of eye aspect ratio.
- A threshold is set based on how long it is open and how often the driver is yawning based on which an alarm is set.

Head tilt detection:

- When drowsy a person’s head often tilts from the correct position. Using 3D facial landmarks of tip of the nose, chin, left corner of the left eye, right corner of the right eye, left corner of the mouth and right corner of the mouth.
- In OpenCV the function solvePnP and solvePnPRansac can be used to estimate pose. solvePnP implements several algorithms for pose estimation which can be selected using the parameter flag.

Major Deliverable

- Face Detection.
- Eye Detection.
- Yawn Detection.
- Head tilt Detection.
- Facial Feature Extraction based on region of interest by Facial Landmarking.
- Classification of various classes based on the multiple features’ state.
- Playing of warning alarm when drowsy state class is detected.

Assumptions

The technology proposed will never have environmental challenges. like lighting, false movements and capturing speed. There would not be any false negatives. The inputs are always taken in good lighting. The alarm beep could not be misunderstood with other beeps. The implemented hardware will always be robust.

Organization

Structure

The team will divide itself to work on OpenCV and dlib software’s. Four of us will be developing the detection modules and one will be working on the Alarm module. In case of delay in delivering the components, there will be proper resource planning depending of the work completed.

Roles and Responsibilities

Person 1

- Working on Video Capturing
- Detection of Face

Person 2

- Recognition of Face
- Extraction of Facial Features

Person 3

- Eye Detection
- Yawn Detection

Person 4

- Head Position Detection

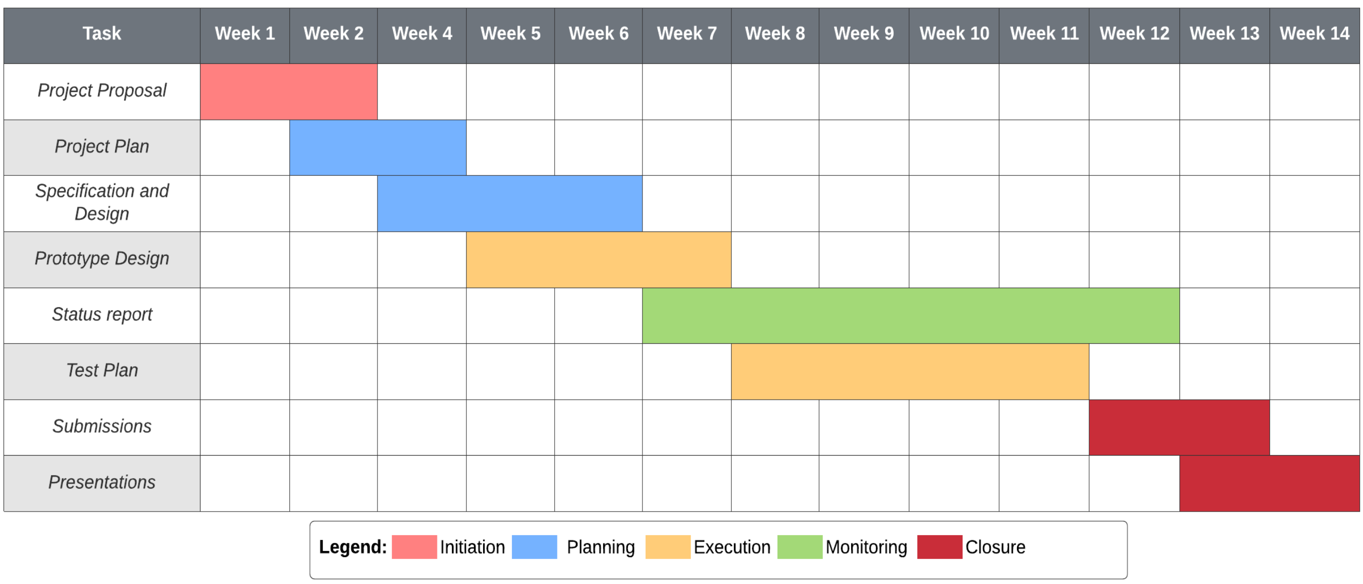
Person 5

- Alarm module

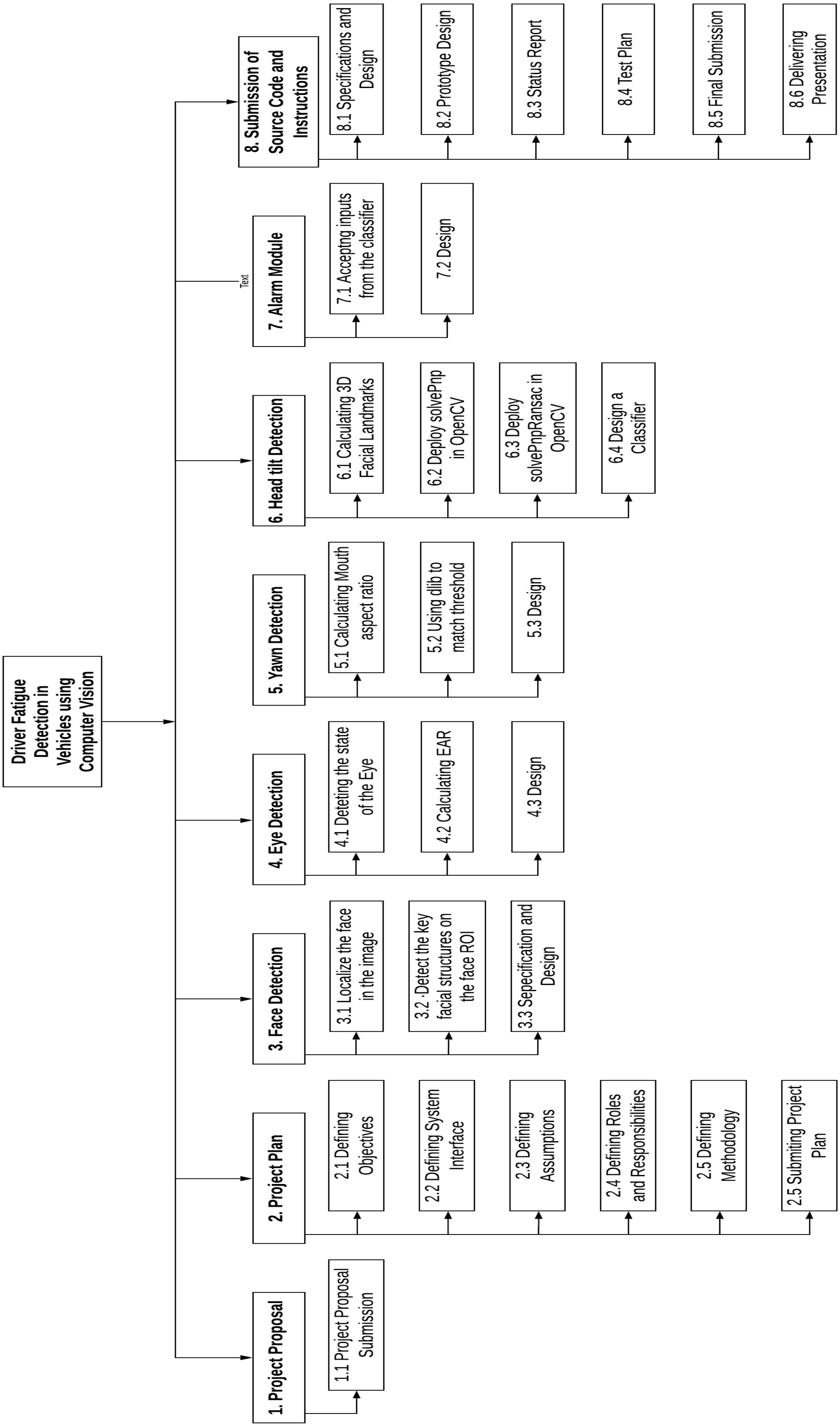
Finally, the collected data from the above detections using the threshold-value-set, is used to classify the image and raise the alarm if the driver is fatigued.

Scheduling

Gantt Chart



Work breakdown structure



Control and Reporting

Due to the current constraint of COVID-19, gathering at a common place for discussions and executions is not possible. In order to keep up with our work we will be relying on Jupiter notebooks to track and counter check our progress. One-hour slots are scheduled daily to keep the track of any progress made. Team members will be using Screen sharing platforms to help each other and give assistance whenever needed. Daily logs are maintained via emails.

