DRIVER DISTRACTION DETECTION USING FACIAL LANDMARKS

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AGENDA

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Motivation

- One of the main causes behind the driver’s lack of alertness is due to long time traveling without sleep and rest.
- According to the US National Highway Traffic Safety Administration, approximately **100,000** crashes occur in US each year due to drivers’ drowsiness.
- To prevent this type of incidents, it is required to monitor driver’s alertness continuously and when it detects drowsiness, the driver should be alerted.

INTRODUCTION

- Every year approximately 1.35 million people die due to traffic accidents, a heartbreaking statistic in this report is that injuries caused by road accidents lead to the death of young people between 5 and 29 years of age [1].
- There are many common distractions causes these road accidents.
- Recently, interest in driver-assistance systems that detect driver actions and help them drive safely has increased.

[1] Road crashes: a preventable epidemic around the world

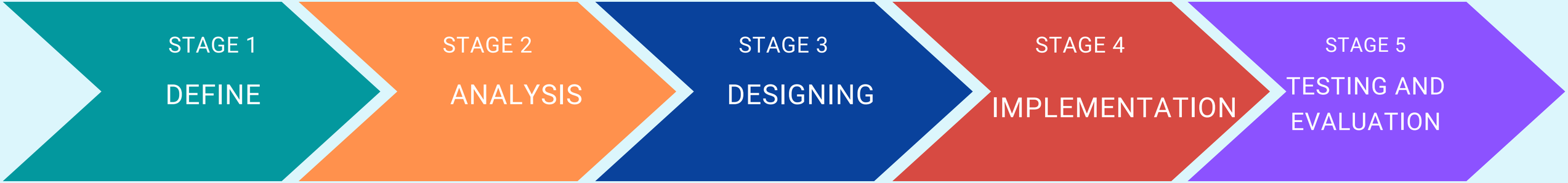
PROBLEM DEFINITION

Camera that detect drowsiness level of the driver does not exist in more than 95% percent of cars.

The National Highway Traffic Safety Administration estimates that every year about 100,000 police-reported, drowsy-driving crashes result in nearly 800 fatalities and about 50,000 injuries. The real number may be much higher,, as it is difficult to determine whether a driver was drowsy at the time of a crash [2]. however

[2] nsc./road/safety-topics/fatigued-driver

PROJECT METHODOLOGY



- searching and looking for literature review
- Define problem statement

- Designing different models.

- Designing the different code functions.
- Designing the hardware

- Using a laptop for implementing the code
- Implementing the code on the raspberry pi.

- Developing an actual system, for detecting drowsy and distracted driver using facial landmarks by using a camera, to be existed in the market.

RELATED WORK

- A real time system is proposed in [3] to monitor driver’s state such as sleepiness, yawning and if drivers fall sleep or yawn more than 4sec, our systems alert the driver to be in normal driving state.
- A RGB camera is mounted at front windows and constantly looking at drivers face.
- He also set a timer for each driver such that if driver is driving constantly till 12 hours, this proposed system triggers an alarm to switch off from driving.
- First step of this approach is to detect the face from each frame and recognize the face to check whether it is same driver or different driver.
- If it is the same driver he constantly monitoring eye closeness and yawning and simultaneously timer is also increases. If it is different driver, a separate timer is initialized and start monitoring the driver state.

[3] Isha Gupta, Novesh Garg, Apoorva Aggarwal, Nitin Nepalia and Bindu Verma Proceedings of 2018 Eleventh International Conference on Contemporary Computing (IC3), 2-4 August, 2018, Noida, India

RELATED WORK CONT.

- The system is basically developed in [4] to detect drivers dozing at the wheel at night time driving.
- The system uses an infra-red night vision camera that points directly towards the driver’s face and monitors the driver’s eyes in order to detect fatigue.
- In such a case when fatigue is detected, a warning signal is issued to alert the driver.
- The decision whether the driver is dozing or not is taken depending on whether the eyes are open for a specific number of frames.
- If the eyes are found to be closed for a certain number of consecutive frames, then the driver is alerted with an alarm.
- Problem with this algorithm is that the same distance can be there between a different set of clusters which are really not the eyes.

[4] Ganesh D. Bhutkar, Priyadarshan S. Dhabe, Manikrao L. Dhore, Assistant Professors Proceedings of the World Congress on Engineering and Computer Science 2007WCECS 2007, October 24-26, 2007, San Francisco, USA

PROPOSED SOLUTION

- In this work, an approach is proposed to solve the problem of eye tracking, a framework for eye movement recognition is built after detecting the contours of the eye, the distance or gap between the upper and lower points is calculated based on these actions, the system will be able to determine whether the eye is open or closed So the system can alert the driver if the eyes are closed.

