Driver Behavior Analysis

Final Year Project Report

Presented

by

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In Partial Fulfillment

of the Requirement for the Degree of

Bachelor of Science in Electrical (Computer) Engineering

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

COMSATS University, ISLAMABAD

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Declaration

We, hereby declare that this project neither as a whole nor as a part there of has been copied out from any source. It is further declared that we have developed this project and the accompanied report entirely on the basis of our personal efforts made under the sincere guidance of our supervisor. No portion of the work presented in this report has been submitted in the support of any other degree or qualification of this or any other University or Institute of learning, if found we shall stand responsible.

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COMSATS University, ISLAMABAD
Feb 2020

Driver Behavior Analysis

An Undergraduate Final Year Project Report submitted to the
Department of
ELECTRICAL ENGINEERING

As a Partial Fulfillment for the award of Degree

Bachelor of Science in Electrical (Computer) Engineering

by

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Final Approval

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Dedication

In the name of ALLAH, the most gracious and merciful. Firstly, we would like to thank Allah Almighty for his gratefulness towards us. We would like to dedicate this dissertation our Parents and Teachers who inspired us in the pursuit of knowledge, continually provided their moral, spiritual, emotional and financial support.

Acknowledgements

Thanking Allah Almighty for his constant kindness on us. We would like to take few lines in thanking our brothers, sisters, mentors, friends and classmates who shared their words of advice and encouragement to finish this study.

Most importantly, we would like to thank our supervisor Mr. Adeel Israr who stood with us through all this time and helped us in gaining the best outcome for the project. From pin to point, he helped us with curricular and co-curricular activities as a true mentor.

This project would not have been possible if we were not blessed with the prayers and love of our parents and also the hard work of every teacher who delivered each lecture with passion and enthusiasm. Curiosity and intersection are the salient features that were required in abundance in making of this project and we are very thankful to Allah that COMSATS University manages to teach their students both of these very important characteristics.

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Abstract

Perilous and risky driving records for the death of more than one million lives and more than 50 million genuine injuries worldwide every year. The U.S. National Highway Traffic Safety Administration (NHTSA) information demonstrates that 1.6 million nonfatal injuries, and 40 thousands fatalities, came about because of auto collisions in 2012, with up to 80% of them because of driver negligence. Driver mistakes and remissness contribute the greater part of the road mishaps happening these days. The significant driver mistakes are brought about by tiredness, drunken and wild conduct of the driver. The improvement of advances for recognizing drowsiness in the driver's seat is a significant test in the field of mishap avoidance system. Due to the peril that drowsiness presents out and about, strategies should be produced for balancing its effects.

There are many creating system to monitor the driver's consideration level and alerting the driver of any shaky driving conditions aware of forestall mishaps. Significant highlights can be removed from facial expressions models are yawning, head movements with close eyes and induced drowsiness. The fundamental point of this is to build up a drowsiness detection system by checking the eyes and mouth; it is accepted that the side effects of driver weariness can be identified early enough to avoid a car accident. The capacity of driving emotionally supportive system to detect the level of driver’s alertness is significant in guaranteeing road safety. By perception of blink pattern and eye movements, driver weariness can be recognized early enough to prevent collisions caused by drowsiness.

Chapter 1

Introduction

Drowsiness is one of the main factor of road accidents and every year the rate of deaths due to these accidents are increasing. National Highway Traffic Safety Administration (NHTSA) estimates that in 2017, 91,000 police-reported crashes involved drowsy drivers and approximately 50,000 people gets injured and 8,000 deaths[1]. So this increasing number of road accidents has become a serious problem for the society[2].

So there must be a requirement of designing such a device that will alert the drivers and other passengers in the car if any alarming situation occurs.

We can detect the drowsiness by completely monitoring the eyes. First we completely localized the eyes from the face than we can apply algorithms to detect that whether the driver eyes are closed or open and if they are closed than to generate an alarm to alert the driver. Similarly yawning is another state of drowsiness that if the driver yawns more frequently than the normal condition than it’s also the detection of the drowsiness state and now again alert the driver by generating an alarm so that driver should stop the car and take rest before continuing its journey.

In growing these structures, it is important to adopt tactics aimed at improving the performance of the entire driver-vehicle cooperative gadget by means of regarding using as interaction between the driver and the vehicle.

Driving sleepiness, alcoholism and carelessness are the key contributions in the accident condition[3]. The fatalities, associated expenses and related risks have been identified as severe risk to the country. All these types of factors led to the development of wise Transportation structures (ITS)[4][5].

Driving mistakes and carelessness make a contribution in maximum of the road accidents happening these days. The driving errors are resulting from drowsiness, drunken and reckless behavior of the driver. The resulted mistakes and errors make a contribution in a lot of humanity loss. With a purpose to reduce the effects of driver abnormalities, a machine for abnormality monitoring has to be in-built with the vehicle.

1.1 Sign Of Driver Drowsiness:

The signs of driver drowsiness are

1) Driver may be yawn frequently
2) Driver is unable to keep eyes open
3) Drift into the other lane

1.2 Factors Causing Driver Drowsiness:

Driver Fatigue is frequently because of four most important factors: sleep, work, time of day, and physical. Regularly human beings attempt to do a lot in a day and that they lose treasured sleep and by taking caffeine or other stimulants humans continue to stay un-sleep. This lack of sleep builds up over a number of days and then body finally collapses and the person falls asleep while driving.

Extending the time awake will subsequently result in the body crashing. Additionally, being emotionally stressed will cause the body to get fatigued quicker.

Driver drowsiness can be detected by three different techniques:

1) Vehicle based
2) Behavioral based
3) Psychological based

1.2.1 Vehicle Based

Some of metrics, together with deviations from lane, movement of the steering wheel, pressure on the acceleration pedal, and so forth, are constantly monitored and any change in these that crosses a distinct threshold indicates that the driver is drowsy.

1.2.2 Behavioral based

The behavior of the driver which include yawning, eye closure, eye blinking, head pose, etc. is monitored via a camera and the driver is alerted if any of these drowsiness signs and symptoms are detected.

1.2.3 Physiological based measures

The correlation between physiological signals ECG (Electrocardiogram) and EOG (Electrooculogram). Drowsiness is detected through pulse rate, heart beat and brain information.

So in this paper we basically proposed a method that locate, track and analyze both driver face and eyes so in order to detect the drowsiness state of the driver. So we use behavioral based technique that include

1) Eye blinking technique
2) Yawning based technique

Eye blinking technique:

In this eye blinking technique eye closure duration is measured to discover driving force's drowsiness. When driver felt sleepy at that time his/her eye blinking and gaze among eyelids are exceptional from everyday situations so that they without problems hit upon drowsiness. Figure 1.1 indicates the eye blinking based drowsiness detection.

Figure-1.1 Eye Detection

Yawning based technique

In this case driver's face is continuously monitored by the video camera that is placed under the front mirror.

Next detecting drowsiness involves two main steps. First to detect the face and then the mouth as shown in Figure 1.2.

Figure-1.2 Mouth Detection

After detection of the mouth, the yawning state is detected based on measuring the rate of changes in the area of the mouth contour and the aspect ratio of mouth area.

1.3 Organization of Thesis:

In Chapter 2 we defined the literature review that the various techniques for the drowsiness detection like eye state investigation, template matching, Pulse sensor method etc. Chapter 3 is based on the design of our system and the algorithm that we are using and all the factors regarding to our algorithm are explained. In Chapter 4 we explain all the information regarding to the hardware that we are using like Raspberry pi, Camera, USB etc. Chapter 5 consists of all the results that we get from our system and their brief explanation. Chapter 6 concludes the thesis with future work plans.

CHAPTER 2

Literature Review and Background

2.1 Assessment On Driver Fatigue Evaluation:

Driver fatigue is another major thing which could purpose traffic accident on the road. The term fatigue refers to a combination of signs which includes impaired overall performance and a subjective feeling of drowsiness [6]. Despite the extensive research that has been achieved, the time fatigue still does not have a universally widely wide-spread definition [7]. As a result, it is far tough to determine the extent of fatigue-associated accidents. However, research show that 25%-30% of riding injuries are fatigue associated [8]. Whilst a driving force is fatigued, positive physical and physiological phenomena may be determined, together with changes in brain waves or EEG, eye activity, facial expressions, head nodding, frame sagging posture, coronary heart charge, pulse, skin electric powered ability, gripping force on the guidance wheel, and other changes in frame activities.

Preceding designs for the detection of fatigue are based totally on the analysis of those driver physical and physiological phenomena and can be widely divided into two classes:

a) Visible functions primarily based

b) Non-visual capabilities primarily based.

2.1.1 Non-visual capabilities primarily based:

Methods dependent on non-visual highlights are commonly nosy and can be isolated into two classes: driver physiological examination and vehicle boundary investigation. For the principal one, driver weariness is dissected through vehicle conduct including development of controlling wheel, pressure on the increasing speed pedal, speed, deviations from path position, reaction time against an obstruction slowing down, and so on. The principle impediments of these methodologies [9, 10] remember their reliance for the state of the road, the vehicle execution, and the way of driving. For the subsequent methodology, driver weakness checking depends on the examination of physiological and biomedical signals, for example, pulse, cerebrum action, temperature, vascular action, strong movement, electroencephalograph(EEG), electrocardiogram (ECG), electrooculography (EOG), and surface electromyogram (SEMG). These signs are gathered through anodes in contact with the skin of the human body. They are broadly acknowledged as great pointers of the change among attentiveness and rest, just as between the distinctive rest stages. It is regularly alluded to as the highest quality level. Svensson [11] objective sleepiness scoring (OSS), which is gotten from EEG signals, as the ground truth for approving other exhaustion identification calculations. Be that as it may, these strategies [12] depend on contactable sensors which decline client experience and increment equipment cost.

2.1.2 Visible Functions Primarily Based:

Procedures utilizing visual highlights exploit computer vision approaches for the identification of fatigue. Abusing visual highlights centers around removing facial highlights like face, eyes and mouth. Breaking down the condition of eyes and mouth can give noticeable prompts to the location procedure. For the most part, procedures utilizing visual highlights can be partitioned into four classes:

a) Eye state investigation,

b) Eye blinking analysis,

c) Mouth and yawning examination

d) Facial expression analysis.

