A Project Report On

IoT-powered technologies and Machine Learning based Driver Drowsiness Detection system.

Submitted in partial fulfillment of the requirement for the 8^{th} semester

Bachelor of Engineering

in

Computer Science and Engineering

DAYANANDA SAGAR COLLEGE OF ENGINEERING

(An Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE & ISO 9001:2008 Certified)

Accredited by National Assessment & Accreditation Council (NAAC) with 'A' grade

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CERTIFICATE

This is to certify that the project entitled **IoT-powered technologies and Machine Learning based Driver Drowsiness Detection system** is a bonafide work carried out by **Annapoorna** [**1DS20CS401**], **Bapu D Puneeth Kumar** [**1DS20CS403**]**, Divya M** [**1DS20CS408**] and **Thejesh Kumar H Mutt S** [**1DS20CS423**] in partial fulfillment of 8th semester, Bachelor of Engineering in Computer Science and Engineering under Visvesvaraya Technological University, Belgaum during the year 2022-23.

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We are pleased to have successfully completed the project **IoT-powered technologies and Machine Learning based Driver Drowsiness Detection system**. We thoroughly enjoyed the process of working on this project and gained a lot of knowledge doing so.

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Abstract

Road accidents are one of the leading causes of fatal accidents indiscriminate of roadway and time. This is intensified by the increase in the number of vehicles around the world. Driving prolonged distances often lead to fatigue and drowsiness among drivers. One of the reasons for the high fatalities of these accidents is the lack of timely medical attention given to the drivers. In the vehicle and driver security system, we recognize the driver's facial recognition, hand grip, and heart rate and give alerts. Whenever the driver is drowsy and he blinks his eyes, he loses control of the steering wheel or his heart rate range goes down automatically and a vibrator and speaker give an alert to maintain their safety. Drowsiness is one of the main reasons major cause s these days for road accidents. Here, to avoid such kinds of accidents we're developing a system which is a drowsiness alert system. Firstly the facial image of the driver is monitored and it is identified by facial recognition techniques once the driver is in the vehicle and he starts driving the vehicle, for instance, if he feels drowsy there will be an alert so that he can get himself awake, take a break and then drive the vehicle. This is a combined approach for driver drowsiness detection using the visual, physiological, and physical behaviour of the driver. The fatigue of the driver is detected by combining both facial and eye analysis using a machine learning image processing algorithm contributing to the visual behavior analysis, Driver heart rate data is obtained using a sensor and is analyzed to detect sleepiness based on the threshold value which contributes to physiological behavior analysis, and for the physical behavior approach steering grip of the driver is obtained using human antenna effect based touch sensing techniques.

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Chapter 1

Introduction

Driver fatigue can be more severe than simply feeling weary it frequently results in drowsiness or even brief sleep episodes. Approximately 1 in 25 adult drivers (age 18 or older) reported falling asleep at the wheel at least once in the previous 30 days, according to studies published by the CDC. Every human being needs sleep, lack of sleep causes human inactiveness, improper reflexes, loss of focus, gets deviation which decreases the capability to make proper decisions which is necessary for driving a vehicle. Fatigue is a safety problem that has not yet been deeply tackled by any country in the world mainly because of its nature.

Fatigue, in general, is very difficult to measure or observe unlike alcohol and drugs, which have clear key indicators and tests that are available easily. Probably, the best so- solutions to this problem are awareness about fatigue-related accidents and promoting drivers to admit fatigue when needed. The former is hard and much more expensive to achieve, and the latter is not possible without the former as driving for long hours is very lucrative. While on the road, an automobile wields the most power and in irresponsible hands, it can be destructive, and sometimes, that carelessness can harm lives even of the people on the road.

One kind of carelessness is not admitting when we are too tired to drive. Fatigue, in general, is very difficult to measure or observe unlike alcohol and drugs, which have clear key indicators and tests that are available easily. Probably, the best solutions to this problem are awareness about fatigue-related accidents and promoting drivers to admit fatigue when needed..

1.1 The Problem

Driving while sleepy or fatigued is referred to as drowsy driving. The most common cause of this is insufficient sleep, although other causes include untreated sleep problems, drugs, drinking alcohol, or working shifts.Unconscious driving is a known threat to traffic safety.

Driver weariness and sleepiness cause 10 to 30percent of fatal collisions. Although it is technically impossible to prevent or regulate drivers from nodding off while driving, it is possible to identify and warn them. It is not possible to manually identify and warn the motorist.

1.2 Real World Application

The project was designed to solve a real problem and be applied in the real world. By leveraging the existing Camera module, smart watch and pressure sensor. we reduce our hardware dependencies. Some of the most noteworthy real world applications are:

1. Driver drowsiness detection in car safety technology:

Driver inattention is might be the result of lack of alertness when driving due to drowsiness and distraction. The camera module will continuous monitor the facial recognition of driver will driving the vehicle if the driver starts yawn and closing eyes system alerts driver through Vibrator and speaker in real time.

2. In aid to prevention of accidents might of drowsiness:

Another application of the project is the quick resolution of drowsy alertness. The system will detect the early symptoms of drowsiness before the driver has fully lost all attentiveness and warn the driver that they are no longer capable of operating the vehicle safely.

3. Efficiently monitors driver behaviour closely:

The project would also ensure that erratic steering wheel movements and the pressure on steering wheel so it can judge the movement you starting to feel sleepy and need to take short nap. It also continually evaluates number of time driver feels drowsy.

4.predicting drowiness using wearble device:

Smartwatches record vital signs like heart rate, skin temperature, step count and more. The smart watches or fitness trackers are very useful devices from a medical point of view. Almost all modern watch models are equipped with sensors that measure blood pressure, heat rate and sleep quality. Self-tracking allows to stick to a healther diet,excersise more and sleep better.

1.3 Organisation of project Report

The project report is organized as follows:

Chapter (2) we discuss the problem statement and the proposed solution. We also take a look at the systems that exist today and the drawbacks.

Chapter (3) takes a more in-depth look at various hardware and software based solutions that exist, with a survey on existing literature available.

Chapter (4) describes the system requirements such as hardware and software requirements.

Chapter (5) looks at the architecture of the proposed solution with an overview of the system design, utilizing system block diagrams and data flow diagrams.

Chapter (6) dives into the Implementation of the solution, by describing the hardware and software requirements, along with dataset descriptions and implementation details.

Chapter (7) describes our testing process.