- The goal is to develop an eye tracking algorithm to enable us to by pass the limitations of eye tracking technologies.

PROPOSED SOLUTION

- Existence of camera that detect drowsiness level of the driver does not exist in more than 95% percent of cars and ones who have are luxurious ones and are not affordable to most of people.

- A real-time algorithm to detect eye blinks, yawn and lack of focusing in a video sequence from a standard camera is proposed. Recent landmark detectors, trained on in-the-wild datasets exhibit excellent robustness against a head orientation with respect to a camera, varying illumination and facial expressions.

- The proposed algorithm therefore estimates the landmark positions, extracts a single scalar quantity – eye aspect ratio (EAR) and mouth aspect ratio (MAR) – characterizing the eye and the mouth opening in each frame.

- Shape predictor algorithm detects eye blinks as a pattern of EAR values in a short temporal window. The simple algorithm outperforms the state-of-the-art results on two standard datasets.

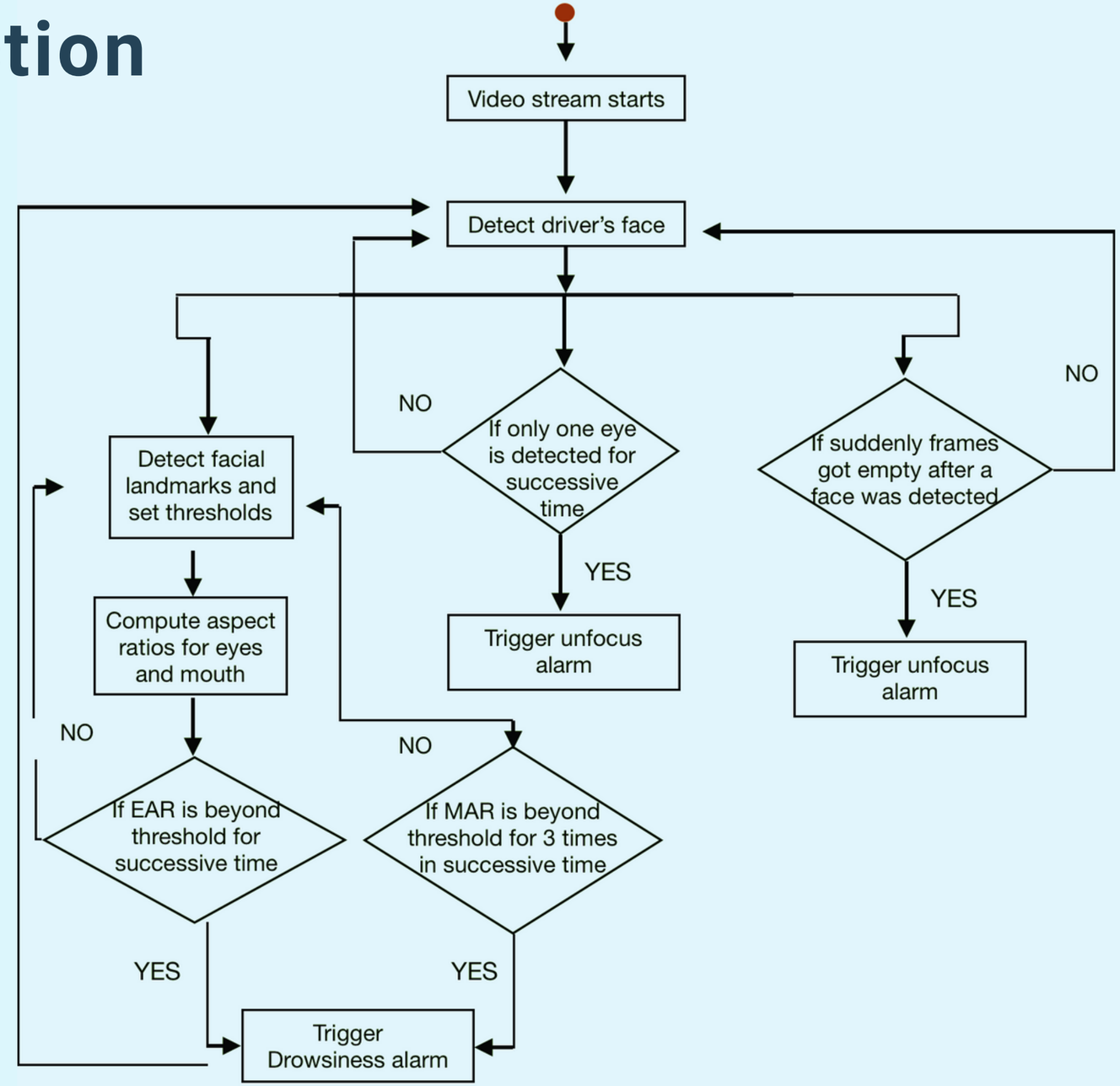
Scope of the work

•The Driver distraction detection framework presented in this work is Digital camera. This camera used in cars while driving. It is suitable for all types of cars.