In the accompanying subsections, the generally utilized methods with these four classifications dependent on visual highlights are clarified in detail.

Researchers are using three different techniques to detect drowsiness as shown in figure 2.1 below:

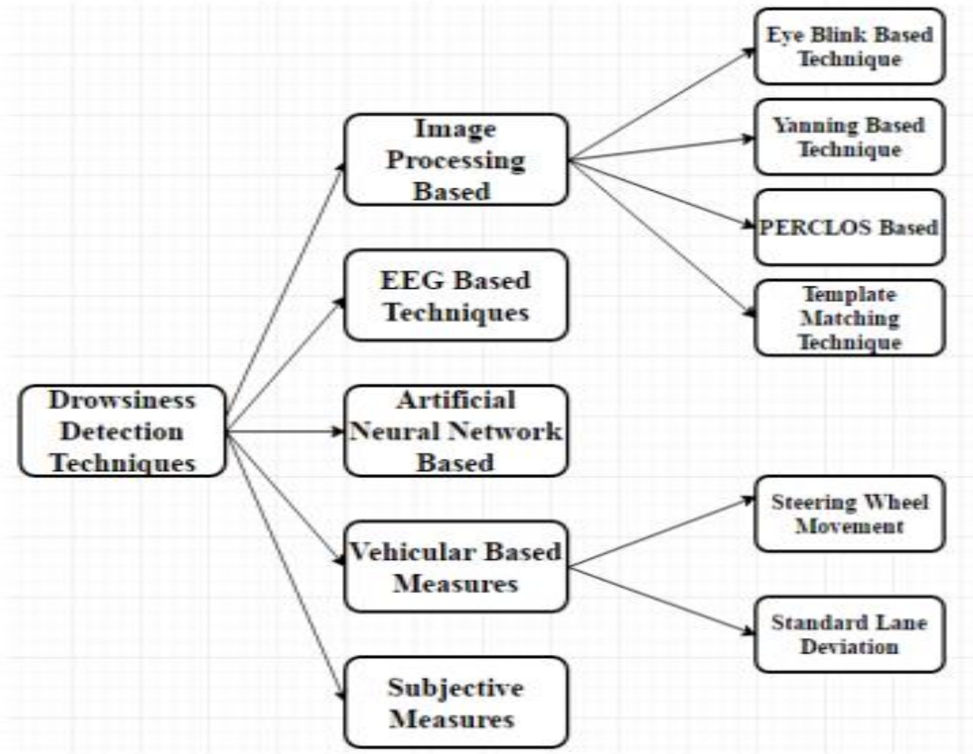


Fig 2.1 Drowsiness Detection Techniques

2.2 Behavioral Parameter-Based DDT

Behavioral boundaries are non-obtrusive measures for drowsiness detection. These strategies measure drivers' exhaustion through conduct boundaries of driver, for example, eye closure ratio, eye blinking, head position, facial articulations, and yawning. The Percentage of eye Terminations (PERCLOS) is one of the most successive utilized measurements in sleepiness discovery dependent on eye state perception. PERCLOS is the proportion of eye conclusion over a period, and afterward on the aftereffect of PERCLOS, eyes are referred as open or shut. Yawning based discovery frameworks dissect the varieties in the geometric state of the mouth of sluggish driver, for example, more extensive opening of mouth, lip position, and so forth. Social based procedures utilized cameras and computer vision strategies to extricate behavioral features. The general structure of procedure in standard of conduct-based drowsiness detection methods is introduced in Figure 2.2.

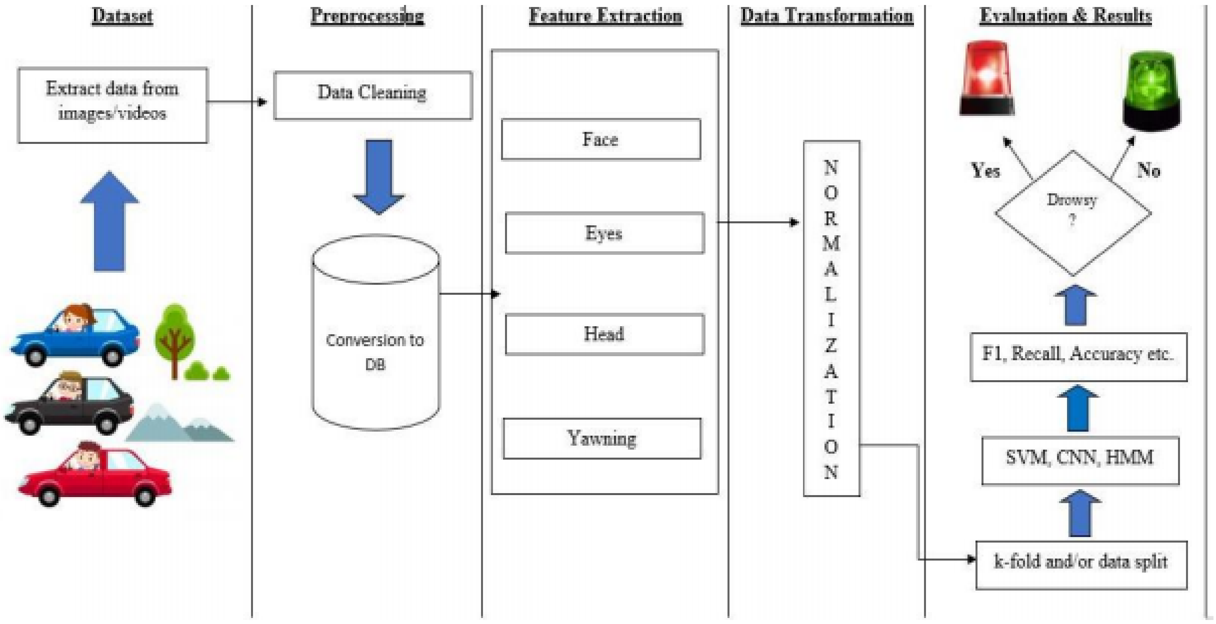


Fig 2.2 Behavioral Pattern-based techniques

2.2.1 Eye State Investigation:

Eye state examination is the most widely recognized and clear procedure for identifying driver exhaustion. The system applying this procedure center around the conditions of eyes [13-15]. In such arrangements, the system cautions the driver by producing an alert, if the driver shuts his/her eye(s) for a specific time. Some accessible system dependent on this strategy utilize a database where both shut and open formats of eye are put away [16]. Not with standing non-versatile frameworks, there are some versatile arrangements where the open and close eye formats of a related driver are abused. Modified format coordinating procedure on a casing by-outline premise is utilized to distinguish the condition of the two eyes [17]. On the other hand, eye state investigation is computationally serious. Notwithstanding that, there are a few confinements, for example, lighting conditions and shades that influence the exactness of the format coordinating method. Another impediment of the format coordinating method is that it would fizzle if the layouts were contorted because of the picture preparing [17]. Considering the above reasons this method is not sufficiently adequate to recognize the driver's drowsiness.

2.2.2 Template Matching Technique:

In this method, one can utilize the conditions of eye i.e. if driver closes eye/s for some specific time then system will create the alert. Because in this techniques system has both Open and Closed Eyes Template. This method is simple and easy to implement because templates of both open and closed eye state shown in figure 2.3 are available to system. Researchers have utilized this strategy [18].

Fig 2.3 Template Matching Technique

2.2.3 Eye Blinking based Technique

In this eye blinking rate and eye closure duration estimated to recognize driver's laziness. Since when driver felt sleepy at that time his/her eye blinking and look between eyelids are not the same as expected circumstances, so they effectively identify laziness. In this system the situation of irises and eye states are checked through an ideal opportunity to assess eye blinking frequency and eye closure duration. [19]. Furthermore, in this type of system utilizes a remotely positioned camera to gain video and computer vision strategies are then applied to successively confine face, eyes, and eyelids positions to quantify ratio of closure.[20]. Using these eyes closure and blinking ratio one can identify drowsiness of driver.

2.2.4 Yawning Based Technique

Yawn is one of the side effects of exhaustion. The yawn is thought to be demonstrated with an enormous vertical mouth opening. Mouth is all the way open is bigger in yawning contrasted with talking. Using face tracking and then mouth tracking one can detect yawn. In paper [21], they detect yawning dependent on opening rate of mouth and the sum changes in mouth shape as shown in figure 2.4.

Fig 2.4 Yawning

Rather than utilizing only one strategy to distinguish drowsiness of driver, some researchers have consolidated different vision-based image processing techniques to have better execution.

2.2.5 PERCLOS TECHNIQUE

PERCLOS is a built-up boundary to distinguish the degree of laziness. The PERCLOS (the level of time that an eye is shut in each period) score is estimated to choose whether the driver is at sleepy state or not. On a normal human squint once at regular intervals (12 flickers for each moment).

2.2.6 Eye Closure and Head Posture Method

Teyeb et al. [22] Proposed use Eyes closed, and head pose to begin with, catch the video utilize the webcam and do the following for each frame e of the video. To distinguish ROI (face and eyes), Use the Viola Jones strategy. Face separated into three sections Area and peruse to the past one indicating the eye area provided by the Haar classifier. At that point distinguish the eye state, wavelet utilize neural system-based systems to train pictures, and afterward think about the coefficients of the learned pictures with the pictures. Test the coefficients of a picture and mention to it what type it is have a place. At the point when closed eyes are distinguished in the frame, If the value exceeds Pre-characterized time, at that point drowsiness is identified. Then developed system estimates head movement Yes: left, right, forward, backward, and left or right turn around. Caught video is separated into frames and concentrate head picture and determine coordinates picture. The pictures are then contrasted with decide the tilt of the head is equivalent to in different cases. At last, the system joins closed eyes time and Estimate head posture to measure drowsiness. To assess the system, we performed experiments on 10 volunteers' Various circumstances.