Chapter (8) examine our experimentation methodology and the obtained results.

Chapter (9) summarizes our conclusions and ends the paper.

1.4 Summary

Chapter 1 introduces us to the problem caused by the drowsiness of the driver while driving and what precautions need to be taken to prevent drowsiness, and all the methods used to detect drowsiness of the driver and in this it tells us where and all those systems can be used in a real world application to prevent the tragic events caused by the drowsiness.

Chapter 2

Problem Statement and Proposed Solution

2.1 Problem Statement

To develop and detect drowsiness efficiently and accurately from the camera module, smartwatch, and pressure sensor. Driving while sleepy or fatigued is referred to as drowsy driving. The most common cause of this is insufficient sleep, although other causes include untreated sleep problems, drugs, drinking alcohol, or working shifts. Unconscious driving is a known threat to traffic safety. Driver weariness and sleepiness cause 10 to 30 percent of fatal collisions. Although it is technically impossible to prevent or regulate drivers from nodding off while driving, it is possible to identify and warn them. It is not possible to manually identify and warn the motorist.

2.2 Existing Systems

This authentication approach has been utilized with various components in IoT devices and external devices which can be added as hardware equipped with vehicles to detect drowsiness. Numerous solutions have been put forth to tackle the detection of drowsiness. Some solutions make use of existing sensors in vehicles. The system which can differentiate normal eye blink and drowsiness can prevent the driver from entering a state of sleepiness while driving. A camera is used for drowsiness detection by identifying yawning patterns, eyelid movement,heartbeat range, and pressure on the steering wheel.

The steering wheel movement, the accelerator of the vehicle or pattern of vehicle brakes, the vehicle's speed, and deviation in position of the lane are monitored continuously in the method which is based on the vehicle. If there is any deviation in the values detected,when it reaches the threshold value it considered as driver drowsiness.

In an intrusive approach, sensors are used to detect driver drowsiness by placing them on the driver's body, whereas, in a non-intrusive approach, a camera is used for drowsiness detection by identifying yawning patterns, eyelid movement, and head inclination, to monitor visual cues, where drowsiness can be detected through yawning frequency, eye-blinking frequency, eye-gaze movement, head movement, and facial expressions to predict the drowsiness of the driver using the steering grip.

2.2.1 Open CV Haar Cascade Model

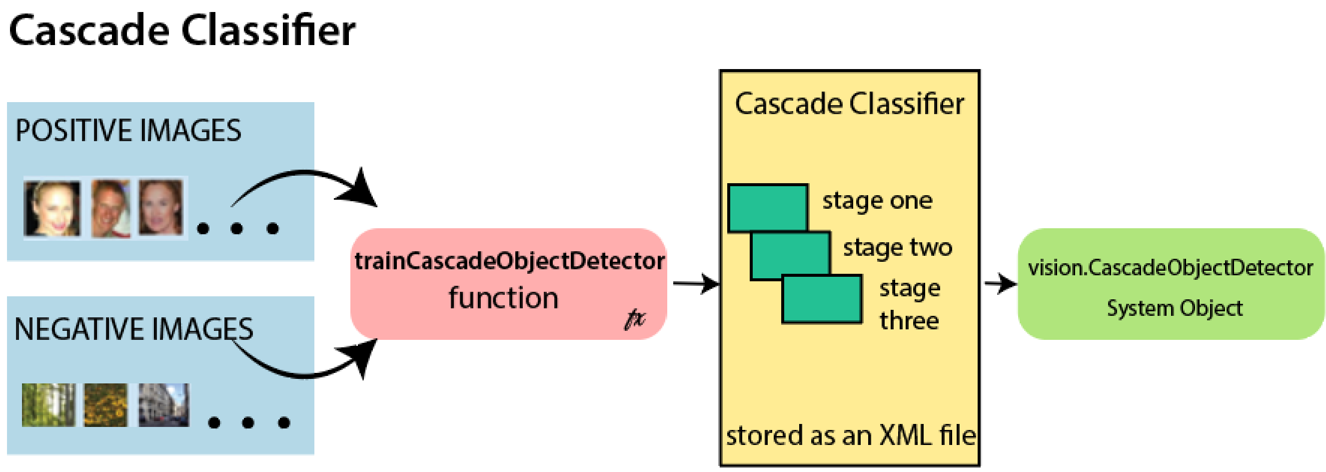

Figure 2.1: OpenCV:Face Detection using Haar Cascade

In terms of detecting drowsiness using Computer Vision, Jahon Karlsson came up with an efficient method of using the Open CV Haar cascade algorithm to classify facial recognition based on their type and severity. By leveraging various other Open CV techniques, several other works were published regarding the classification and detection of drowsiness. A highly helpful approach that takes into account the many visual characteristics of drowsiness detection was proposed .open cv was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in commercial products.

When it comes to facial landmark algorithm is a computer vision task in which a model needs to predict key points representing regions or landmarks on a human face like eyes, nose, lips, and others. It works by identifying and measuring facial features in an image. The face land marker uses a series of models to predict face landmarks.

The first model detects faces, the second model locates landmarks on the detected faces, and the third model uses those landmarks to identify facial features and expressions. Drowsiness is one of the leading causes of near-miss or real road accidents. While drowsiness is alerted by smart watch researchers have invested a considerable amount of effort in identifying ways to the detect drowsiness state of drivers and alert them in a timely manner to avoid serious consequences. Easy prediction of drowsiness is consumer wearable devices such as smart watch while monitoring the heart rate variability.

2.2.2 Open CV in object Detection

Open CV using Haar Cascade algorithm after the facial recognition the eye blinks and yawning should be monitored. The Open CV is used to video feed of the driver's face is continuously scanned for gestures such as yawning which indicates the fatigue state of the driver. It is based on the longitude and latitude of the mouth while yawning. An infrared night vision camera is placed inside the vehicle which records the behavior of the driver.
It also measures the eye blink rate similar to the yawning-based method a camera records the driver's face and checks if the driver's eyes are closed or open. The estimated average blinking duration is between 100-400ms. If the camera sees that the eye of the driver closes for a duration far more than the threshold value it marks the driver as asleep and some sort of vibrator and speaker gives an alert 3 to 4 times if the driver again goes for drowsy without taking nap automatically to message is sent to the emergency contact for better safety of the driver.

