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Driver Fatigue Detection System using Face Detection

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Abstract - *In recent years driver fatigue is one of the major causes of vehicle accidents in the world. Due to these accidents, many people lose their lives or get severely injured. A direct way of measuring driver fatigue is measuring the state of the driver i.e. drowsiness. So, it is very important to detect the drowsiness of the driver to save life and property. This work is aimed towards developing a prototype for drowsiness detection and accident prevention using Raspberry Pi. This system is a real-time system which captures image continuously and measures the state of the eye according to the specified algorithm and gives a warning if required. So, when the closure of the eye exceeds a certain amount which is observed by the camera module connected to the Raspberry Pi, the driver is identified to be sleepy and an alert is given in the form of a buzzer or any other sound from the Pygame module present in the Raspbian OS. If the alerts are found to be more than a particular count, the processor gradually reduces the speed of the vehicle and the system ignition is set to off state by stopping the motor and send the email to the registered person. If there aren't any alerts i.e. the eye closure range is within a certain threshold, then the system lets the engine run without any interruption. This system continuously monitors the drowsiness of the driver and thus helps in reducing the possibility of occurring accidents*

Key Words: **Fatigue Detection,Face detection, Raspberry Pi, USB camera, Eye Aspect Ratio..**

1. INTRODUCTION

Each year, around 1.5 lakh people die in road mishaps in India. Some of them due to drowsy or sleep-driving. Around 400 people on average are losing their lives every day on Indian roads. That means 16 precious lives being sucked out every minute. We often hear of drunken driving, no seat belt, speeding, road condition, bad weather, and mechanical failures. But one of the biggest and yet often unrecognized human errors is drowsy driving. A major problem not only in India but across the globe. The risk, danger, and often tragic results of drowsy driving are alarming indeed. Lack of sleep is the main culprit. And add to it the promoters like medications, alcohol and sleep disorders, sleepiness gets in serious condition. Many drivers sacrifice sleep, an often overlooked and dangerous behaviour that results in the majority of them being sleep-divested while behind the wheel every day. There is no official count of lives lost in drowsy driving-related crashes in our country. Falling asleep at the wheel is suicidal. It is not only dangerous to the driver but all other road users. It certainly risks our lives. Vision-based systems are becoming more popular and are more widely used in different applications. Such complex systems could also be used to detect vehicle operator fatigue using vision-based solutions. Drowsiness is such a condition of a man, which does not allow for a full concentration. It influences the human response time to decrease because the tired person reacts much slower, compared to the rested one. Nowadays, more and more professions require long-term concentration. People who work for the transportation business must keep a close eye on the road, so they can react to sudden events immediately. Long hours of driving cause driver fatigue and, consequently, reduces her/his response time. Some of them conducted experiments with the driving simulator and they concluded that a tired driver is much worse dangerous than a person whose alcohol level in blood is 25% above the allowed limit. Driver fatigue can cause the driver to fall asleep behind the wheel. Therefore, there is a need to develop a system that will detect and notify a driver which could significantly reduce the number of fatigue-related car accidents. Due to the increasing number of vehicles on the road, which translates into road accidents directly, equipping a car with the fatigue detection system is a must. One of the technical possibilities to implement such a system is to use a vision-based approach

We came up with the solution implemented in the form of image processing. To perform image processing, Open CV and D-Lib open source libraries are used. Python is used as a language to implement the idea. Camera is used to continuously track the facial landmark and movement of eyes andlips of the driver. This project mainly targets the landmarks of lips and eyes of the driver. For detection of drowsiness, landmarks of eyes are tracked continuously. Images are captured using the camera . These images are passed to image processing module which performs face landmark detection to detect distraction and drowsiness of

driver. If the driver is found to be distracted then a voice(audio) alert and is provided and a message is displayed on the screen. Following use cases are covered in this project.

1. If eyes of drivers are closed for a threshold period of time then it isconsidered that driver is feeling sleepy and corresponding audio alarm is usedto make the driver aware.

2. If the mouth of driver remains open for the certain period of time then it is considered that driver is yawning and corresponding suggestion are provided to the driver to overcome drowsiness.