2.2.7 Mouth and Yawning Analysis

Weariness is the fundamental cause of road traffic accidents. to maintain a strategic distance from issue, Sarada Devi and Bajaj [23] raise driver fatigue identification system dependent on mouth and yawn examination. To begin with, the system finds and tracks the driver's mouth Cascade utilizing classifier training and mouth recognition enter the picture. At that point mouth and yawning pictures Use SVM for training. At last, SVM is utilized to characterize the mouth region to distinguish yawns and warn fatigue. For tests, the creator gathered a few videos, Select 20 yawning pictures and more than 100 normal videos as a data set. The outcomes show that the proposed system has preferable outcomes over system utilizing geometry feature. Recommended system detects yawns and alarms Get tired early and help keep the driver safe.

2.3 Physiological Parameter-Based Techniques

The Physiological boundaries-based procedures recognize drowsiness dependent on drivers' states of being such as pulse, beat rate, breathing rate, respiratory rate, and internal heat level, and so forth. These organic boundaries are increasingly solid and exact in drowsiness discovery as they are worried about what is going on with driver truly. Exhaustion or drowsiness change the physiological boundaries, for example, a reduction in blood pressure, pulse, and internal heat level, and so on. Physiological boundaries-based sleepiness discovery frameworks recognize these progressions and caution the driver when he is in the state, close to rest. The upside of this approach is that it makes the driver aware of take some rest before the physical indications of laziness show up. A general structure of a sleepiness location framework in view of physiological boundaries is introduced in Figure 2.5.

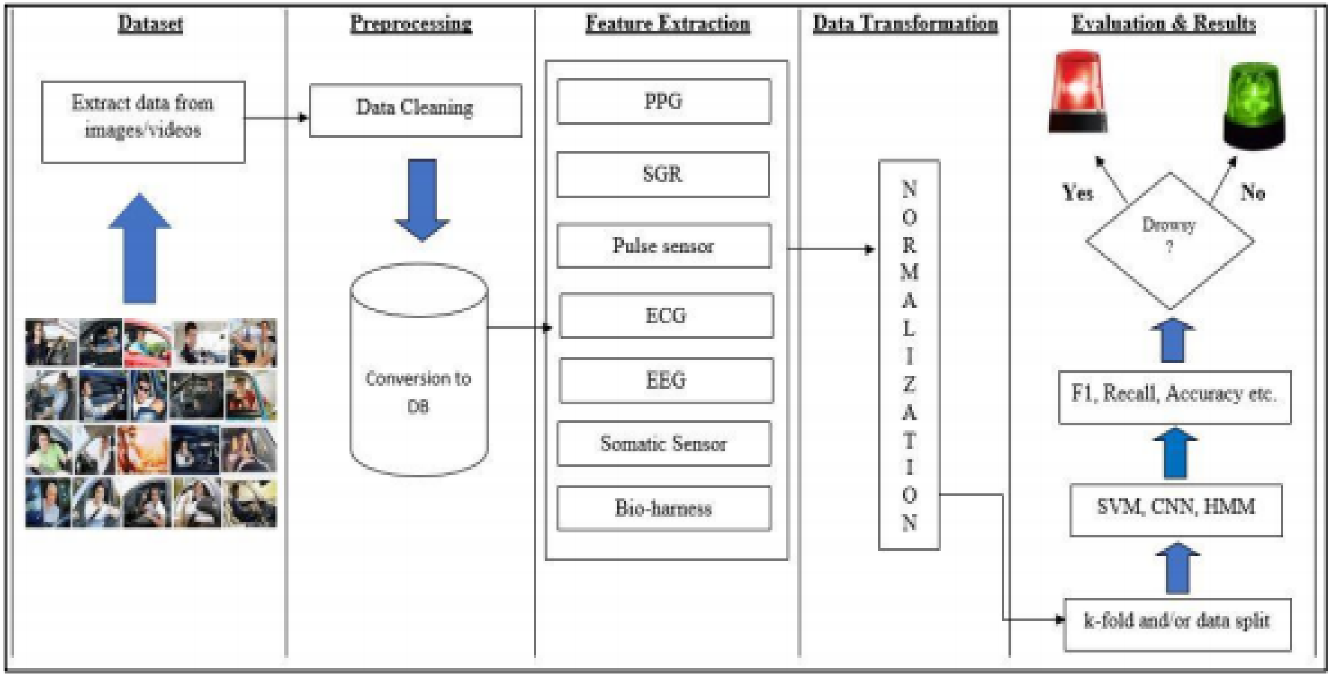


Fig 2.5 Physiological Parameter-Based Techniques

2.3.1 EEG Based Technique

In this procedure it is mandatory to wear electrode helmet by drivers while driving This helmet have different electrode sensors which set at right place and get information from brain. Researchers [24] have utilized the characteristic of EEG signal in drowsy driving. A technique dependent on power spectrum analysis and FastICA algorithm was proposed to decide the fatigue degree. In a driving simulation system, the EEG signals of subjects were captured by instrument NT-9200 in two states, one state was sober, and the other was drowsy. The multi-channel signals were breaking down with FastICA algorithm, to evacuate visual electric, my electric and power frequency interferences Figure 2.6 shows how EEG based systems get data for acquisition. Experimental results show that the technique introduced in this paper can be utilized to decide the sleepiness level of EEG signal solidly.

Fig 2.6 EEG Based Technique

2.3.2 Pulse Sensor Method:

Generally, past investigations center around the states of being of drivers to detect drowsiness. That is the reason Rahim et.al [25] identifies the lazy drivers utilizing infrared pulse sensors or heartbeat sensors. The beat sensor quantifies the heartbeat rate from drivers' finger or hand. The sensor relates to the finger or hand, identifies the measure of blood moving through the finger. At that point measure of the blood's oxygen is appeared in the finger, which makes the infrared light reflect off and to the transmitter. The sensor gets the variance of oxygen that are associated with the Arduino as microcontroller. At that point, the heartbeat rate is imagining by the product handling of HRV recurrence space. Trial results show that LF/HF (Low to high recurrence) proportion diminishes as drivers go from the condition conscious to the lazy and numerous street mishaps can be kept away from if an alarm is sent on schedule.

2.4 Vehicular Based Methods:

Another methodology for estimating driver sleepiness includes vehicle-based estimations. In the majority of the cases, these estimations are resolved in a recreated condition by putting sensors on different vehicle parts, for example, directing haggle increasing speed pedal; the signs sent by the sensors are then investigated to decide the degree of tiredness. A few analysts found that lack of sleep can bring about a bigger changeability in the driving pace [26]. Be that as it may, the two most normally utilized vehicle-based measures are the controlling wheel development and the standard deviation of path position. A general structure of a drowsiness identification framework dependent on vehicular measures is appear in Figure 2.7.

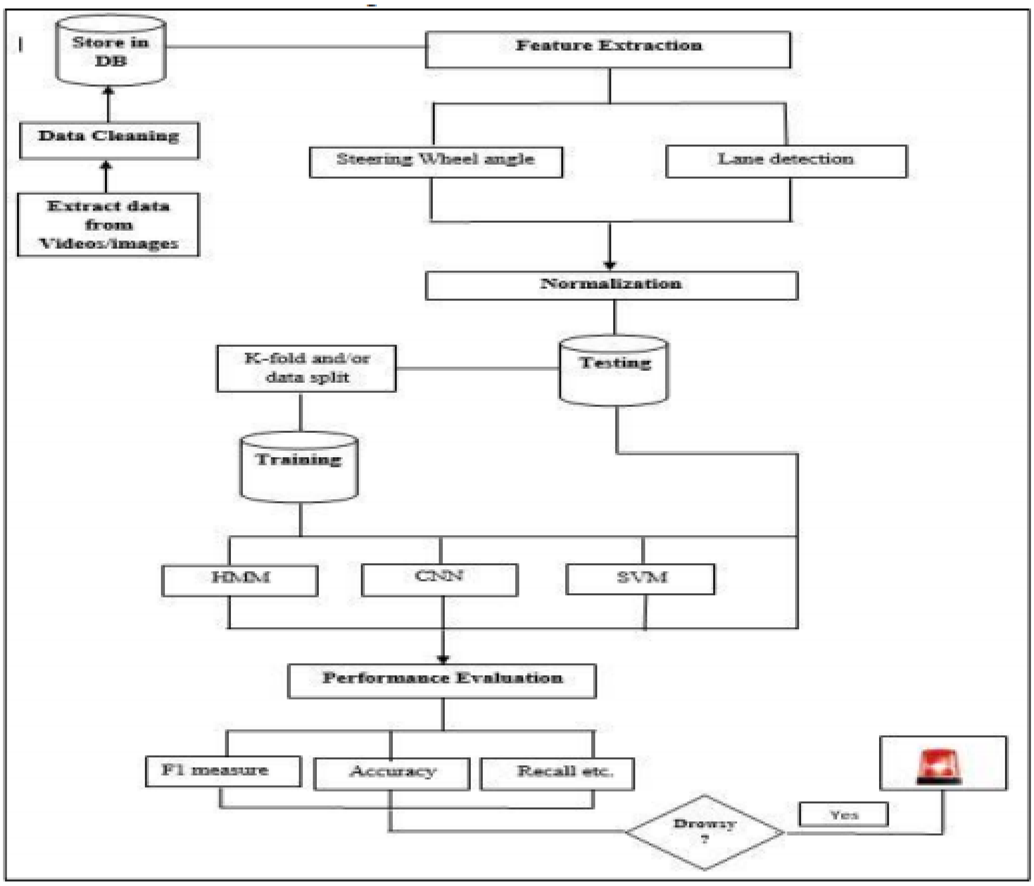


Fig 2.7 Vehicular based

2.4.1 Steering Wheel Movement (SWM):

SWM is estimated utilizing steering angle sensor and it is a generally utilized vehicle-based measure for recognizing the level of driver drowsiness [26]. The driver's directing conduct is estimated utilizing an angle sensor mounted on the steering segment as shown in the figure 2.8. At the point when the driver is tired, the quantity of micro corrections on the directing wheel lessens contrasted with ordinary driving. Fairclough and Graham found that rest denied drivers made less guiding wheel inversions than ordinary drivers [26]. To remove the impact of path changes, the analysts thought about just little guiding wheel movements (somewhere in the range of 0.5° and 5°), which are expected to change the parallel situation inside the path [27]. Subsequently, considering little SWMs, it is conceivable to decide the laziness condition of the driver and in this manner give warning of tired driver if necessary. In a recreated domain, light side breezes that pushed the vehicle to the correct side of the road were included along a bended road so as to make varieties in the sidelong position and power the drivers to make restorative SWMs . Vehicle organizations, for example, Nissan, BMW, Volvo, Renault and so on have received SWMs however it works in constrained circumstances. This is on the grounds that they can work dependably just at specific situations and are considerably more reliant on the geometric qualities of the road and to a less degree on the dynamic qualities of the vehicle.