2.2.3 Facial landmarks with DLIB model

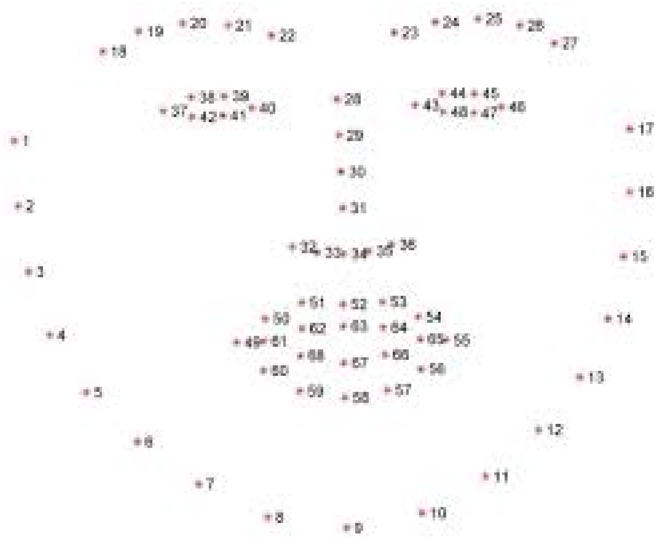

Figure 2.2: Facial landmarks with DLIB Model

The first step of the solution involves accurately detecting drowsiness using facial landmark algorithms to identify the locations of the facial key landmark points on a facial image or from a video. The key landmark points are monitored by a night vision camera which can also predict the driver's drowsiness in the dark without any lights and normally includes the facial regions like the nose tip, eye corner, eyebrows, and chin tip.

Depending on the facial appearance and facial shape patterns, drowsiness is predicted and an alert is given. The facial landmark API is called Face mark. DLIB library includes face detection functions in it. DLIB face detection uses histogram-oriented methods (HOG) and landmark detection. It returns different 68 feature points from a face. The classification is done as open eye or closed eye based on the value of PERCLOS, eye blink rate. The method based on eye blinking analysis is used blink frequency as a measure to detect driver drowsiness.

2.2.4 Pressure Sensor Matrix Using Velostat

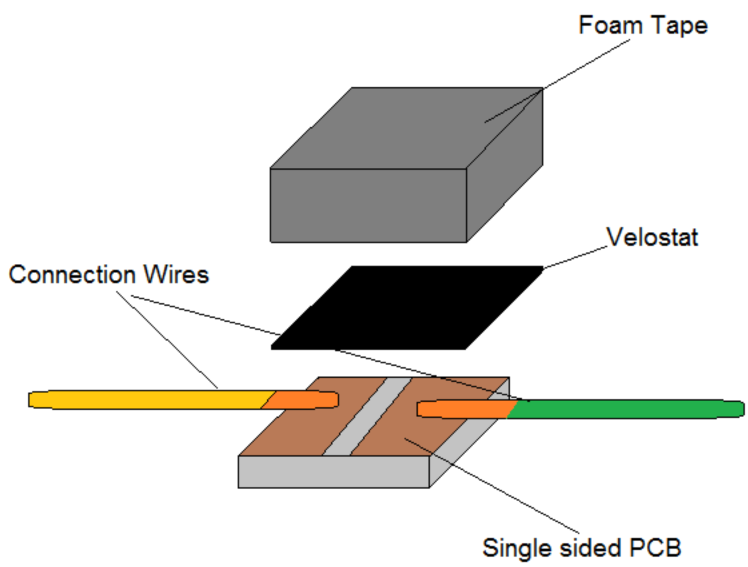

Figure 2.3: Velostat Working Principle

Velostat is a flexible strain sensors for human motion detection are a promising field. velostat is a cheap and widely available material for at home construction of simple flexible pressure sensor they promise to be an unobtrusive way of integrating smart electronics and data collection into everyday objects such as clothing . The distance between these particles informs the resistivity of the material. This forms a flexible, plastic sheet which can be easily cut or shaped for many application. Three material for strain and pressure sensing are discussed velostat is discussed as a practical application due to its low cost and ease of use in vehicles.

Flexible strain sensors for human motion detection are a promising field. They promise to be an unobtrusive way of integrating smart electronics and data collection into everyday objects such as clothing. The objective of this report is to outline a selection of flexible strain sensors in the application of detecting human motion and discuss their readiness to be applied to real world devices. Three materials for strain and pressure sensing are discussed. Velostat is discussed as a practical application due to its low cost and ease of use. Strain threads are discussed, as they have been demonstrated to have high accuracy and utility and can be fabricated for a relatively low cost. Finally, piezoelectric materials are broadly discussed, with a focus on PVDF as the primary available material.

The distribution of human plantar pressure data reflects factors relating to the foot, including foot function and control over whole body posture. A medical diagnosis can benefit greatly from measurements of the pressure distribution in the human foot. Analysing the distribution of foot plantar pressure to determine the interface pressure between the foot plantar surface and shoe sole is one method that has drawn a lot of interest from researchers working on biological and sports-related applications. Capacitive, resistive, piezoelectric, and piezo-resistive pressure sensors are the most often used types. Commonly used in capacitive force sensors, parallel plate capacitors vary their capacitance in response to the applied force.

2.3 Proposed Solution

Combining the various methods, we propose a solution that not only makes use of Open CV feature extraction but also takes into consideration the facial landmark for the detection of driver drowsiness by leveraging state face Detection methodologies combined with a single approach detection algorithm. An MI band using for heart rate variability to detect driver drowsiness and give a vibration alert to wake. The velostat pressure sensor is also implemented to monitor pressure on the steering wheel. The approach to drowsiness detection can be classified into three separate stages

(i) Drowsiness detection based on Open CV is a very useful technique when we required scaling in object detection. Classification of the detected drowsiness by facial land mark algorithm. It identify the locations of the facial key landmark points on a facial image or from a video.

(ii) MI band is used to detect the drowsiness through heart beat.

(iii) Velostat pressure sensor is used to monitor the driver hand grip through steering wheel while driver feels drowsy he looses the grip on steering wheel that time alert is given to driver.