3.If driver don't keep eyes on the road then it is observed using facial landmarks and the corresponding alarm is used to make the driver aware . All this functionality is then implemented with the help of an audio interfacing which is used to provide audio feedback to the user and a small screen is used to display the message. A solution to this problem is to identify when the driver is falling asleep and alarming the passengers of the situation so that appropriate measures can be taken.

4. If count exceeds the threshold level, the motor speed reduces. The speed of the motor can be controlled by PWM. This system is interfaced with Raspberry PI 3 with Raspbian OS, USB camera, Motor.

Car drivers, truck drivers, taxi drivers, etc. should be allowed to use this solution to increase the safety of the passengers, other road users and the goods they carry.

2. EXISTING SYSTEM

2.1 Driver Drowsiness Detection System for Vehicle Safety using sensors –

Feature-This system uses eyeblinking sensors to identify driver drowsiness.

Disadvantage- Driver have to wear Bulky specticlas equpied with sensor and wire.

2.2 Steering Wheel Behavior Based Estimation of Fatigue

Feature- This system uses sensor on the steering wheel to check the behavior of driving while feeling fatigue and while being awake and compare them.

Disadvantage – Sensors can send data induced with noise and every vehicle have different type and size sterring wheel which will result in inaccuracy

2.3 Lane Departure Warning System-

Feature- This system uses sensor to keep track of the road lanes and alert the driver if it shifting lanes

Disadvantage – This system will work only if the Lane lines are visible and properly drawn on the Road

3. PROPOSED METHODOLOGY

The principal goal is to detect the fatigue of the driver, the sleepiness of the driver is captured by a camera module. Open cv is a library of programming functions aimed at real-time computer vision and it consists of a large number of libraries for detecting object faces. The detection is done using object and face detection algorithms like Haar Cascades and Shape predictor libraries. The Eye Aspect Ratio which indicates the drowsiness of the driver is calculated at every instant of time and is compared with the threshold values. The proposed method involved the following methodologies such as H Classifiers, Shape Predictor_68_facial landmark detection, Eye Aspect Ratio (EAR), alert system, Motor speed control using PWM.