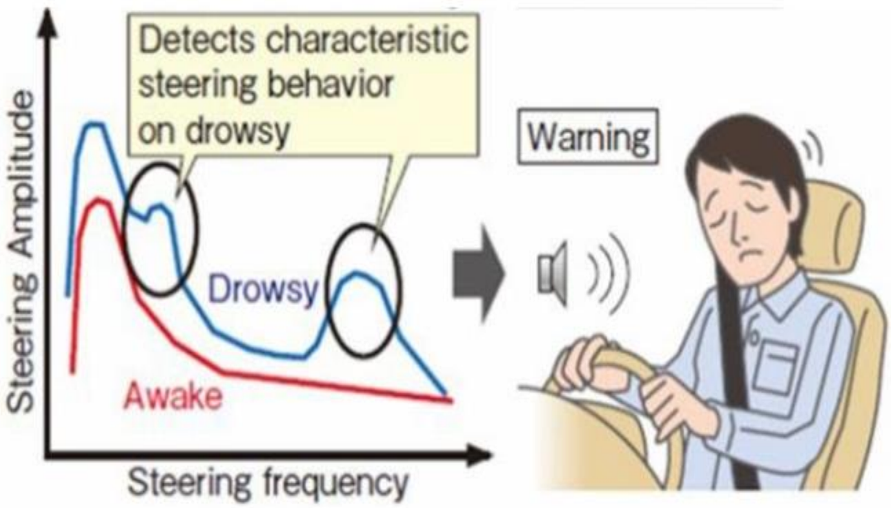


Fig 2.8 SWM

2.4.2 STANDARD DEVIATION OF LANE POSITION (SDLP)

SDLP is another measure through which the degree of driver drowsiness can be assessed [28]. In an imitative condition, the product itself gives the SDLP and if of field analyzes the situation of path is followed utilizing an outside camera. Ingre et al. led an examination to infer numerical measurements dependent on SDLP and found that, as KSS evaluations expanded, SDLP (meters) likewise expanded [28]. For instance, KSS ratings of 1, 5, 8, and 9 compared to SDLP estimations of 0.19, 0.26, 0.36 what is more, 0.47, individually. The SDLP was determined dependent on the normal of 20 members; be that as it may, with a few drivers, the SDLP did not surpassed 0.25 m in any event, for a KSS rating of 9. In the above test by performing relationship investigation regarding a matter to subject premise noteworthy contrast is noted. Another impediment of SDLP is that it is simply reliant on outside elements like road marking, climatic and lighting conditions. In outline, numerous investigations have established that vehicle-based measures are a poor indicator of execution blunder hazard because of drowsiness. In addition, vehicular-based measurements are not explicit to drowsiness. SDLP can likewise be brought about by a hindered driving, including driving affected by liquor or different medications, particularly depressants [29]

2.5 Subjective Measures:

Emotional estimates that assess the degree of laziness depend on the driver's very own estimation and numerous instruments have been utilized to make an interpretation of this rating to a measure of driver sluggishness. The most regularly utilized sluggishness scale is the Karolinska Sleepiness Scale (KSS), a nine-point scale that has verbal stays for each progression. Hu et al. estimated the KSS evaluations of drivers each 5 min and utilized it as a source of perspective to the EOG signal gathered [29]. A few scientists looked at the self-determined KSS, which was recorded each 2 min during the driving assignment, with the variety of path position (VLP) also, found that these measures were not in understanding [29]. Ingre et al. decided a connection between the eye squint term and the KSS gathered each 5 min during the driving undertaking [30]. Specialists have discovered that significant path takeoffs, high eye squint term and languor related physiological signs are common for KSS evaluations somewhere in the range of 5 and 9 [10]. Be that as it may, the emotional rating does not completely agree with vehicle-based, physiological, and social measures. Since the level of sleepiness is estimated roughly every 5 min, unexpected varieties cannot be distinguished utilizing emotional measures. Another impediment to utilizing emotional evaluations is that the self-contemplation alarms the driver, in this manner diminishing their languor level. Likewise, it is hard to get languor criticism from a driver in a genuine driving circumstance. Accordingly, while abstract appraisals are valuable in deciding sluggishness in a reenacted domain, the remaining measures might be more qualified for the discovery of sleepiness in a genuine domain.

2.6 Artificial Neural Network Based Technique:

In this method they use neuron to identify driver's drowsiness. Just a single neuron is not a lot of precise and the aftereffect of that isn't acceptable contrast with more than one neuron. Some researchers [31] are completing examinations in the field of improvement of driver drowsiness identification utilizing Artificial Neural Network People in fatigue exhibit certain visual behaviors that are effectively recognizable from changes in facial features, for example, the eyes, head, and face Visual practices that commonly mirror a person’s level of fatigue incorporate eyelid development, gaze, head movement, and facial expression. To utilize these obvious signals, they made artificial neural network to detect drowsiness. They tried examples and got 96% outcome. Figure 5 shows that flow how an artificial neural network system can detect drowsiness.

2.7 Advantages And Limitations Of Techniques:

The accompanying (Table – 2.1) gives the points of interest and restrictions of the considerable number of procedures that we examined previously. Image Processing strategies are non-nosy in nature and furthermore simple to utilize however they don't give high exactness on which a driver can depend. It is likewise influenced by lighting conditions and foundation. While EEG based procedures gives better precision, yet they are meddlesome in nature. Artificial Neural Network based procedures too gives great outcomes however are tedious and difficult to execute. Vehicular Measures are increasingly reliant on the geometric conditions like nature of road and so on rather than motor properties of vehicle. Subjective measures are survey in nature and subsequently they are impractical progressively.

Table 2.1

Technique	Specification	Superiority	Limitations
Image Processing methods	PERCLOS, Yawning, Eye Blink Rate	Nonintrusive; Ease of use	Lighting condition Background
Artificial Neural Network	Neural Network	Reliable, Accurate	Implement, calculation intensive
EEG Based Technique	EEG, ECG, Heart Rate	Reliable; Accurate	Intrusive
Vehicular Measures	SWM, SDLP	Non-intrusive	Unreliable
Subjective Measures	Questionnaire e	Subjective	Not possible in real time

Chapter 3

Design And Implementation

Implementation of the project was done by considering all the previously implemented algorithms. The algorithm used is focusing on just eyes and mouth regions of the face in-order to detect whether the person is drowsy or not.

3.1 Flow Chart

The working of algorithm is shown in the figure 3.1 below:

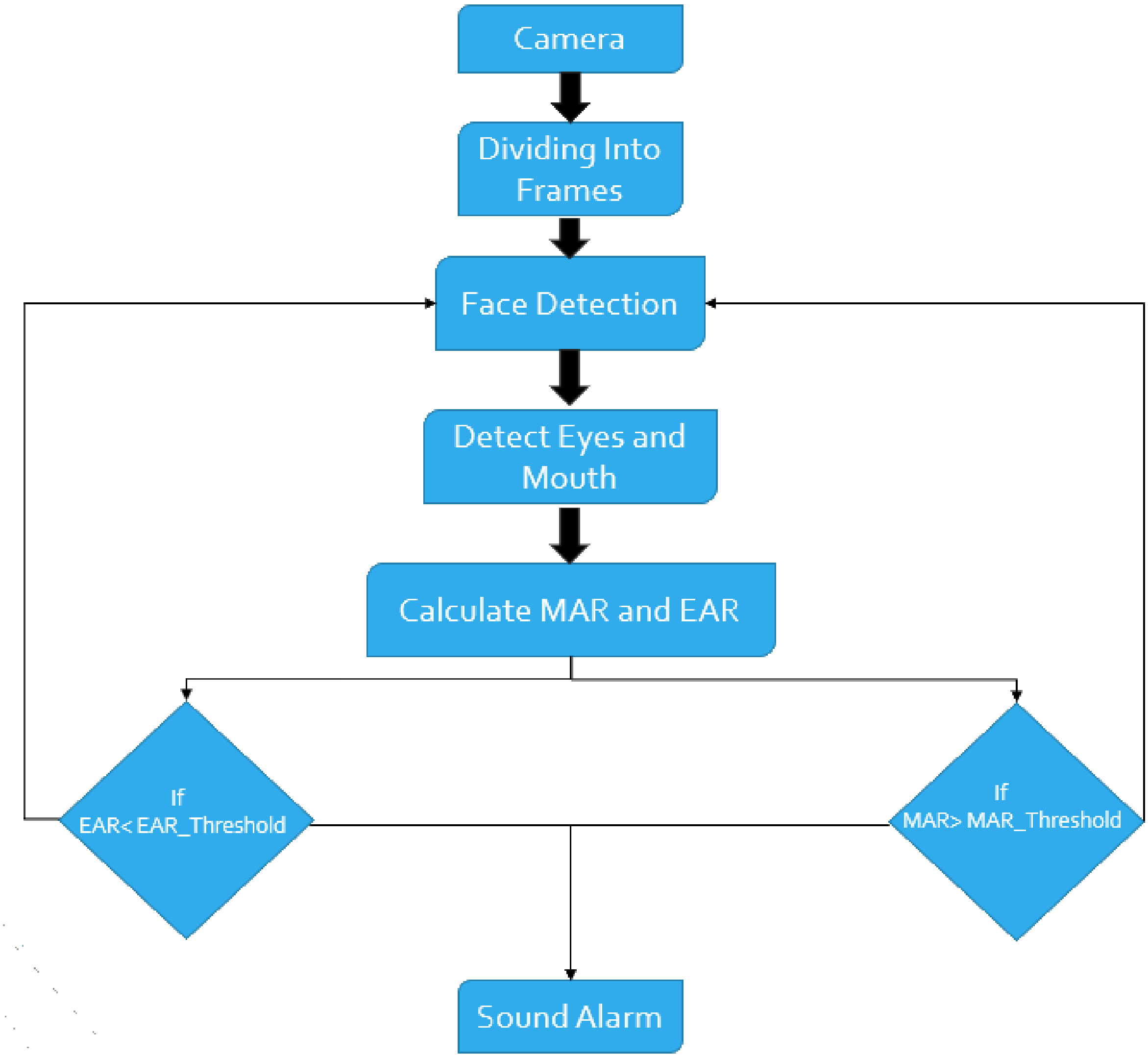


Figure-3.1: Flow Chart explaining the procedure of our algorithm.