2.3.1 Facial Detection using OpenCV Voila jones Algorithm and Dlib library

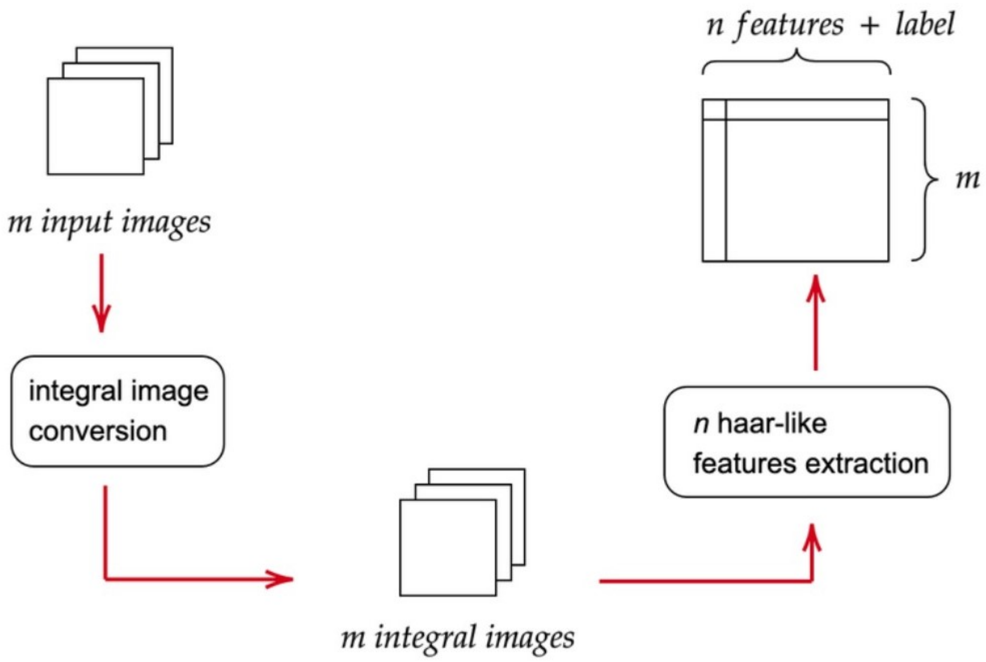

Figure 2.4: Face detection flow using Voila jones with Haar-like features

Face Detection

The above Figure 2.4 depletes Firstly, we must identify the user's face in order to determine whether or not they are sleepy. There are various algorithms available nowadays, but in this case, we need to choose one that is quick, accurate and needs little computing power (so that it can operate on a Raspberry Pi). As a result, we choose to detect faces using the well-known "Viola-Jones" algorithm. Better accuracy can be achieved with deep learning-based methods as well, but those cannot be used in real-time on the Raspberry Pi (or even on a PC without a strong GPU).

Eye Aspect Ratio

We must determine whether the user's eyes are open or closed in order to determine whether the user is asleep or not. We are employing the Eye-Aspect-Ratio (EAR) to determine that. When the eyes are open and closed, the typical eye aspect ratios are 0.339 and 0.141, respectively. As a result, anytime our system detects a face, it calculates the EAR and, if it falls below the threshold (specified by the user), continuously alerts the user until the user opens their eyes. We must identify eye landmarks in the face in order to calculate the EAR. We will utilise Dlib's 68 facial

landmark model, which is a pre-trained model and is simple to use with Python, to determine these landmarks. The 68 coordinates (x, y) that map the facial locations on a person's face are estimated using this method.
To calculate the eye's blink rate, we use the EAR formula. Below is the formula for the eye aspect ratio graph (EAR).

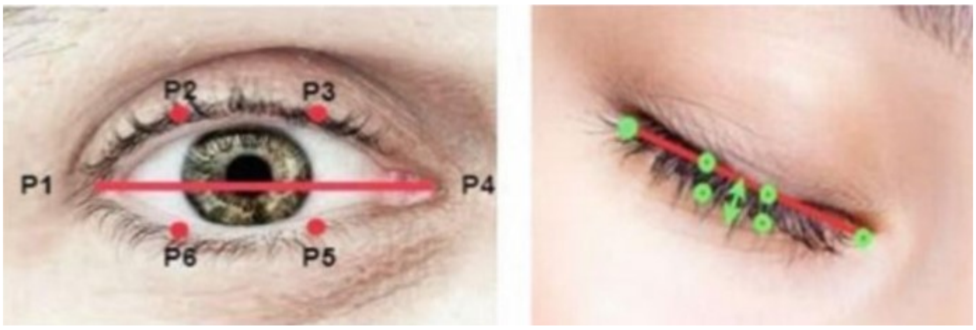

Figure 2.5: Eye Landmarks

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

The Euclidian is calculated in the equation above in order to obtain the EAR ratio. The ratio allows us to determine whether or not a person is sleepy. Take a look at Fig 2.5 above. The EAR would be huge and steady throughout a time when the eye is wide open. While the EAR value decreases noticeably when the eye is closed, or when there is a blink.
The variation in the EAR ratio is displayed in the graph in Fig 2.6 below. When the eye is open, it stays stable, but when the eye is closed, it falls quickly. Then again, it grows, signalling that one blink has happened.

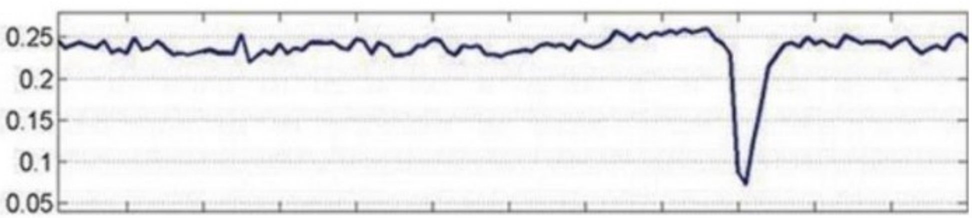

Figure 2.6: Eye Aspect Ratio Graph

Yawn Detection

In the below Figure 2.7 We must determine the user's upper lip to lower lip distance in order to detect the yawn. As a result, when someone is talking, the distance will be within a certain range, but when they yawn, it will be significantly greater than the range. We'll utilize the DLIB's facial landmark model in this instance to identify the landmarks of the lips in order to determine the distance between two lips. The measurement between the midpoints of the upper and lower lips will then be made easily. The system will notify the user of a yawn if the distance exceeds the threshold.