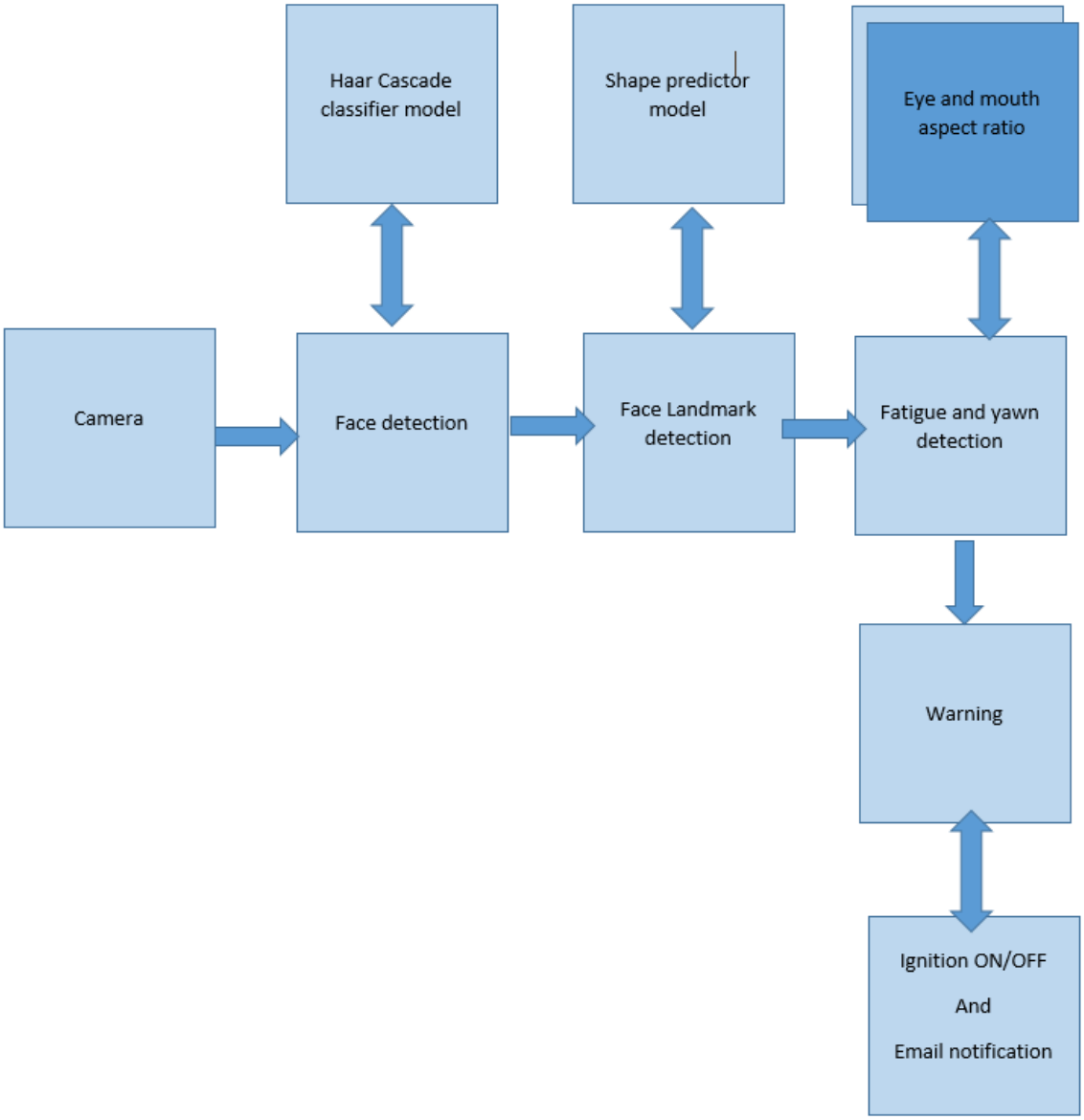


Figure 1 -Architure of the System

3.1Taking Image as Input from a Camera.

With a webcam, we will take images as input. So to access the webcam, we made an infinite loop that will capture each frame. We use the method provided by OpenCV, to access the camera and set the capture object will read each frame and we store the image in a frame variable.

3.2 Haar Cascade Classifiers

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. It is a machine learning-based an approach, where a cascade function is trained from a lot of positive

and negative images the First step, is to collect the Haar Features. A Haar feature considers adjacent window sums up the pixel intensities in each region. At first, we apply every feature on all training images. There are about 6000 features. A window is created instead of applying 6000 features they are grouped into stages and applied one by one. Open cv provides a training method or pre-trained models upon installation.

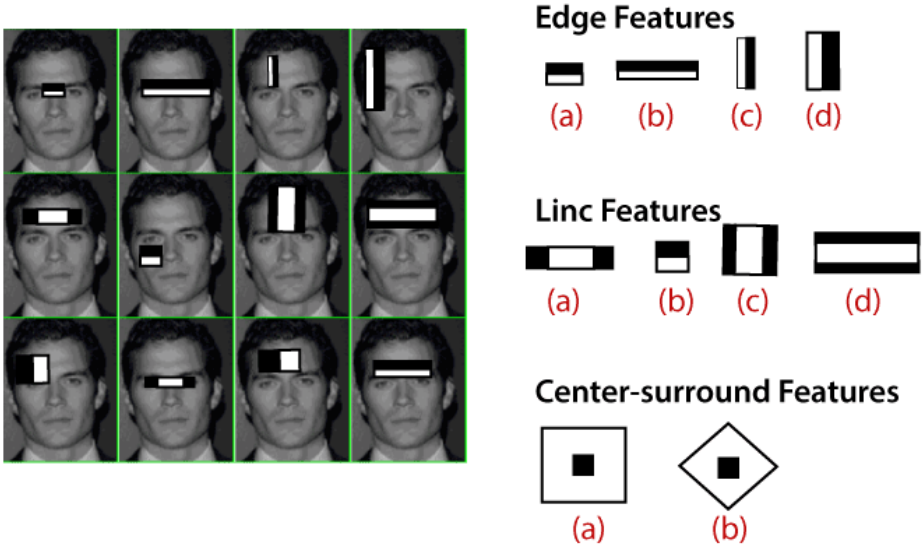


Figure 2 – Haarcascade classification example

3.3 Detection of Face in the Image and Create a Region of Interest (ROI) using DLib

It localizes the face in the image and detects key facial features using open cv haar cascade and facial landmarks in the dlib library. Detecting landmarks is a subset of the shape prediction problem. Given an input image, a shape prediction algorithm attempts to localize key points.