•This proposed project detects eye blinks, yawn, lack of focusing and sudden face disappearance.

•To increase the driver’s attention and to reduce the possibility of an accident.

Driver distraction detection



DRIVER DISTRACTION DETECTION :

1.VIDEO STREAM

- The car was rigged with a drowsiness detector.

- The camera was used for this project was a Webcam Night Vision 300 GoldShip Mod.3526 - Leadership.

- This is the preferable camera as it:

1. Is relatively affordable.
2. It has 6 LEDs for use in dark environments.
3. Is plug-and-play compatible with nearly every device was
4. tried it with (including the Raspberry Pi).

- The camera was taken and mounted to the top of the dash using some double sided tape to keep it from moving around during the drive.

- The camera was then connected to the Raspberry Pi or to the laptop on the seat next to the driver.

DRIVER DISTRACTION DETECTION :

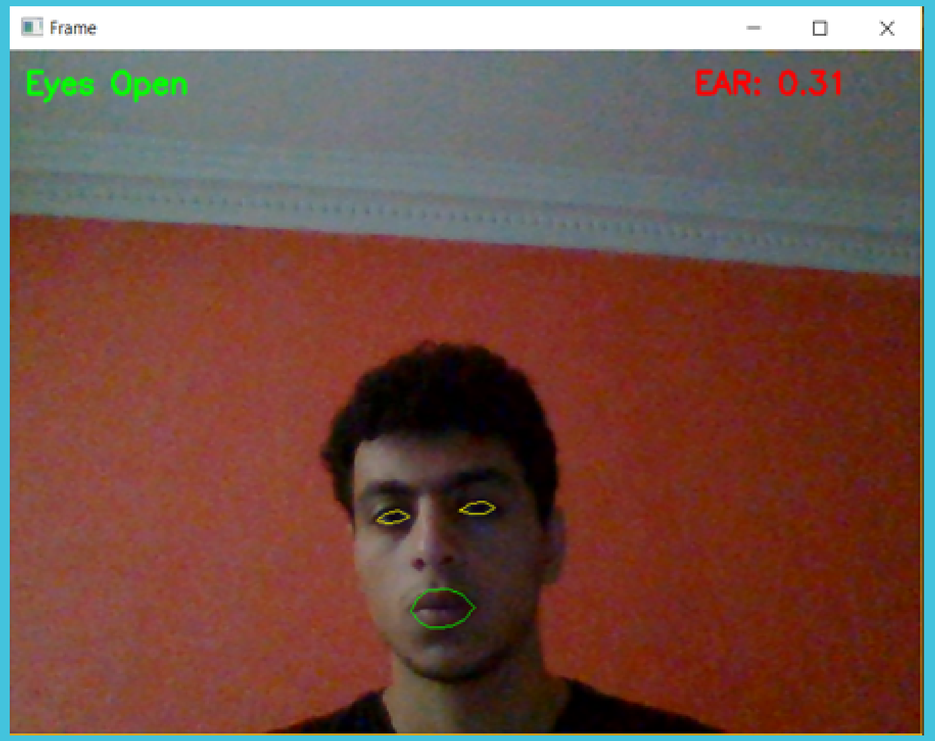
• 2. FACE DETECTION WITH DLIB (HOG + LINEAR SVM)

- HOG (Histogram of Oriented Gradients) + Linear SVM (Support Vector Machine) face detector is accurate and computationally efficient.

- The idea behind HOG is to extract features into a vector, and feed it into a classification algorithm , Support Vector Machine in our case, that will assess whether a face is present in a region or not.