3.1.1 Camera:

Any webcam with good video quality can be used to capture the video. In this project Raspberry Pi 4 camera module is used which has ability to record the video up to 1080p at 30 fps and has a adjustable lens of 5 mega pixels and is easily replaceable. Figure 3.2 shows the camera module which is used in the project.

Figure-3.2: Raspberry Pi 4 Camera Module with 5 MP lens

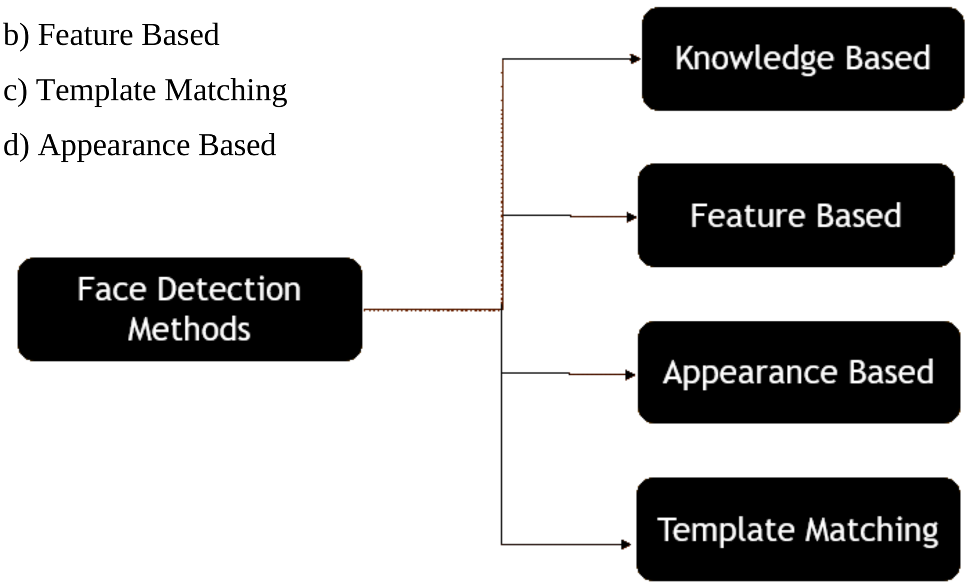
3.1.2 Dividing Into Frames:

Camera used in project is recording the video with 1080p resolution at 30 fps. For the correct working of algorithm each frame has to be processed. In this step all the frames are extracted from the video and then by using computer vision and machine learning techniques face is searched in each frame.

3.1.3 Face Detection:

There are many ways to detect the faces. Some of them are discussed below briefly:

a) Knowledge Based
b) Feature Based
c) Template Matching
d) Appearance Based



a) Knowledge Based:

[32] Knowledge Based method depends on human knowledge to detect faces and it is based on the set of rules. Like a face must consist the following body parts i.e. nose, eyes and mouth with certain positions and distance. The main disadvantage of this method is that it is difficult to build an appropriate rule to detect the face in multiple images. The results could be false if the rules are too detailed or too general.

b) Feature Based:

The feature based method detect the face by using the structural features of the face. The most common and successful algorithm that uses this method is Viola Jones algorithm. [33]Viola Jones algorithm is designed to detect the frontal faces rather than the faces looking sideways, downwards or upwards. Before the face detection the image is converted to gray scale because it is easier to work with lesser data. This algorithm uses three Haar features i.e. edge features, line features, four-sided features. These features helps the machine whether the face is present or not.

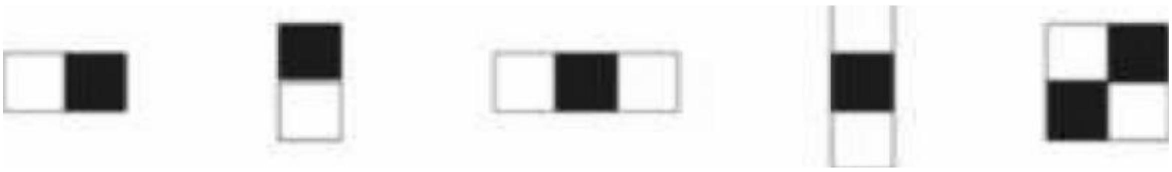


Figure-3.3: Haar Features

c) Template Matching:

[34] In this method pre-defined or parameterized face templates is used to detect the faces by the correlation between the templates and input images. A face model can also be built by using the edge detection method. This approach is very simple to implement but it does not give satisfying results in face detection.

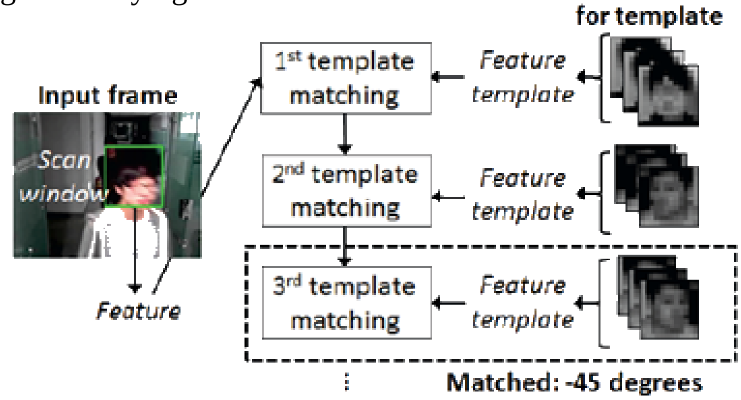


Figure-3.4: Template Matching

d) Appearance Based:

The appearance based method uses a set of delegate training face images to find out the face in the images. This is the best approach in terms of accuracy and performance. This approach rely on the techniques of machine learning and deep learning to find the relevant characteristics of face images.

D-lib Face Land Mark Predictor:

There are many facial land mark predictors but all methods focuses on the following facial regions:

1) Mouth
2) Right Eyebrow
3) Left Eyebrow
4) Right Eye
5) Left Eye
6) Nose
7) Jaw

These are the important feature of the face. In order to train the model researchers manually and painstakingly labeled the data and created a dataset commonly known as iBUG-300W dataset. The main purpose of the iBUG-300W is to train a shape predictor capable of localizing each individual facial structure including the eyes, eyebrows, nose and mouth. A model which is trained by using this dataset can predict the location of each of these facial regions explained above.

In this thesis the face is detected in each frame by using the d-lib face predictor library. The pre-trained model of dlib facial landmark predictor uses the location of 68 (x,y)-coordinates that map to facial structures on the face. The indexes of the 68 coordinates can be visualized
in the figure 3.5.