To detect the face in the image, we need to first convert the image into grayscale as the OpenCV algorithm for object detection takes gray images in the input. We don't need color information to detect the objects. We will be using classifier to detect faces. It returns an array of detections with x,y coordinates.

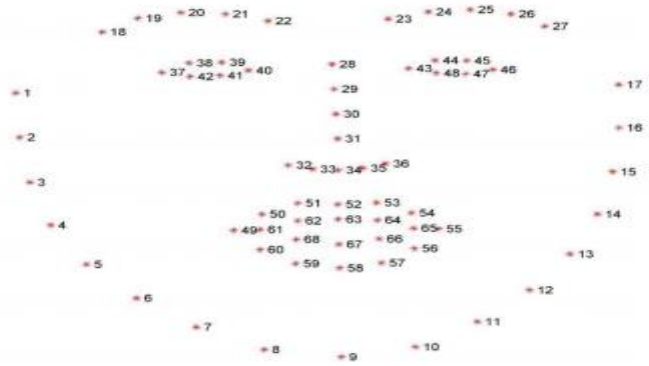


Figure 3 – Facial Landmarks

Given the training data, an estimate is obtained to find landmark positions. The result is a facial landmark detector that can be used to detect facial landmarks in real-time with high-quality predictions.

3.4 The Classification of whether Eyes and mouth are Open or Closed.

We'll need the SciPy package so we can compute the Euclidean distance between facial landmarks points in the eye aspect ratio and mouth aspect ratio calculation

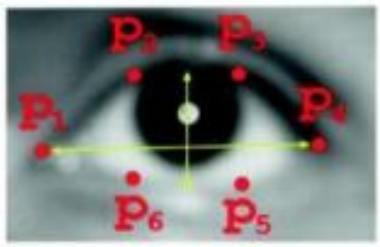


Figure 4(a) – segments of eye

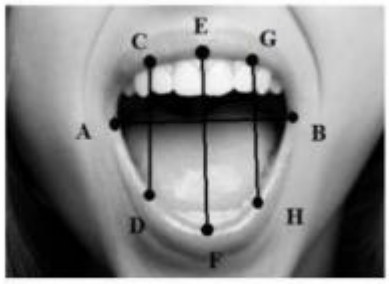


Figure 4(b)- segments of mouth

3.5 Calculation to Check whether Person is Drowsy.

The score is basically a value we will use to determine how long the person has closed his eyes. So if both eyes are closed, we will keep on increasing score and when eyes are open, we decrease the score. We are drawing the result on the screen which will display real time status of the person.

$$EAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|} \qquad MAR = \frac{|EF|}{|AB|}$$

Figure 5 – Eye and Mouth aspect ratio

3.5 Triggering of Alarm

The alarm will be triggered when the person is drowsy or yawning again and again and the message will be announced on speaker and also will be displayed on screen.

3.6 Action after Alarm

When the Alarm is triggered and the person is still sleeping the alarm count will increase and after reaching the threshold the power to the motor will be cut which result in gradually decreasing the speed of the motor and finally it stops.

4. Hardware and Software

The Human Drowsiness detection system provides a solution to the accidents occurring due to the drivers being in the state of drowsiness.

To achieve this the proposed system includes a collection of hardware components as well as a Software program to provide optimum
solutions/results.
The components used in the system are explained in brief as follows:

4.1 Hardware

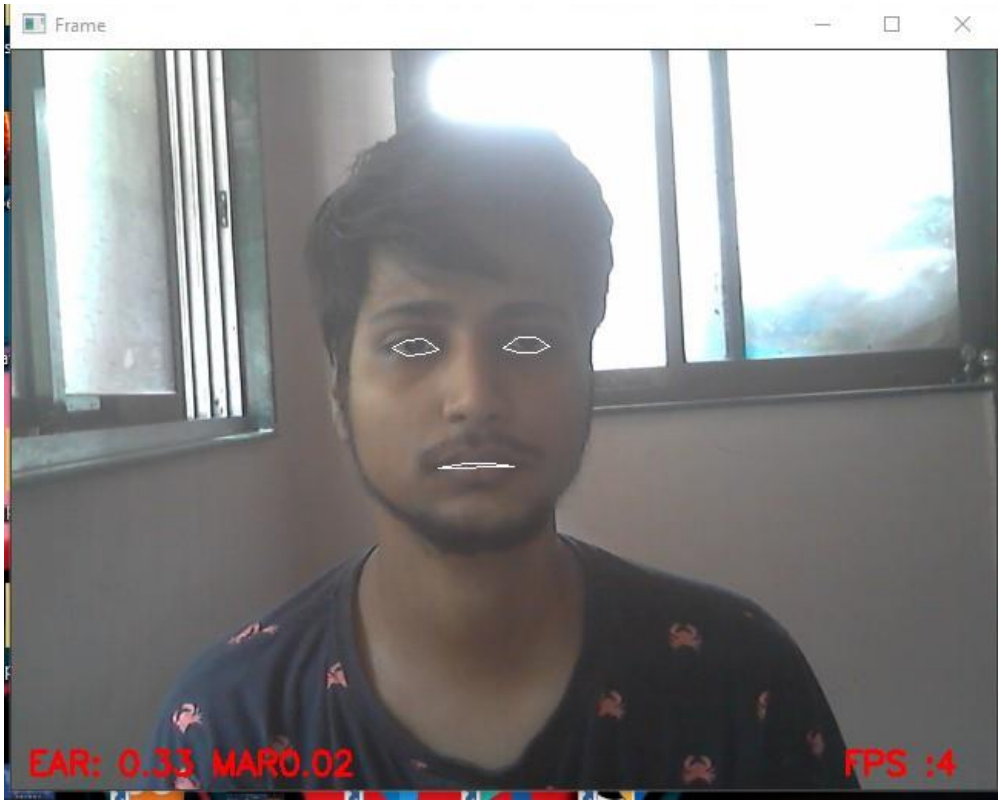
1. Raspberry pi /any mini computer that supports python
2. Webcam
3. DC motor
4.speaker

4.2 Technology

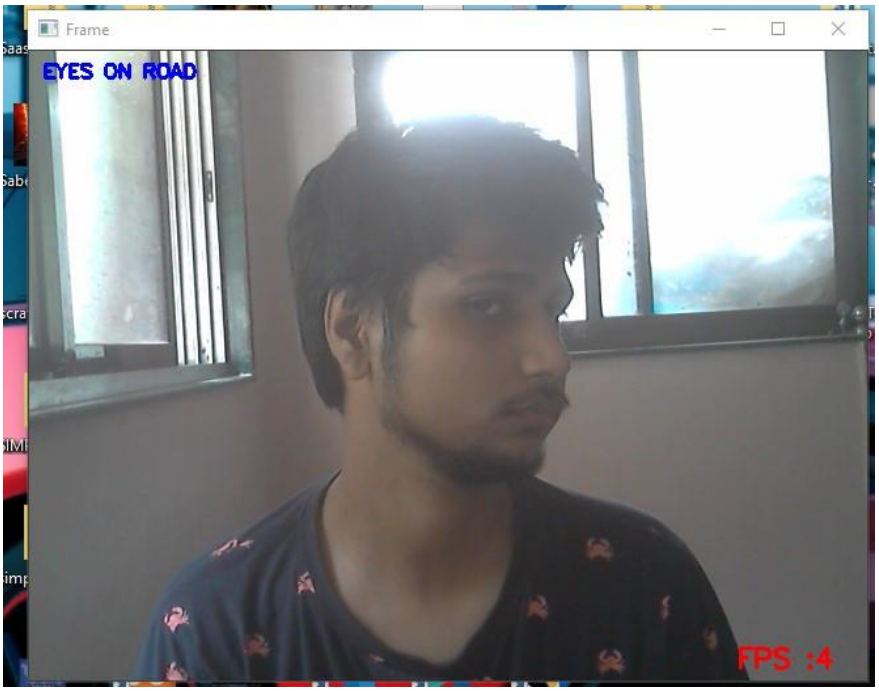
1.Python: Python is the basis of the program that we wrote. It utilizes many of the python libraries.
2.Libraries:
Numpy : Pre-requisite for Dlib
Scipy : Used for calculating Euclidean distance between the eyelids and lips
Playsound : Used for sounding the alarm
Dlib : This program is used to find the frontal human face and estimate its pose using 68 facelandmarks.
Imutils : Convenient functions written for Opencv.
Opencv : Used to get the video stream from the webcam, etc.