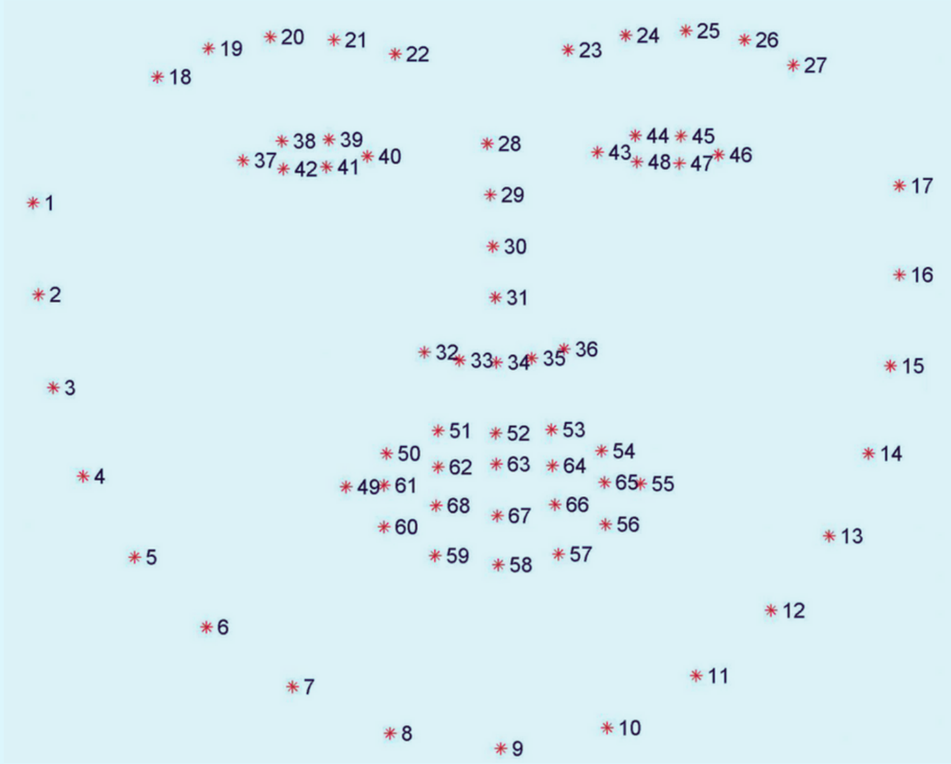
- HOG has four main steps :

1. Preprocessing
2. Calculate the Gradient Images
3. Calculate Histogram of Gradients
4. Block Normalization



DRIVER DISTRACTION DETECTION : 3. FACIAL LANDMARKS DETECTION

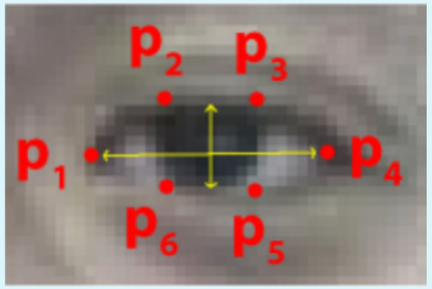
- The pre-trained facial landmark detector inside the dlib library in OpenCV is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face.
- The indexes of the 68 coordinates can be visualized on the image below:

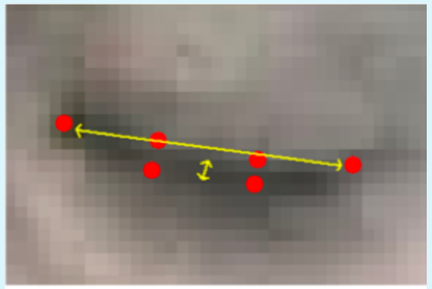


Driver distraction detection :
4. Eye aspect ratio (EAR) and mouth aspect ratio (MAR)

EYE ASPECT RATIO (EAR)

- From the landmarks detected in the image, we derive the eye aspect ratio (EAR) that is used as an estimate of the eye opening state. Since the per-frame EAR may not necessarily recognize the eye blinks correctly, a classifier that takes a larger temporal window of a frame into account is trained. For every video frame, the eye landmarks are detected. The eye aspect ratio (EAR) between height and width of the eye is computed.