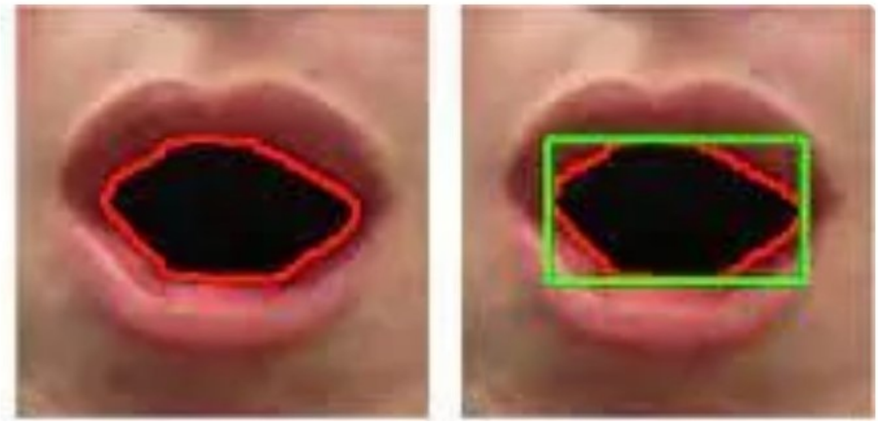

Figure 2.7: Yawn detection

2.3.2 Heart-rate analysis using Mi Band 4

Xiaomi is one of the top manufacturers of smart watches. Xiaomi is currently one of the top five brands, with the Mi Band series (MB) being one of the most well-known low-cost fitness trackers. For about 21 days, the Mi Band 4 (MB4) may record everyday activity. The MB4 records SC and HR among other things. Therefore, the MB4 can be used to track daily PA and activity intensity. A fitness tracker validation process is required because inexpensive fitness trackers are affordable to a large portion of the public and offer an incentive to raise PA levels and improve a healthy lifestyle.

An application has been designed to detect if a driver is falling asleep and generate an alert to wake them up. Security is taken into account, improving road safety and reducing accidents caused by drowsiness while driving.

Using Mi Band 4 we determine the real-time Heart rate data of the driver which is compared to the predefined threshold if the Heart rate of the driver is less than the threshold the system alerts the driver by sending an alert notification to the Mi Band 4.

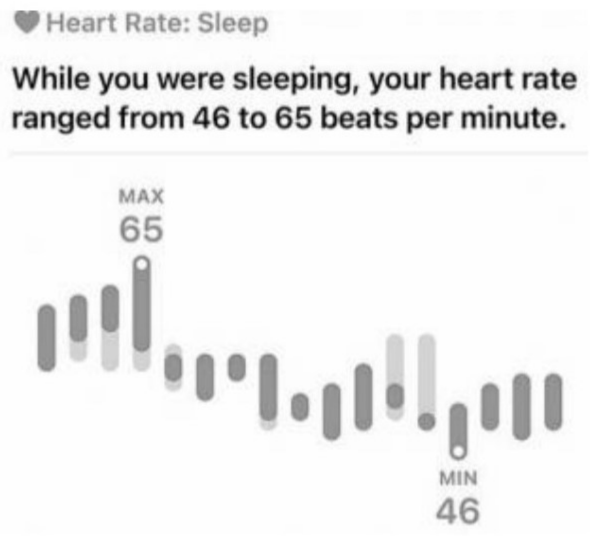

Figure 2.8: Typical smart device HR data

2.3.3 Steering hand grip detection using velostat

Velostat is an inexpensive and widely accessible material that may be used to build straightforward, flexible pressure sensors at home. It is made of a polymer and contains conductive particles. The resistivity of the material is dependent on the spacing between these particles. This creates a flexible plastic sheet that is simple to cut and shape for a variety of purposes. A straightforward resistor divider can be used to measure the material's strain because the resistance of the material changes with strain.

In the below Figure 2.9, piezoresistive properties of the velostat are employed to detect pressure variations applied to the steering wheel by the driver and compared to the threshold. If the pressure is below the threshold, a warning is given.

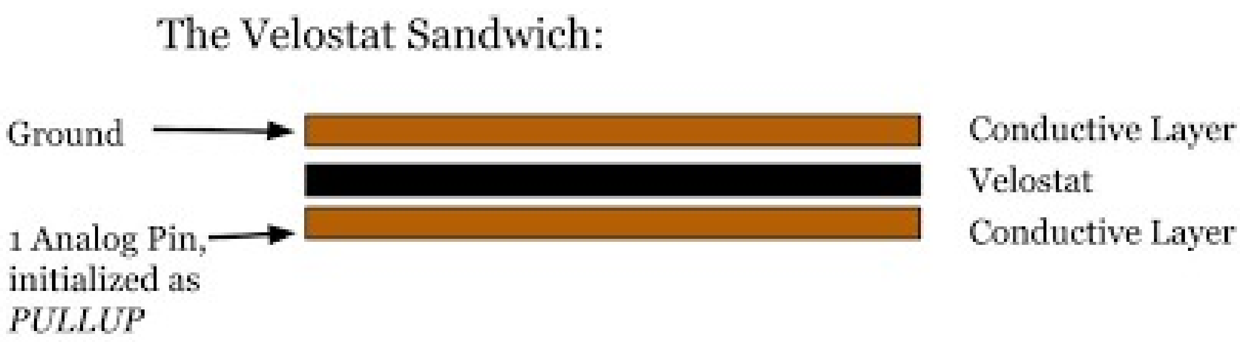

Figure 2.9: Velostat Pressure sensor

Above Figure 2.9 is the sensor setup for pressure sensing using Velostat (Pressure-sensitive sheet) and two conductive materials such as copper tape or woven conductive fabric.

2.4 Drawbacks of Existing System

(i) It is not possible to maintain a perfect light for the camera sensor.

(ii) Heart rate sensor failure or smart watch failure can affect the HR input data.

(iii) Failure of Hum antenna coil or low current flow in the coil may affect its accuracy.

2.5 Summary

Here we have defined the problem statement of our proposed system and existing system, and to overcome these drawbacks, we have used different technologies such as a Camera module for iris detection, an MI 4 Smartwatch for heat beat monitoring, and Velostat Pressure sensor for holding steering wheel capacity. We used two different algorithms as Open CV haar cascade algorithm and Dlib Facial landmarks algorithm. To overcome the above drawbacks we have used a combined approach.

Chapter 3

Literature Survey

There are several ways to detect drowsiness of driver:

- Camera Methodology.
- Smart Watch Methodology.
- Velostat Pressure Sensor Methodology.