5. OUT PUT SCRRENS

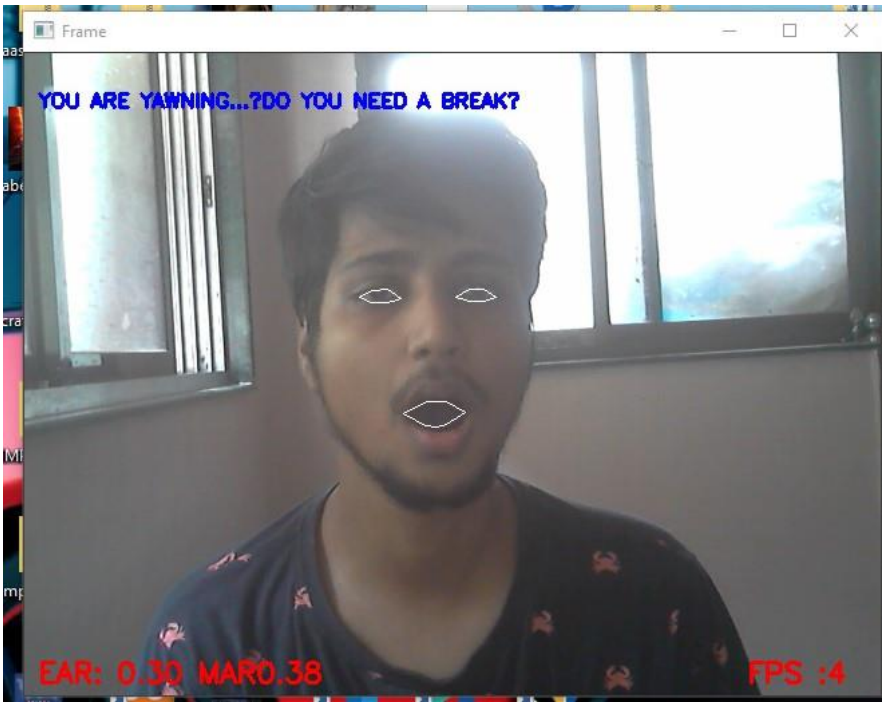
1.Driver in normal state.



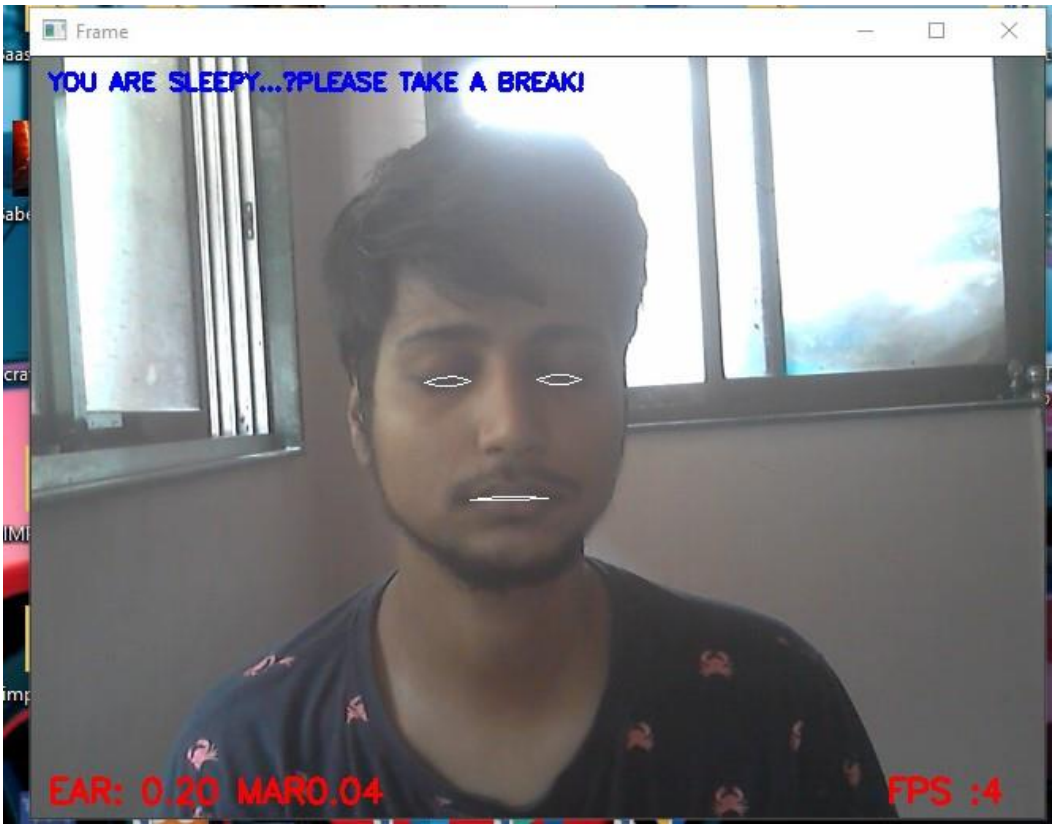
2.Driver is Distracted.