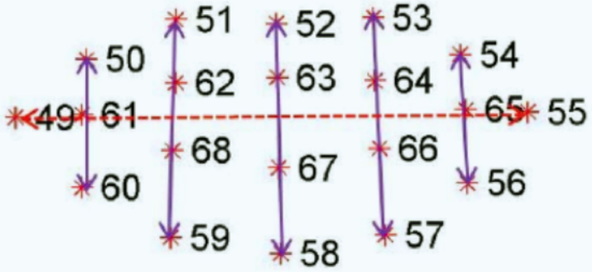




$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|},$$

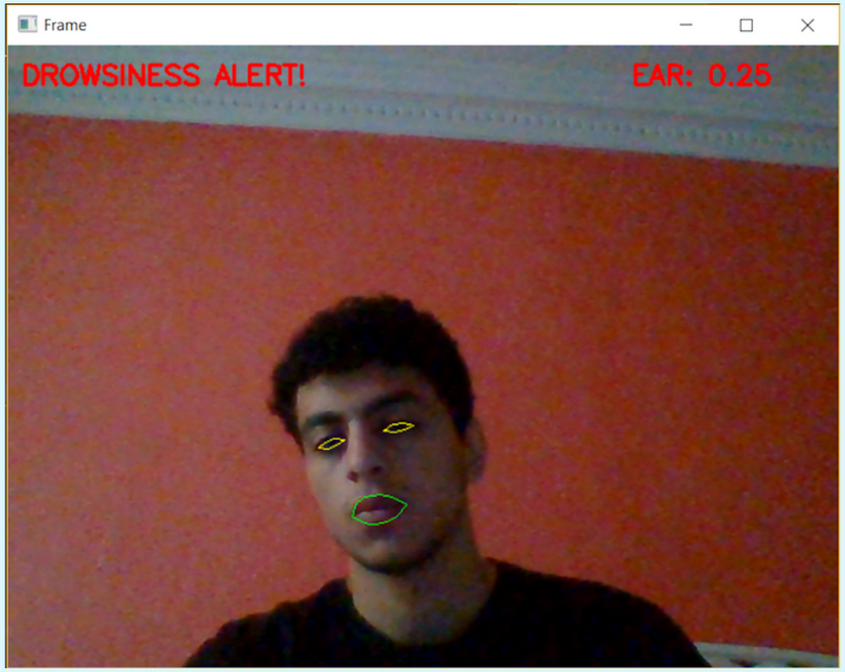
MOUTH ASPECT RATIO (MAR)

- The horizontal and vertical distance of the mouth is calculated as : MAR=(50-60)+(51-59)+(52-58)+(53-57)+(54-56)/(2*(49-55))

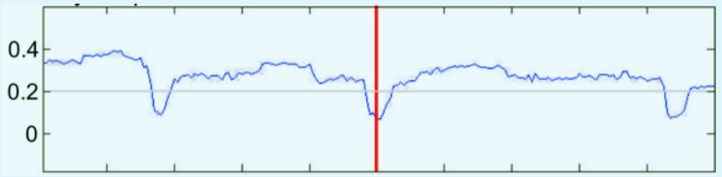


DRIVER DISTRACTION DETECTION : 5. EAR IS BEYOND THRESHOLD

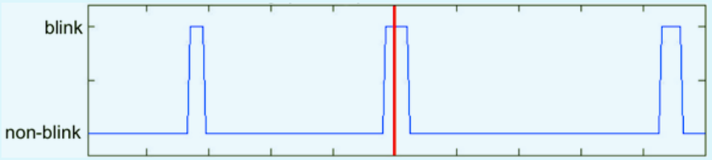
- Example of detected blinks. The plots of the eye aspect ratio EAR results of the EAR thresholding (threshold set to 0.25), the blinks detected by EAR SVM and the ground-truth labels over the video sequence. Input image with detected landmarks (depicted frame is marked by a red line).



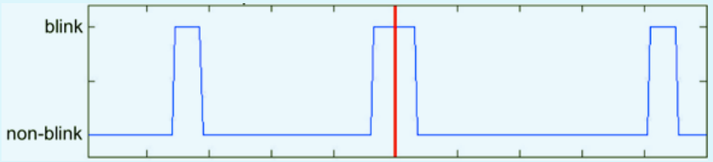
EYE ASPECT RATION



EAR THRESHOLDING (T=0.25)