Hardware solutions tackle the detection process primarily through sensors attached to vehicles or through the ones that are present at junctions. On the other hand, software solutions analyse video feeds to decide if drowsiness has occurred. The following subsections talk about various hardware and software solutions in detail. Road accidents are one of the leading causes of fatal accidents indiscriminate of roadway and time in action to predict the drowsiness of the driver.

3.1 Camera Methodology

Sinchana N Rao et al.,[1] This project seeks to develop a system that can detect driver drowsiness and issue a timely alarm, increasing the safety of the road. Snoozebreaker (SB) is made to identify people based on facial landmarks such as the lips and eyes and the Haar cascade algorithm for the face. It also delivers alarm alerts when it detects driver drowsiness.The OpenCV library from Python can be used to detect weariness, and this language is quite simple to implement for doing so. This method can speed up the process of identifying the eyes and face frame by at least 20 times. This technology analyses visual information to examine the driver's eyes and mouth in order to determine whether or not they are sleepy.

Omar rigane et al.,[2] was desceribed For intelligent driver sleepiness detection, the article employs a fuzzy logic controller. Multiple possible truth values (0 and 1) can be processed by a single variable using fuzzy logic. Using a Haar feature-based cascade classifier, faces are detected in each frame of the video. After removing the eye frame, two components—luminosity (EYEMAPLl) and chrominance (EYEMAPC)—can aid in the detection of faces and the complexity of eyes, as well as the application of the structural similarity measure (SSM). Here, we are utilising OpenCV and Tensorflow to monitor data in order to identify driver drowsiness.

Rajasekar R et.al.,[3] In this work, ocular blinks are measured using IR sensors. The IR sensor consists of two parts. Using an IR transmitter, we can direct infrared photons towards our eyes. The IR receiver detects the infrared waves that the eye reflects. When the eye is closed compared to open, the IR receiver's output is higher. To ascertain whether the eye is open or closed in given conditions, this is done.

Ilhan Umutl et.al.,[4] This paper proposes [Conceive and put into action a system that can identify drowsy drivers. The eye postures are measured using this real-time technology that uses image processing and machine learning techniques. An image made up of both the left and right eye images is blended. The open and closed eye photographs were categorised using these characteristics. The J48 Tree method has the fastest classification speed and the highest accuracy 94.76,percent while the IBK algorithm has the highest accuracy (91.98) percent. CLOSDUR determines the length of time an eye is closed, and PERCOLS measures how many times it closes in a minute. When the value is 0.15 or higher, PERCOLS generates the first alert. When the value is 0.3 or higher, PERCOLS generates the second alarm, which provides a delay report.

Nawal Alioua et.al.,[5] This paper is to identify the driver's tiredness, the eye state analysis technique is used. As a result, the computational cost for faces retrieved from video frames is reduced. In this case, we are employing the CHT, or circular hough transform, approach for drowsiness detection. The upper and lower effective eye boundary lines will be found in the reduced region of the face image using the SVM technique. The facial image is modified by CHT so that it can identify the eye edge points and determine their radius. Micro-sleep intervals will be picked up by this method. When the driver nods off, the system will notify them with a brief nap time.

V Praveen Kumar et.al.,[6] This paper is used to keep tracking an eye on the driver's physiological actions, which have an impact on the stability of the car and help prevent accidents, this study will be of assistance. Input and output extractions, as well as hardware tools, must work together to perform this range of software algorithms. This system comprises of three interconnected modules, including one for piezoelectric sensor-based accident and crash detection and two for Haar Cascade Classifier-based driver sleepiness detection and OpenCV-based alcohol contact detection. The "MQ3 gas sensor" is utilised to implement for recognising the ethanol gas molecules at concentrations from "0.05mg/lLto 10 mg/L" in these prototypes. Several hardware and software algorithms that are compatible and cost-effective were used in the design and implementation of the driver aid system.

Nawal Alioua et.al.,[7] This work provides a robust innovative approach for eye state analysis utilising "iris detection based on circular Hough transform (CHT)", a brand-new algorithm that doesn't require any training data or specialised cameras. With accurate value detection based on human-computer interfaces and face alignment for an automatic face recognition system, the test carried out to assess our eye state analysis technique on real video sequences captured by a cheap webcam produces positive results. This approach (CHT) uses phase extraction based on the "SVM technique" and genuine video sequences of diverse subjects and lightning situations to display the results.

Ashish Tawari et.al.,[8] In order to predict drivers' coarse gaze direction, this study introduces a distributed camera infrastructure that takes into account both head and eye inputs. Robustly estimating gaze direction while driving in a realistic setting presents a hurdle. The majority of the gaze zones in the head-alone experiment produced results within an overall weighted accuracy of 79.8 percent, which is a respectable performance. The use of a cell phone or another electronic device, including a vehicle's infotainment system, is one of the most frequent distractions at that time. A little break in focus might also result in distraction. sophisticated driver assistance system with the capacity to track the driver's concentration and issue alerts. The training process for getting a series of regressions is described in the algorithm's pseudocode. The current approach only makes use of video clips.

Qianjang Zhuang et.al.,[9] This study presents a reliable method for detecting fatigue based on pupil and iris segmentation and ocular health. Convolutional neural networks are utilised to precisely calculate with PERCLOS to determine the eye status in real time. The eye images are obtained directly as input. Due to the focus on The Pupil and Iris in many features, the two-step approach performs better than an end-to-end fatigue detection.

3.2 Smart Watch Methodology

Aouatif Amine et.al.,[10] This paper is Using wide-angle and fisheye lenses, this research suggests a reliable and unobtrusive technique for tracking driver drowsiness. When utilising a wide-angle lens, it is possible to identify tiredness by separating out micro-sleep from the presence of the iris in some frontal and profile faces. On the circular hough transform, the eye state analysis is built. Wide-angle lenses make it possible to see the condition of the eye even when the driver has a low profile, which is not possible with traditional lenses. both regular automobiles and an intelligent vehicle called "SeTcar" were used to record the sequences. microsleep durations in real-time and promptly generates an alarm to warn the sleepy motorist. The experiment's automated face and eye identification has also been included, but not was assessed in this study. All experiments are carried out using Matlab on a MAC with an Intel Core 2 Duo processor running at 2.4 GHz. Our technology has a 95 percent success rate with these kinds of lenses and can detect abnormal behaviours, including those who aren't staring straight ahead. are watching persons who are frequently closing their eyes in the rearview mirror for extended periods of time, etc.