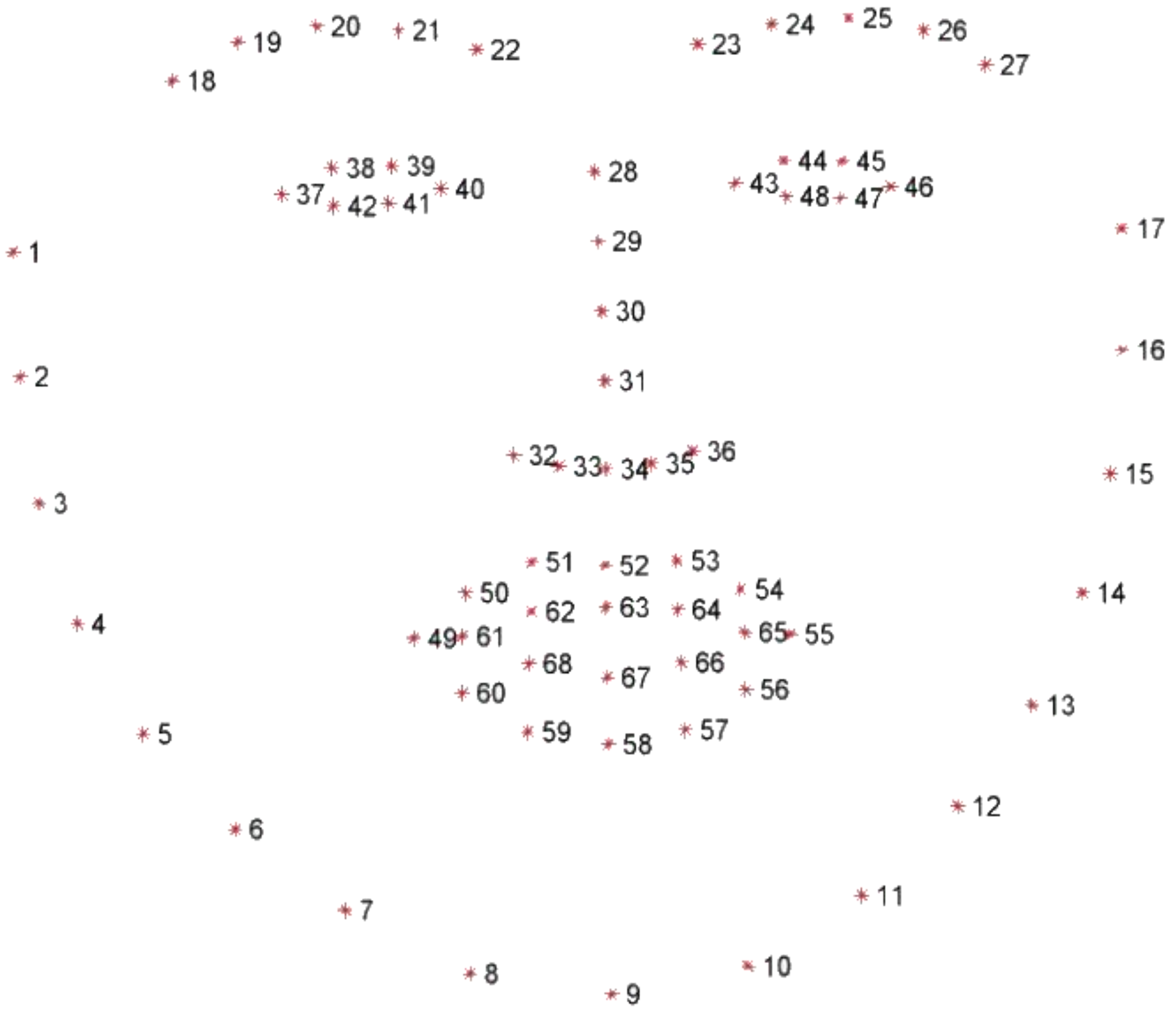


Figure-3.5: Visualizing the 68 facial landmark coordinates from the iBUG 300W dataset

3.1.4 Working:

After detecting the face from each frame then it comes to detect the eye and mouth regions from the face. Eyes and mouth regions can be detected easily by using our face predictor as shown in the figure 3.6. The problem that comes after detecting the face and eyes regions of the face is that how to detect that whether the person is drowsy or not. This can be done by measuring the Eyes Aspect Ratio(EAR) and Mouth Aspect Ratio (MAR).

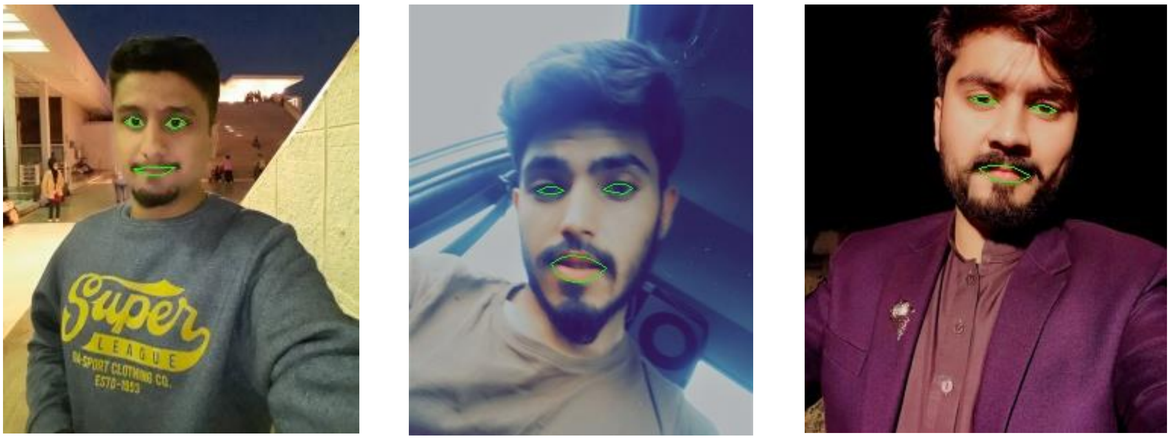
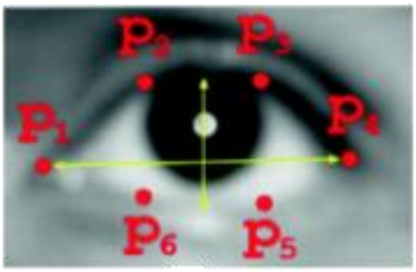


Figure-3.6: Eyes and Mouth Regions Detected

Eye Aspect Ratio

EAR is the ratio between the length of eyes to the width of eyes. The length can be easily calculated by using the two horizontal points and the height can be calculated by using the two vertical points as shown in the figure. If the person is drowsy then his height of eyes gets decreased. If it is less than the defined threshold then the system detects that driver is drowsy and an alarm is sounded in order to wake up the driver.

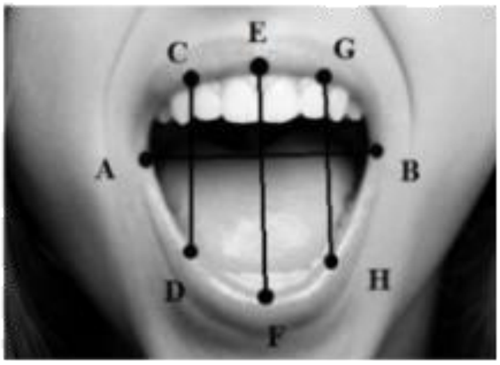


$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Figure-3.7: Eye Aspect Ratio

Mouth Aspect Ratio

MAR is the ratio between the length of the mouth to the width of the mouth. It is computationally, similar to the Eye Aspect Ratio(EAR). When driver is feeling drowsy, he may likely to yawn and lose control over his mouth resulting in increase in MAR. When the MAR crossed certain threshold then system detect that driver is going in drowsy state and an alarm is sounded to alert the driver. Figure 3.8 shows how to calculate the MAR.



$$MAR = \frac{|EF|}{|AB|}$$

Figure-3.8: Mouth Aspect Ratio

Chapter 4

Hardware

4.1 Raspberry Pi

The Raspberry Pi tool seems like a motherboard, with the hooked up chips and ports uncovered (something you'd assume to look best if you opened up your computer and looked at its inner boards), however it has all of the components you need to connect input, output, and garage gadgets and begin computing as shown in the figure 4.1.

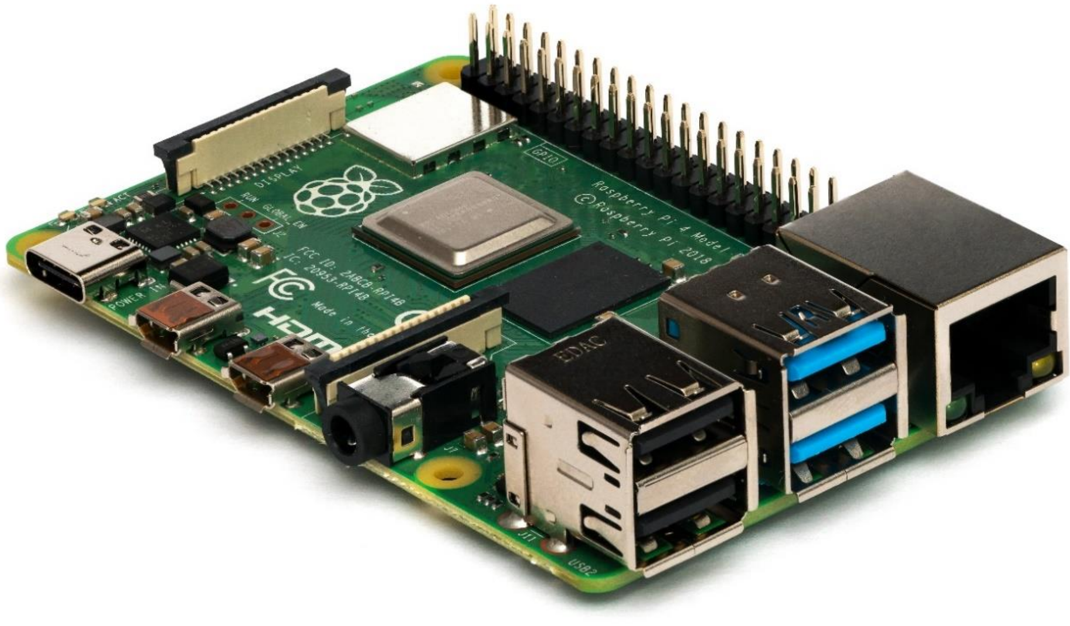


Fig 4.1 Raspberry Pi

The Raspberry Pi gauges generally 3.4 inches by 2.1 inches (8.6 centimeters by 5.3 centimeters), however it is truly ground-breaking for such a little device. This was made conceivable by the prepared accessibility of economical and little processors for cell phones, which need to pack a respectable measure of handling and sight and sound capacity into a little shell with the capacity to remain generally cool and not suck power excessively fast.

The establishment picked a chip with ARM design thus (a processor engineering normally utilized for cell phones and comparable devices). The chip has 256 MB of RAM, runs at 700 MHz, and incorporates a 1080p-fit GPU. Although there are other ARM chips accessible, the gathering picked a Broadcom chip to some extent because of Eben Upton's relationship with the organization (he works for them). Broadcom's eagerness to give a mass rate for little requests permits the establishment to show signs of improvement cost on this chip than on any practically identical contender's processor. In the same way as other of the most punctual home PCs, the device comes without peripherals or inside extra room, and the client should connect input, output, and capacity peripherals. At least, you will need a TV or screen for output, a console (and potentially a mouse) for input, a SD card on which to house the OS and store information, a power supply and any essential links. You can include an outside hard drive for extra storage, however the SD card will even now be essential, as the OS will boot from SD as a matter of course.

The perfect working frameworks for the device are all Linux disseminations. Linux was picked in any event halfway for its low memory overhead, making it conceivable to run a completely useful OS on such a basic device, that is without worked in permanent storage. Linux is likewise commonly free and has extraordinary potential as a CS learning instrument, since its conveyances frequently accompany some programming languages previously introduced

Here are the various additives on the Raspberry Pi board:

4.1.1 ARM CPU/GPU

This is a Broadcom BCM2835 System on a Chip (SoC) that is comprised of an ARM central processing unit (CPU) and a Video core 4 graphic processing unit (GPU). The CPU handles all the calculations that make a PC work (taking information, doing estimations, and delivering yield), and the GPU handles illustrations yield.