EAR SVM OUTPUT

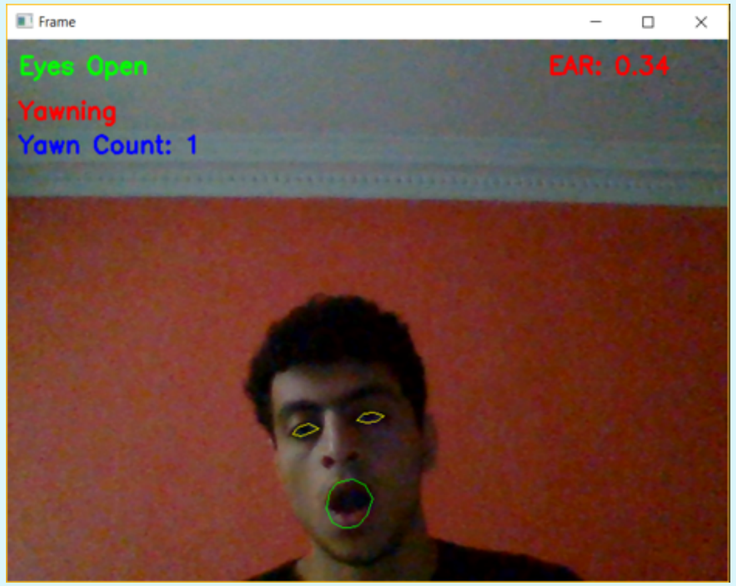


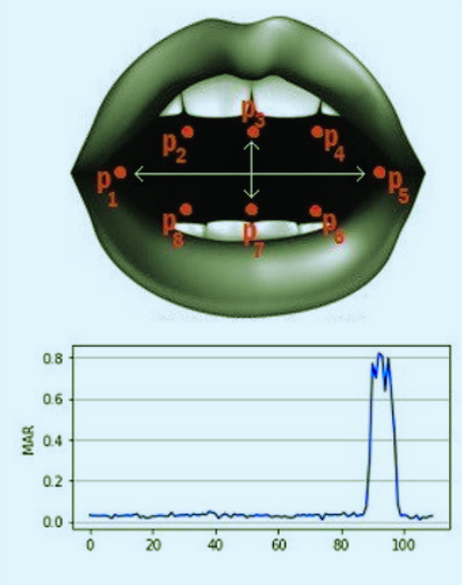
GROUND-TRUTH

DRIVER DISTRACTION DETECTION : 5. MAR IS BEYOND THRESHOLD

- Example of detected yawning. The plots of the mouth aspect ratio MAR results of the MAR thresholding (threshold set to 0.8), the yawns detected by MAR SVM and the ground-truth labels over the video sequence.

- When the driver yawns three times in a short period of time, the system will notice drowsiness and then trigger a drowsiness alarm.

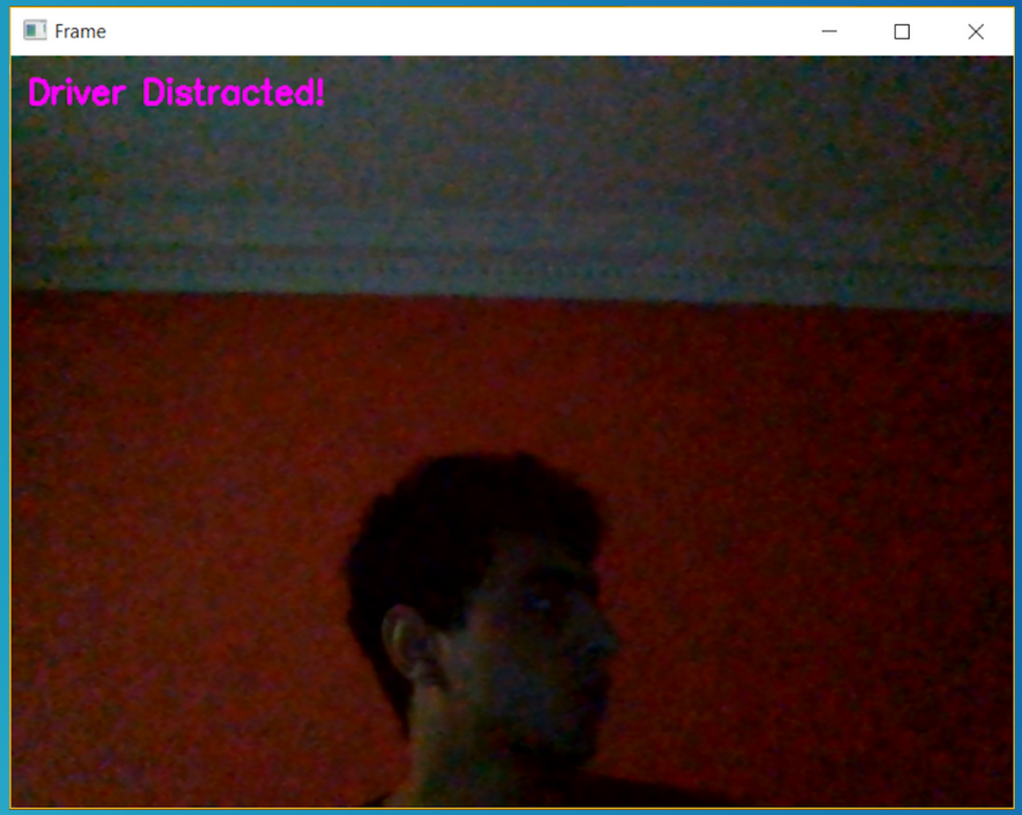




$$\mathbf{MAR} = \frac{\|p_2 - p_8\| + \|p_3 - p_7\| + \|p_4 - p_6\|}{2\,\|p_1 - p_5\|}$$