Risk/ Constraints Management

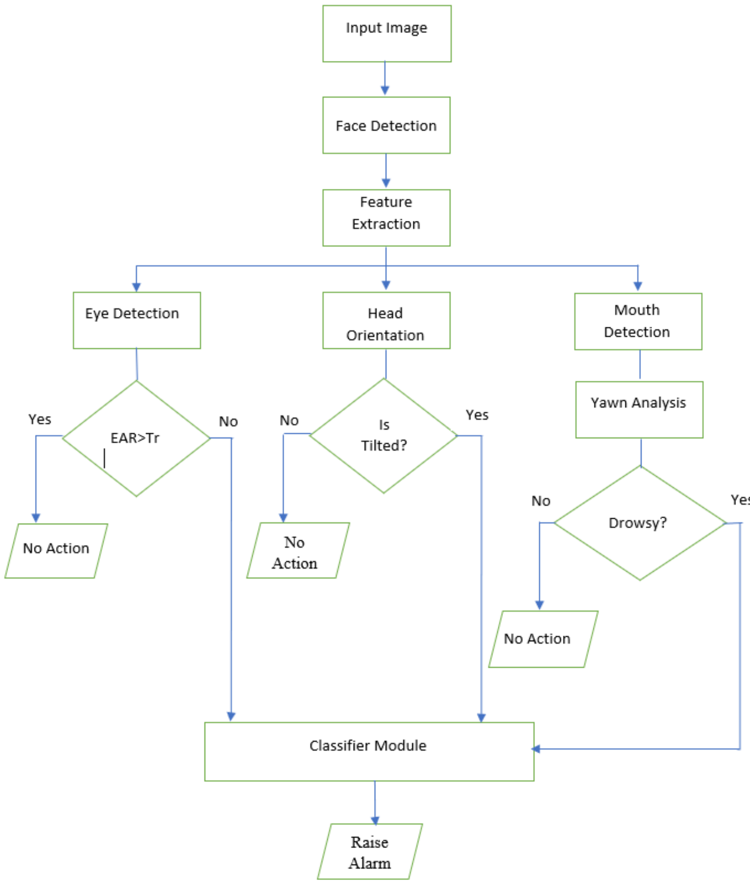
To meet the requirements of efficiency and functionality the technology should comply with the following guidelines:[7]

- It should measure what it is operationally and conceptually intended to measure and be consistent in these measurements over time. Thus, a device designed to measure eye blinks (operationally) and alertness (conceptually) should measure these all the time for all drivers.
- The software technology used in the device should be optimised for sensitivity and specificity. False negatives should be minimised through accurate and reliable detection of reduced alertness levels. False positives should be minimised through accurate and reliable identification of safe driving and operator vigilance.
- The device should be robust, reliable and capable of continuous operation over extended periods, such as a shift. Maintenance and replacement cost should not be excessive.
- Be capable of real time monitoring of driver or operator behaviour.
- The device should be capable of accurately operating under various operational conditions during the day, at night and under illuminated conditions. Accuracy should not be compromised by conditions in the operator cab, such as humidity, temperature, vibration, noise, etc.
- Audible warning signals should not startle the operator and should be adjustable over a reasonable range. The signals should be distinct and audible under operating conditions to not be confused with other alarms and signals.