4.1.2 GPIO

Those are uncovered general-purpose input/output connection points on the way to permit the actual hardware hobbyists the opportunity to tinker.

4.1.3 RCA

An RCA jack permits association of simple TVs and other comparative output devices

4.1.4 Audio out

This is a standard 3.55-millimeter jack for association of sound yield gadgets, for example, earphones or speakers. There is no sound in.

4.1.5 LEDs

Light-transmitting diodes, for the entirety of your marker light needs.

4.1.6 USB

This is a typical association port for fringe devices of various types (counting your mouse and console). Model A has one, and Model B has two. You can utilize a USB center point to grow the quantity of ports or fitting your mouse into your console on the off chance that it has its own USB port.

4.1.7 HDMI

This connector permits you to attach a top-quality TV or other perfect devices utilizing a HDMI link.

4.1.8 Power

This is a 5v Micro USB power connector into which you can plug your perfect power supply

4.1.9 SD card slot

This is a full-sized SD card space. A SD card with an operating system (OS) introduced is required for booting the device. They are accessible for buy from the makers, yet you can likewise download an OS and save it to the card yourself if you have a Linux machine.

4.1.10 Ethernet

This connector takes into consideration wired system get to and is just accessible on the Model B.

4.2 Raspberry Pi pinout

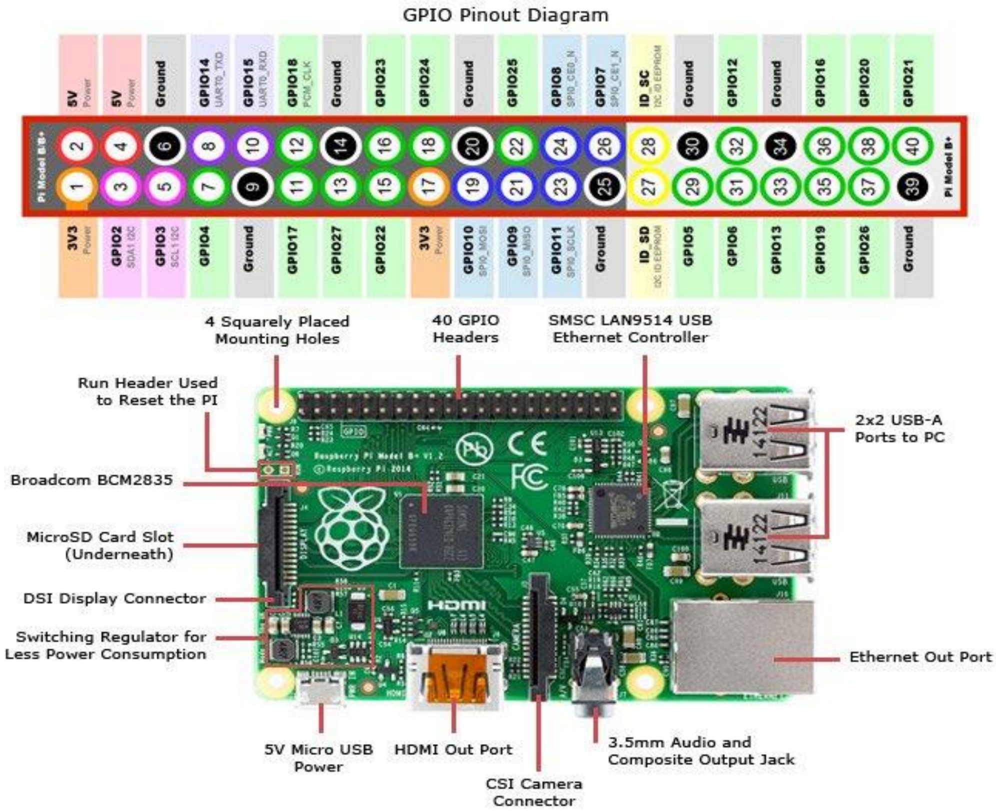


Fig 4.2 Raspberry Pi/Pinout

4.3 Camera

Raspberry Pi Night Vision Camera plugs straightforwardly into the CSI connector on the Raspberry Pi, and highlights two high-force Infrared LED spotlights for evening time recording! The IR LED's are powered straight forwardly from the CSI port, and are fit for lighting a zone a good way off up to 8m! In testing, the best pictures were captured a good way off 3m to 5m. The camera likewise includes a movable 3.6mm central length focal point and 75.7 degree viewing angle. This Raspberry Pi night vision camera utilizes the equivalent OV5647 as the standard Raspberry Pi camera and is thusly ready to convey a completely clear 5MP resolution picture or 1080p HD video recording at 30fps!

Fig 4.3 Night Vision Camera

4.3.1 Description

5 Megapixel OV5647 Camera

2 x 3W high-power 850 infrared LEDs:

Onboard photoresistor to detect ambient light

Onboard adjustable resistor, for controlling the ambient light threshold of toggling the infrared LED

The camera is capable of 2592 x 1944-pixel static images, and also supports 1080p @ 30 fps, 720p @ 60 fps and 640 x480p 60/90 video recording.

CCD size: 1/4inch

Aperture (F): 1.8

Focal Length: 3.6MM (adjustable)

Diagonal: 75.7 degree

Sensor Resolution: 1080p

Dimension: 25mm x 24mm

4 screw holes

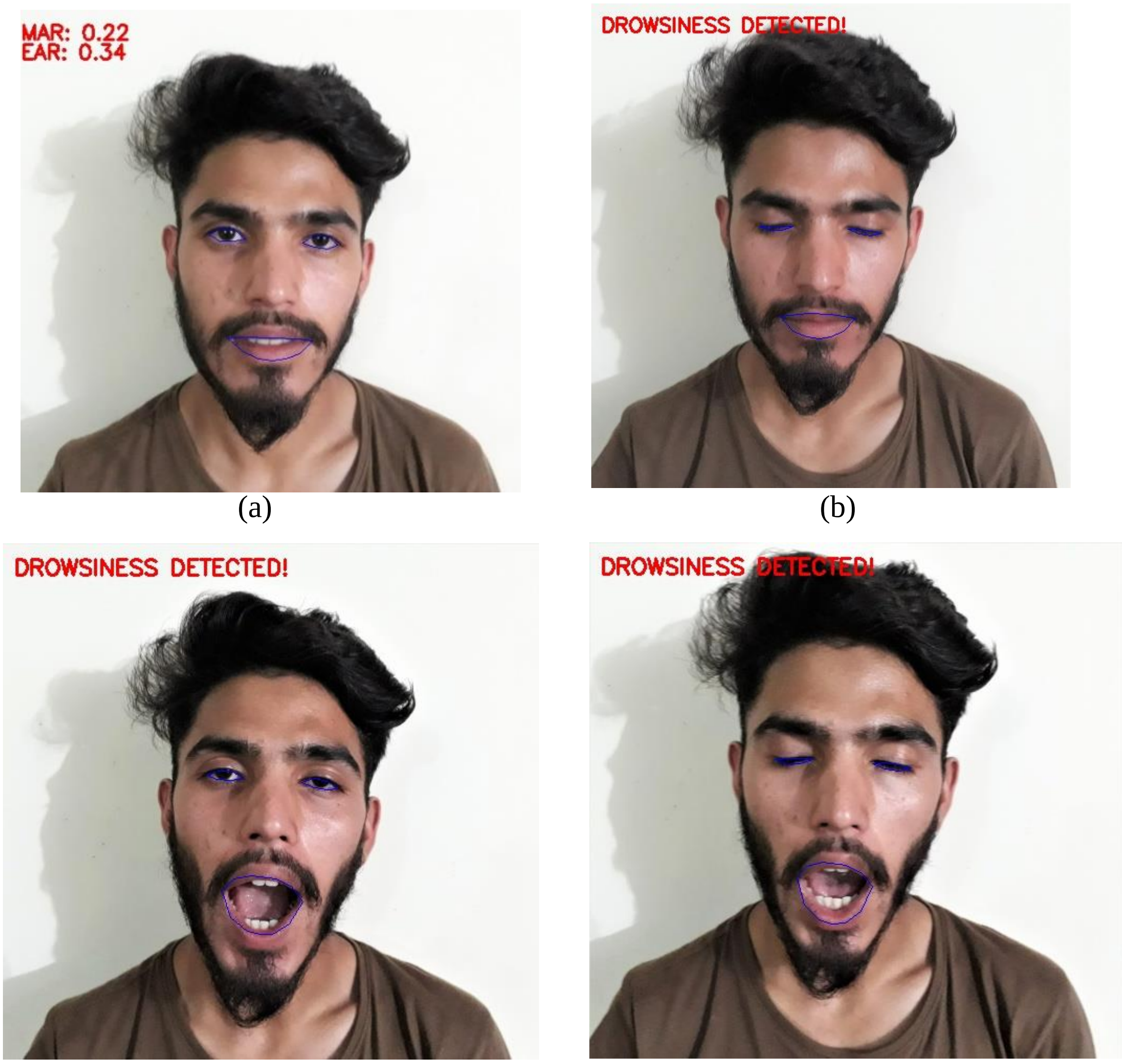
Used for both attachment and 3.3V power supply

Supports up to 2 infrared LEDs

Chapter 5

Results

Drowsiness detector is able to work in a variety of conditions like in the direct sunlight when driving on road and also in low lightening conditions like in garages. The experimental results in figure 5.1 shows that the algorithm used in detecting the driver drowsiness outperform the state of art in terms of accuracy and robustness. But by using the deep learning models, it is able to achieve the better performance measures while dealing with large data processing.



(a) (b) (c) (d)

Figure-5.1: (a) Normal Condition (b) Person with sleep (c) Person Yawning (d) Person in state of drowsiness.