Zheren Ma et.al.,[11] This paper uses both behavioural change detection and vehicle-based measures require large components. They also notice the driver's tiredness too late to prevent accidents. It is possible to detect the beginning of driver fatigue using the early stage physiological signal alterations. In this study, a wearable sleepiness detection system is developed. This system analyses the electrooculography (EOG) signal, wirelessly transmits the signal to a smartphone, and, in the event that it accurately predicts the EOG signal's behaviour 0.5 seconds in the future, may sound an alarm. This system is comfortable, light, and affordable. The ability to forecast events within 0.5 seconds gives drivers just enough time to adjust their behaviour, eventually saving lives.

Venkata Phanikrishna et.al.,[12] Similar to many other drowsiness detection methods, EEG-based approach is seen as an instant, effective, and promising tool. There are many different feature types that have been used in EEG-based drowsiness detection. In this study, a novel feature extraction technique based on a single Hjorth parameter was presented, and its classification performance was compared to that of the Power spectral density (PSD) feature, which was already in use. The results show that the proposed H-parameter features perform stronger and better than the PSD features of the existing work. In this area, conventional feature extraction methods fall short. To the best of our knowledge, this effort is the first to actually assess EEG and its subbands using Hjorth characteristics in order to identify driver fatigue.

AnilKumar C.V et.al.,[13] The main objective of this work is to present an apparatus that reduces accidents caused by abnormal human behaviour. The driver's head motions are tracked, and indicators of weariness and heart rate are found by employing image processing techniques. Drowsiness can be recognised by using the R-peak detection method to assess heart rate and the frame difference technique to recognise head movements. A buzzer alarm is transmitted to the driver if any anomalies are found during detection, both for the driver's safety and the safety of the passengers. As a preliminary step, we are utilising MATLAB to model the process.

Andrea Amidei et.al.,[14] This investigation is on bulky, intrusive multi-modal acquisition equipment to collect data about drivers from various In order to implement a real-time warning system based on the internet of things, machine learning, and artificial intelligence, sensors either worn by the person or embedded in the car cabin can detect the driver's drowsiness through a convenient wrist-worn device by analysing only the physiological signal of skin conductance for early identification of the incipient drowsiness. Physiological changes are impacted by the autonomous nervous system (ANS) activity, which is related to drowsiness. When employing several approaches for cross-validation, only one subject is not included.

George S. Maximous et.al.,[15] This study looks at a variety of sensors that are now used to determine how safe an automobile is. The system complexity and implementation costs of such sensors are onerous design factors that restrict their widespread adoption. It is hypothesised and proven that the hum-the-antenna effect can serve as the foundation for a simple, affordable passive touch sensor that can detect drowsy driving. The majority of surveys, according to the European e Survey of Road User Attitude (ESRA), concluded that drowsy driving is the main contributor to accidents. The functioning principle of the system is based on the use of spectroscopy to measure the blood alcohol content in the tissues of the driver's hand using a touch-sensing device. There ought to be a place near the Controller and the Alarm.

Gao Zhenhai et.al.,[16] The research is based on a when studying the steering wheel's angular velocity characteristics over time temporal detection after the shutdown of Windows. If both the extent constraint and the variability constraint are met by the detection feature in that window, a drowsy condition is recognised. In order to detect fatigue when there is a sudden direction change, this study employs a novel intelligent vehicle and steering wheel angle approach for time series analysis. A driver's declining driving abilities are evident from this considerable alteration in the driving procedure. In a time series when specific steering wheel indicators are present, it advises using the temporal detection window to calculate the steering wheel's angular velocity.

Fuwang Wang et.al.,[17] The research is based on significant step towards raising traffic safety is the ability to promptly and correctly identify driver fatigue. This recommendation is based on the man-machine reaction mode (MRM), a method that can be applied in trucks since it is practical and economical. Driver fatigue is one of the key contributing factors in traffic accidents [1, 2]. 15.20 percent of fatal crashes, according to past studies, include fatigued drivers. The

MRM is employed to treat driving tiredness brought on by protracted periods of monotonous driving; on average, the subject requires 0.16 seconds in normal driving modes and 0.535 seconds in the MRM to react to an emergency stop of a car in front of them. The buzzing sound from the delay report aids in reducing tiredness progression.

Ratna Kavya M et.al.,[18] Driving while fatigued impairs concentration, which leads to a loss of coordination and increases the risk of serious accidents. The sleepiness type is detected by the proposed system using the "Rasberry Pi" and a variety of sensors, including vibration and gas sensors. Human sleep may be divided into three categories: completely awake, non-rapid eye movement, and rapid eye movement sleep, and the anti-fatigue system can be divided into two categories: (1) estimating drowsiness and (2) capturing the driver's vision. The second is to calculate drowsiness using heart rate. utilises EEG (Electroencephalogram), ECG (Electrocardiogram), and HRV (Heart Rate Variability), it is always preferable to take safeguards by integrating the type of system in the car for security.

Zheren Ma et.al.,[19] This article addresses these concerns using a variety of methods, including vehicle-based sensors, behaviour change detection, and physiological signal processing. The creation of a wearable sleepiness detection device is described in this work. This system wirelessly transmits a "Electrooculography(EOG)" signal to a smartphone in order to quantify sleepiness detection. Based on an estimate of "0.5 seconds" before the transmission of the EOG signal, the prediction system in this case can alert the driver. To identify somnolence, many algorithms have been created. Through Bluetooth connectivity, a "Novel EOG signal" analyses the signal and transmits it to an Android phone. Sliding window feature extraction and a "ARIMA Model" were combined to create a "Novel EOG Signal Prediction Algorithm".

3.3 Velostat Pressure Sensor Methodology

Mika Sunagawa et.al.,[20] This work presents a drowsiness detection programme that can recognise all degrees of tiredness, from weak to strong. Our strategy is based on the basic tenet that the sitting posture-related index may be an indicator of insufficient tiredness that drivers are unaware of. First, we evaluated the sensitivity of the posture index and other indices to various levels of drowsiness. Then, to account for all sleepiness stages, we created a sleepiness detection model with several indicators sensitive to both mild and severe sleepiness. The model was trained and evaluated using a dataset that included data collected from around 50 drivers during simulated driving exams. The results demonstrated that posture information improved the accuracy of weak sleepiness detection, and our proposed model integrating All levels of fatigue were detected in the driver's blink and posture data (F1-score 53.6 percent, root mean square error 0.620). Future applications of this strategy might include systems that can intervene before a driver starts to nod off as well as warning systems for drivers who are really weary. The model presented here can be used in a range of real-world circumstances because measuring the information doesn't require limited instruments like onbody electrodes. It is based on blink and posture information.