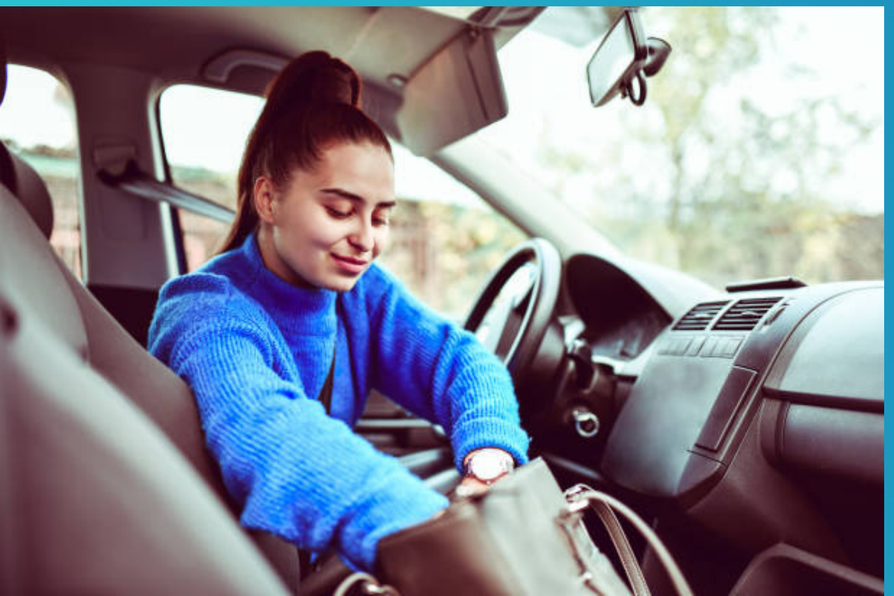
DRIVER DISTRACTION DETECTION :
6.ONE EYE IS DETECTED FOR SUCCESSIVE TIME

- If the process of face detection failed to detect the two eyes and the complete mouth, this means that the driver is looking right, left or down. In this case, a different alarm will be triggered to make him focus while driving.



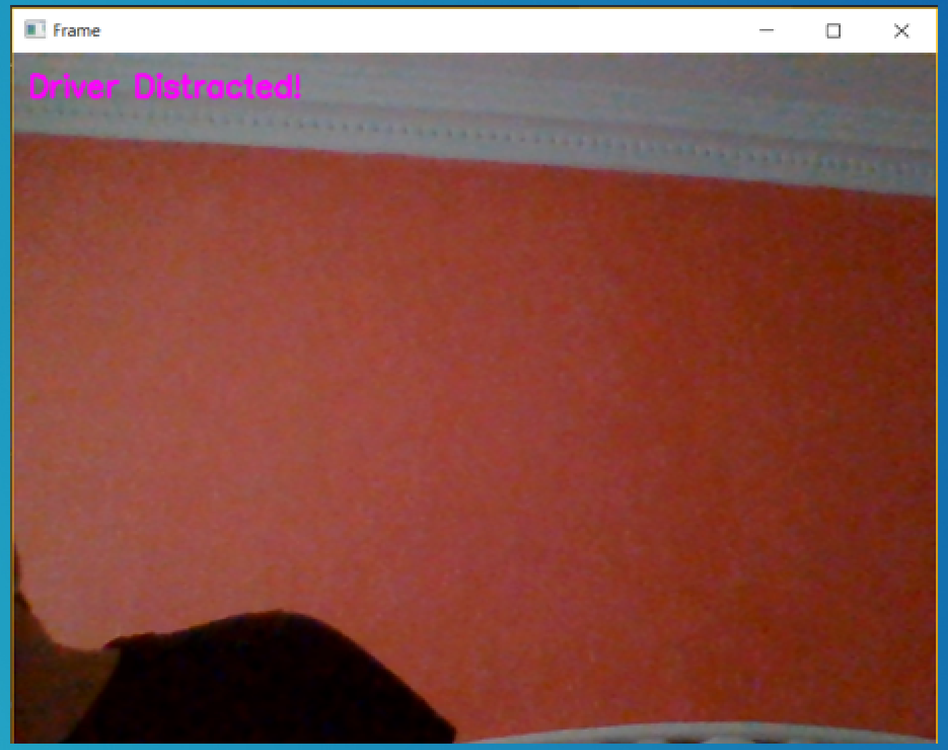
DRIVER DISTRACTION DETECTION :
7.SUDDENLY FRAMES GOT EMPTY AFTER A FACE WAS DETECTED

- If suddenly frames got empty after a face was detected, this means that the driver may have been distracted that he got off to pick up something from down or might be doing something behind. In this case, unfocus alarm is triggered to make the driver focus while driving.