Limitations:

Following are the limitations of our designed system that this system will not work under these conditions:

1) If the driver is wearing sun glasses and mask(anything that cover the mouth).
2) If there is any other person near the driver that camera can detect than there is may be possibility that camera may consider other person as the driver.
3) This system does not work in the night condition however if a night vision camera tuned at night conditions can be used to proper working of this algorithm.

Chapter 6

Conclusion

Driver drowsiness detection in a vehicle includes capturing a sequence of video image frames with a pi-cam, and each frame consists of image of the driver. We are using 5MP night vision pi-cam that takes 30 frames per second and process those images to monitor the drowsiness state of the driver. Now if the driver is detected drowsy that one of these two or both conditions are fulfilled than this system will beep an alarm to alert the driver.

Following are the two conditions:

1) If (EAR<Threshold) that is if Eye aspect ratio is less than the defined threshold than the driver is in drowsy state.
2) If (MAR>Threshold) that is if Mouth aspect ratio is greater than the defined threshold than the driver is in drowsy state.

Appendix A

Code for computer:

```
from scipy.spatial import distance as dist
from imutils.video import VideoStream
from imutils.video import FileVideoStream
from imutils import face_utils
from threading import Thread
import numpy as np
import playsound
import argparse
import imutils
import time
import dlib
import cv2
def sound_alarm(path):

	playsound.playsound(path)
def eye_aspect_ratio(eye):
	A = dist.euclidean(eye[1], eye[5])
	B = dist.euclidean(eye[2], eye[4])
	C = dist.euclidean(eye[0], eye[3])
	ear = (A + B) / (2.0 * C)
	return ear

def Mouth_aspect_ratio(mouth):
	A1 = dist.euclidean(mouth[3], mouth[9])
	B1 = dist.euclidean(mouth[0], mouth[6])
	mar = abs(A1)/abs(B1)
	return mar

ap = argparse.ArgumentParser()
ap.add_argument("-p", "--shape-predictor", required=True,
	help="path to facial landmark predictor")
ap.add_argument("-a", "--alarm", type=str, default="",
	help="path alarm .WAV file")
#ap.add_argument("-w", "--webcam", type=int, default=0,
 #	help="index of webcam on system")
ap.add_argument("-v", "--video", type=str, default="",  #####
	   help="path to input video file")
args = vars(ap.parse_args())
EYE_AR_THRESH = 0.2
M_MAR_THRESH = 0.45
EYE_AR_CONSEC_FRAMES = 5
COUNTER = 0
ALARM_ON = False
print("[INFO] loading facial landmark predictor...")
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor(args["shape_predictor"])
```

```
(lStart, lEnd) = face_utils.FACIAL_LANDMARKS_IDXS["left_eye"]
(rStart, rEnd) = face_utils.FACIAL_LANDMARKS_IDXS["right_eye"]
(mStart, mEnd) = face_utils.FACIAL_LANDMARKS_IDXS["mouth"]
time.sleep(1.0)

#vs = VideoStream(src=args["webcam"]).start()
vs = FileVideoStream(args["video"]).start()
# loop over frames from the video stream
a=1
while True:
	a=0
	frame = vs.read()   #For Live Stream
	#frame = cv2.imread('1b.jpg')  #For only Single Image
	frame = imutils.resize(frame, width=720)
	gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
	rects = detector(gray, 0)
	for rect in rects:

		shape = predictor(gray, rect)
		shape = face_utils.shape_to_np(shape)
		leftEye = shape[lStart:lEnd]
		rightEye = shape[rStart:rEnd]
		mouth_ = shape[mStart:mEnd]
		mouthmar=Mouth_aspect_ratio(mouth_)
		leftEAR = eye_aspect_ratio(leftEye)
		rightEAR = eye_aspect_ratio(rightEye)


		# average the eye aspect ratio together for both eyes
		ear = (leftEAR + rightEAR) / 2.0
		leftEyeHull = cv2.convexHull(leftEye)
		rightEyeHull = cv2.convexHull(rightEye)
		jaw_Hull = cv2.convexHull(mouth_)

		#print("jaw_hull")
		#print(jaw_Hull)
		cv2.drawContours(frame, [leftEyeHull], -1, (255, 0, 0), 1)
		cv2.drawContours(frame, [rightEyeHull], -1, (255, 0, 0), 1)
		cv2.drawContours(frame, [jaw_Hull], -1, (255, 0, 0), 1)
		#print("mar")
		#print(mouthmar)

		if ear < EYE_AR_THRESH or mouthmar > M_MAR_THRESH :


			COUNTER += 1

			if COUNTER >= EYE_AR_CONSEC_FRAMES:
			    if not ALARM_ON:
			        ALARM_ON = True
```

```
                if args["alarm"] != "":
                    t = Thread(target=sound_alarm,
                            args=(args["alarm"],))
                    t.deamon = True
                    t.start()

            cv2.putText(frame, "DROWSINESS DETECTED!", (10, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)



        else:
            COUNTER = 0
            ALARM_ON = False
            cv2.putText(frame, "EAR: {:.2f}".format(ear), (0, 50),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 255), 2)
            cv2.putText(frame, "MAR: {:.2f}".format(mouthmar), (0, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 255), 2)

    # show the frame
    #cv2.imwrite('/home/sajid/Mouth_yawn.jpg', frame)
    cv2.imwrite('/Users/Zaeem Barlas/Downloads/Yawning/zaeem.jpg', frame)
    cv2.imshow("Frame", frame)
    key = cv2.waitKey(1) & 0xFF


    if key == ord("q"):
        break
# do a bit of cleanup
cv2.destroyAllWindows()
```

Code for Raspberry Pi:

```
from scipy.spatial import distance as dist
import RPi.GPIO as GPIO
from picamera import PiCamera
from picamera.array import PiRGBArray
from imutils import face_utils
from threading import Thread
import numpy as np
import playsound
import argparse
import imutils
import time
import dlib
import cv2

GPIO.setmode(GPIO.BCM)
camera = PiCamera()
camera.sharpness = 100
camera.framerate = 5
IM_WIDTH = 1024
IM_HEIGHT = 768
camera.resolution = (1024, 768)
rawCapture = PiRGBArray(camera, size=(IM_WIDTH,IM_HEIGHT))
GPIO.setup(23,GPIO.OUT)

GPIO.output(23, GPIO.HIGH)
time.sleep(2)
GPIO.output(23, GPIO.LOW)
time.sleep(1)
rawCapture.truncate(0)

def sound_alarm(path):

	playsound.playsound(path)

def eye_aspect_ratio(eye):
	A = dist.euclidean(eye[1], eye[5])
	B = dist.euclidean(eye[2], eye[4])
	C = dist.euclidean(eye[0], eye[3])
	ear = (A + B) / (2.0 * C)
	return ear

def Mouth_aspect_ratio(mouth):
	A1 = dist.euclidean(mouth[3], mouth[9])
	B1 = dist.euclidean(mouth[0], mouth[6])
	mar = abs(A1)/abs(B1)
	return mar
```

```
EYE_AR_THRESH = 0.2
M_MAR_THRESH = 0.35
EYE_AR_CONSEC_FRAMES = 2
COUNTER = 0
ALARM_ON = False
print("[INFO] loading facial landmark predictor...")
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor("shape_predictor_68_face_landmarks.dat")
(lStart, lEnd) = face_utils.FACIAL_LANDMARKS_IDXS["left_eye"]
(rStart, rEnd) = face_utils.FACIAL_LANDMARKS_IDXS["right_eye"]
(mStart, mEnd) = face_utils.FACIAL_LANDMARKS_IDXS["mouth"]
time.sleep(1.0)
# loop over frames from the video streamsharpness
for frame1 in
camera.capture_continuous(rawCapture,format="bgr",use_video_port=True):


    frame = np.copy(frame1.array)
    frame.setflags(write=1)
    # frame = cv2.imread('foo.jpg')
    #frame = imutils.resize(frame, width=450)
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    rects = detector(gray, 0)
    for rect in rects:

        shape = predictor(gray, rect)
        shape = face_utils.shape_to_np(shape)
        leftEye = shape[lStart:lEnd]
        rightEye = shape[rStart:rEnd]
        mouth_ = shape[mStart:mEnd]
        mouthmar=Mouth_aspect_ratio(mouth_)
        leftEAR = eye_aspect_ratio(leftEye)
        rightEAR = eye_aspect_ratio(rightEye)


        # average the eye aspect ratio together for both eyes
        ear = (leftEAR + rightEAR) / 2.0
        leftEyeHull = cv2.convexHull(leftEye)
        rightEyeHull = cv2.convexHull(rightEye)
        jaw_Hull = cv2.convexHull(mouth_)

        #print("jaw_hull")
        #print(jaw_Hull)
        cv2.drawContours(frame, [leftEyeHull], -1, (0, 255, 0), 1)
        cv2.drawContours(frame, [rightEyeHull], -1, (0, 255, 0), 1)
        cv2.drawContours(frame, [jaw_Hull], -1, (0, 255, 0), 1)
        print("mar")
        print(mouthmar)

        if ear < EYE_AR_THRESH or mouthmar > M_MAR_THRESH :
```

```
            COUNTER += 1
            cv2.putText(frame, "EAR: {:.2f}".format(ear), (300, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
            cv2.putText(frame, "MAR: {:.2f}".format(mouthmar), (0, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

            if COUNTER >= EYE_AR_CONSEC_FRAMES:
                GPIO.output(23, GPIO.HIGH)
                COUNTER=0
                cv2.putText(frame, "DROWSINESS ALERT!", (500, 30),
                cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 0, 0), 2)


        else:
            GPIO.output(23, GPIO.LOW)


            cv2.putText(frame, "EAR: {:.2f}".format(ear), (300, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
            cv2.putText(frame, "MAR: {:.2f}".format(mouthmar), (0, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

    # show the frame
    cv2.imwrite('Mouth_yawn.jpg', frame)
    cv2.imshow("Frame", frame)
    key = cv2.waitKey(1) & 0xFF


    if key == ord("q"):
        GPIO.cleanup()
        break
    rawCapture.truncate(0)
camera.close()
# do a bit of cleanup
cv2.destroyAllWindows()
```

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