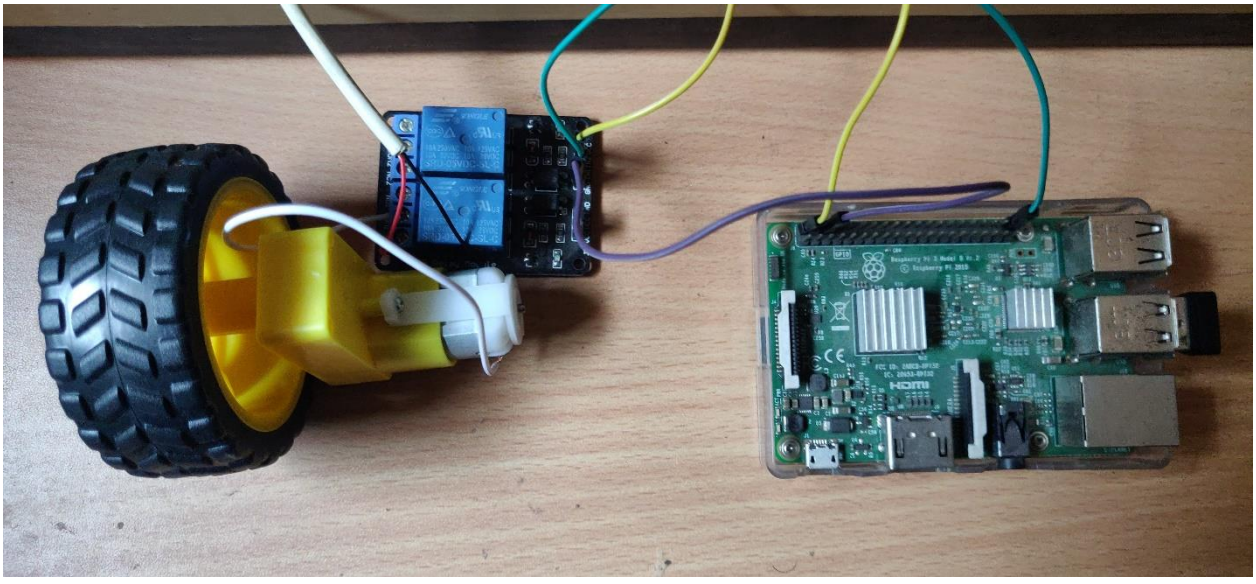
3.Driver is Yawning



4.Driver is sleeping.



5. Demonstration of ignition ON/OFF.



6. CONCLUSION

Driver fatigue detection using face detection is designed mainly to keep the driver awake while driving to avoid the accident due to sleepiness the raspberry pi and camera used to capture eyes or face. Fatigue is measured by detecting Eye and face using Haar Cascade Classifier, especially facial landmarks is detected using shape-predictor and Eye Aspect Ratio (EAR) by calculating the Euclidean distance between the eyes. Accurate eye detection and faces in every frame This will help to calculate the drowsiness level.

Frequent detection of eye blinking. When he/she reaches the maximum threshold, the driver will be alarmed by a Buzzer that will wake up the driver from the sleep state. When the buzzer alert also reaches threshold point the speed of the motor reduces gradually and comes to a rest position.

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