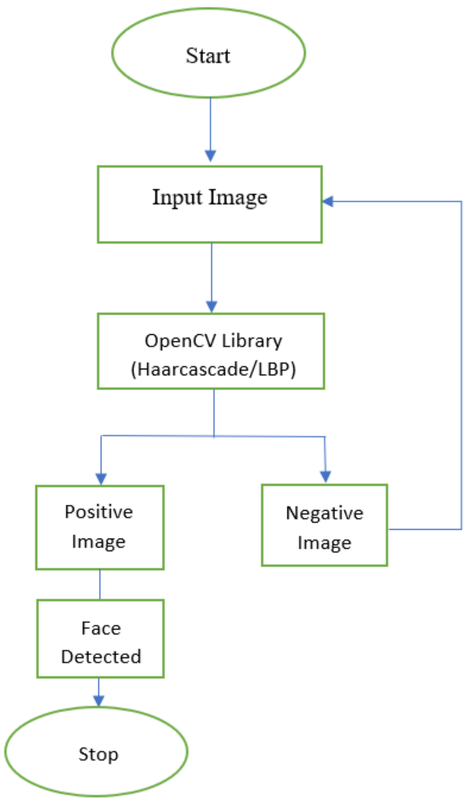
Delivery Strategy

Approach/ Methodology

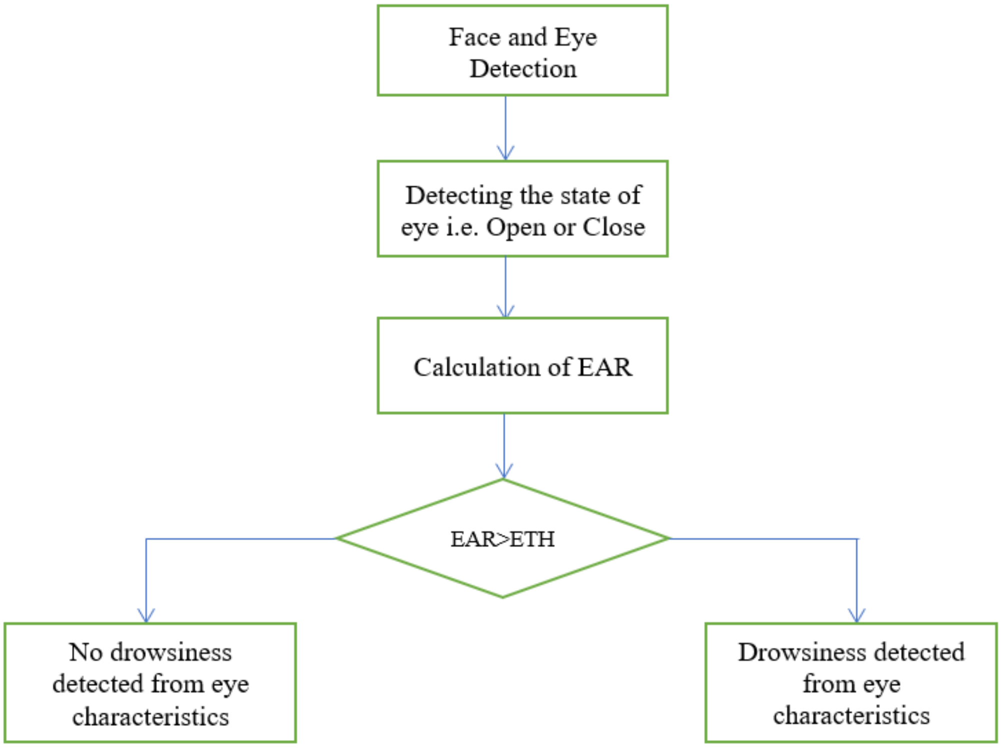
Data Flow Diagram for Execution:



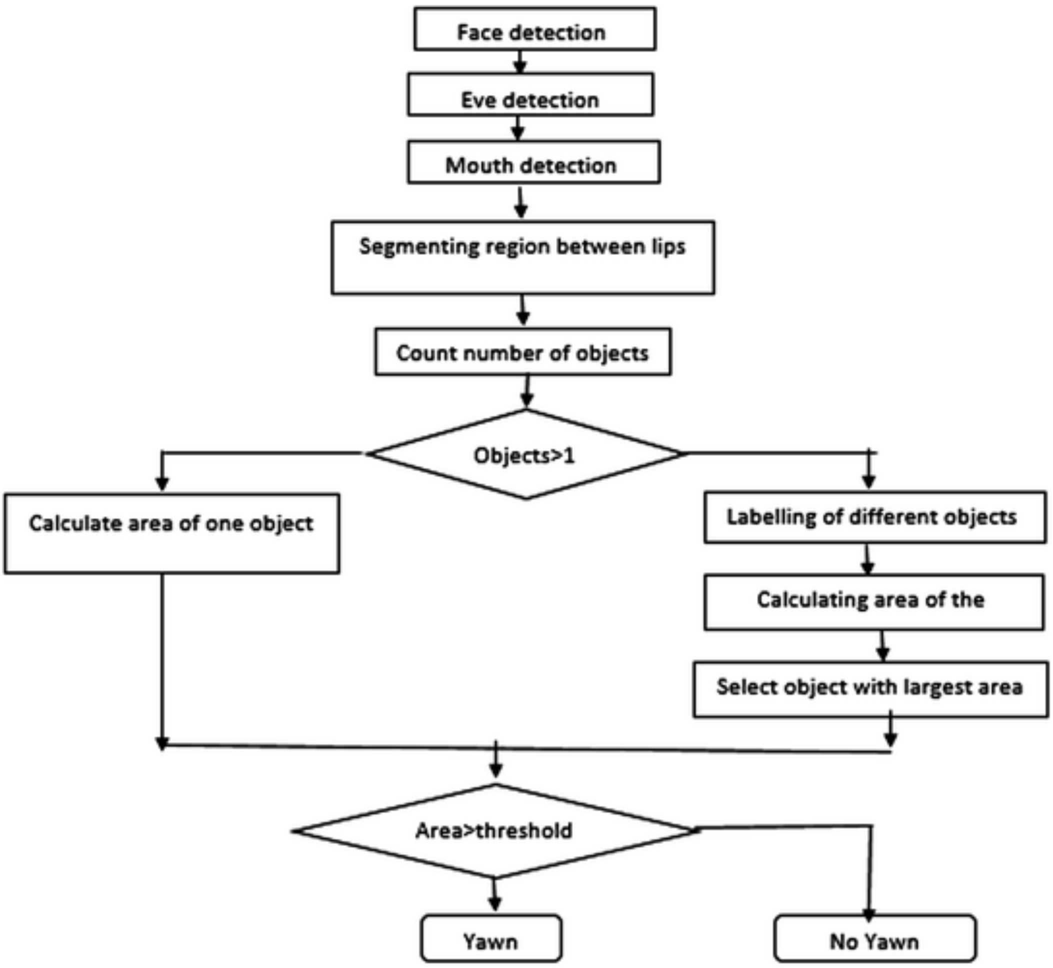
Flow Chart for Face Detection:



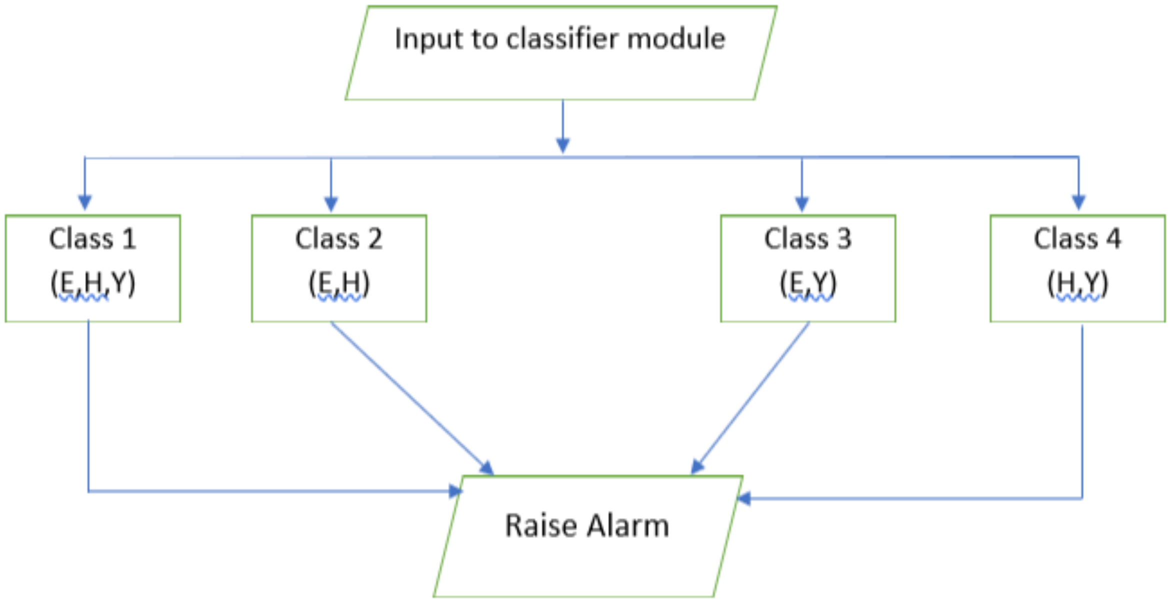
Data flow Diagram to Detect Drowsiness in Eye:



Data Flow Diagram for Yawn Analysis:



Data Flow Diagram for classifier:



E: Drowsiness detected in eye

H: Drowsiness detected in Head tilt

Y: Drowsiness detected in Yawn analysis