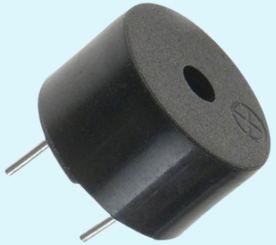


DRIVER DISTRACTION DETECTION : 7.SUDDENLY FRAMES GOT EMPTY AFTER A FACE WAS DETECTED CONT.

- Our demo for when suddenly the frames got empty.

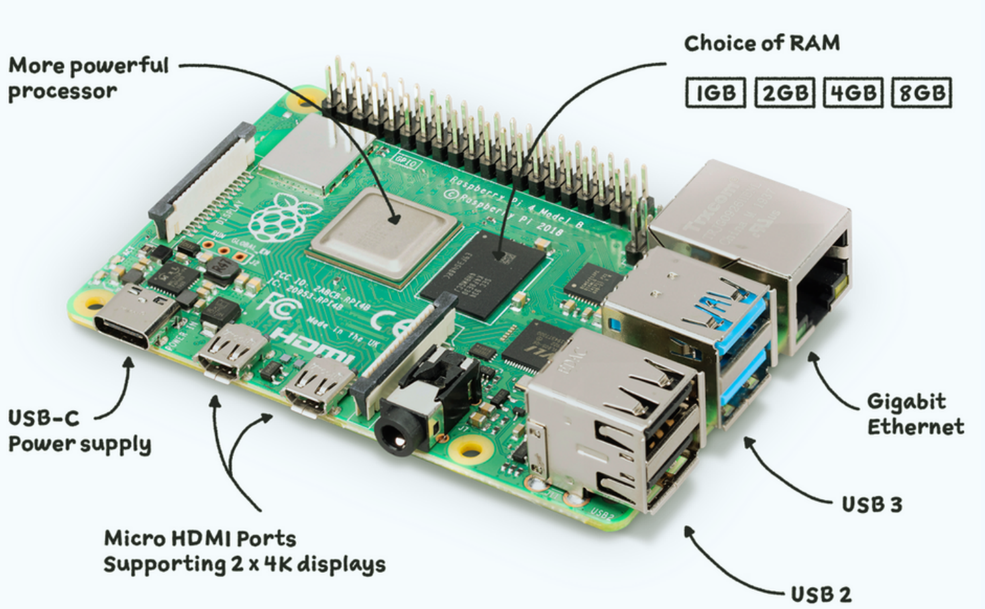


HARDWARE



RASPBERRY PI

- 2gb ram raspberry pi (4 processors dual core, version 4, model B).

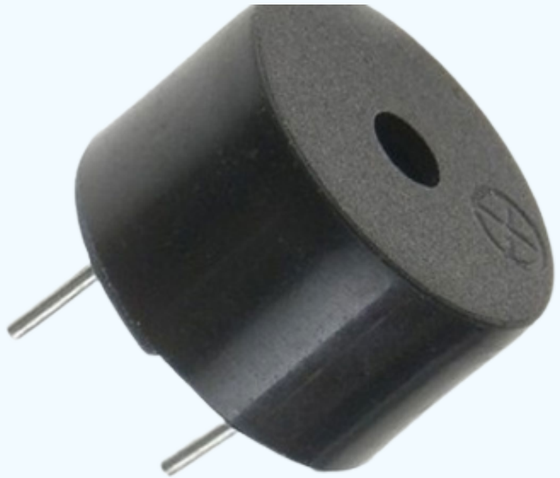


WEBCAM NIGHT VISION 300 GOLDSHIP MOD.3526 - LEADERSHIP

- It has 6 LEDs for use in dark environments.
- Automatic light sensor that lights up the LEDs if the ambient lighting is not adequate.
- Electronic exposure control.
- Focus: 10 cm to infinity.
- Maximum Resolution: 5M Pixels.

BUZZER

- enclosed inside the Raspberry Pi casing.
- Connected to the GPIO of Raspberry Pi.
- Provides a medium loud beeping sound to alert the driver if he/she is in a drowsy condition or unfocused condition.



HDMI CABLE

- Displays the output.

CONCLUSION AND FUTURE WORK

- The driver distraction detection system developed is capable of detecting **drowsiness** and **distraction** in a rapid manner.
- The system can differentiate normal eye blink and drowsiness.
- Can be implemented in all cars types.
- This project can be implemented in the form of mobile application to reduce the cost of hardware.
- This project can be integrated with car, so that automatic speed control can be imparted if the driver is found sleeping.


THANK YOU