Jaewoo Kim et.al.,[21] This study examines the driver's drowsiness detection sensor system, which relies on respiration. A piezoelectric pressure sensor affixed to the seat belt's abdomen and a personal computer make up the sensor system. The movement of the driver's abdomen during breathing was used to cause pressure fluctuations, which were measured using a piezoelectric pressure sensor. Labview was used to create the signal processing software for detecting driver intoxication. The studies were carried out with a driver who was 30 years old. The respiration's amplitude in the awake state was higher than it was in the sleepy condition. The breathing rate was lower in the alert state than it was in the drowsy state, on the other hand. Based on the trial, a drowsiness detecting sensor system could successfully detect the driver's drowsy on real time.

Anil Kumar Biswal et.al.,[22]The Paper based on an outside, forward-facing camera is used in this paper's sleepiness detection system to watch for rapid, pronounced corrections in lane position. Others employ an inside camera to look for signs of sleepiness in the driver's face or eyes. Although effective, camera-based solutions have shortcomings. An internal camera may be less useful at night, and an external camera may be obscured by muck. The posture of a driver can change when they fall asleep, experience a sudden medical emergency, or are under the influence of alcohol. Scientists have already investigated employing piezoelectric sensors - self-powered materials that collect an electrical charge in response to pressure - for this purpose. Although high temperatures are necessary for electrical and electronic equipment in automobiles, current piezoelectric sensors cannot survive them. Toshimi Nagase and associates sought to further flexible, heat-resistant piezoelectric sheet sensors that could be embedded in a vehicle's seat to monitor the driver's posture.

Histaka Nakane et.al.,[23] On what this study is based Workplace accidents and diseases are thought to be influenced by fatigue. As a result, spotting exhaustion through regular health checks on a person is helpful in avoiding mishaps and illnesses. There are several traditional techniques for detecting fatigue; however, these techniques call for users to keep an eye on how tired they are using gauges and other instruments that may limit users' movements. Posturography, on the other hand, can help to solve this issue by detecting exhaustion. Because sitting is a fairly typical activity in daily life and because posturography may be measured while the user is still free to move around, this study focuses on posturography in the seated position. Subjects are asked to sit on a chair that is fastened to a pressure sensor sheet in order to quantify posturography while they are seated. We a presumption that the centre of pressure (COP), which measures how weary a person is, converges towards a spot more quickly. On the basis of this supposition, we examined the difference in postural sway in a seated position when subjects transitioned from a state of fatigue to non-fatigue. The results of the experiment demonstrated that subjects who were fatigued experienced left-right axis convergence earlier than subjects who were not fatigued.

3.4 Summary

This chapter describes about techniques, methods introduced by different researchers and how they proposed system was accurate than other methods. Some of them were iot components based and some of them were software based. So here different methods were introduced by different resreachers for detecting drowsiness using different algorithms and models.

Chapter 4

System Requirement Specification

Small single-board computers (SBCs) called Raspberry Pi were created in the UK by the Raspberry Pi Foundation in collaboration with Broadcom. The Raspberry Pi project was first designed to support the teaching of fundamental computer science at educational institutions. The initial design exceeded expectations in terms of popularity, selling outside of its intended market for applications like robotics. Its inexpensive price, versatility, and open design make it widely utilised in a variety of fields, including weather monitoring. Due to its support of the HDMI and USB standards, it is mainly used by computer and electronics hobbyists.
On Pi Day 2018, the Raspberry Pi 3 Model B+ was released with an upgraded 1.4 GHz processor, three-times faster Gigabit Ethernet, and 2.4 / 5 GHz dual-band 802.11ac Wi-Fi (100 Mbit/s). The throughput of the internal USB 2.0 connection is 300 Mbit/s. Other features include USB boot, network boot, and Power over Ethernet (PoE) (with the PoE HAT add-on). An SD card is no longer necessary for network boot.

4.1 Hardware Requirements

- Operating System Windows 10 Rasberry Pi OS
- Processor Intel(R) Core(TM) i5-5200U
- RAM 8GB
- Raspberry Pi 3 Model B+
- Raspberry Pi Night vision camera
- Mi Band 4 Watch

- Velostat Sensor
- Analog-to-Digital Converter

4.2 Software Requirements

- Virtual Network Computing (VNC) viewer
- Raspberry pi OS

A specially created add-on for Raspberry Pi is the OV5647 5MP 1080P IR-Cut Camera for Raspberry Pi 3 and 4 with Automatic Day Night Mode Switching. Through one of the tiny connections on the top of the board, it is connected to the Raspberry Pi. This makes use of the CSI interface, included into the Raspberry Pi specifically for interacting with cameras.

Night vision is supported by the camera. It works with every version of the Pi. It has a 5-megapixel OV5647 sensor with a top 1080p resolution. The IR LED, which is externally attachable, aids in the operation of night vision. 3.3V power output is provided by the mounting holes. allows for the connection of an infrared LED and/or a fill LED. It has a movable resistor to regulate the ambient light threshold for turning on and off the infrared LED; when ambient light is less than the threshold value, the infrared LED is on, and vice versa. Power supply and attachment are both accomplished through onboard screw holes.

A brief ribbon cable is used to connect it to the Raspberry Pi. The sensor itself has a fixed focus lens and a native resolution of 5 megapixels. The camera can capture still photographs with a resolution of 2592 x 1944 pixels and video in 1080p 30, 720p 60, and 640x480p 60/90 frames per second.

The Xiaomi Mi Smart Band 4 (also known as the Xiaomi Mi Band 4 in China) is a wearable activity tracker created by Xiaomi Inc. It was released in China on June 16, 2019, in Europe on June 26, and in India on September 19, all of which are in 2019. It sports a super capacitive AMOLED display, is 39.9 percent bigger than its predecessor, and offers continuous heart rate monitoring.

The Xiaomi Mi Smart Band 4 consists of a PPG (Photoplethysmography) sensors which use a light-based technology to measure the blood volume controlled by the heart's pumping action. An optically produced plethysmogram called a photoplethysmogram (PPG) can be used to identify changes in blood volume in the microvascular bed of tissue. A pulse oximeter is frequently used to obtain a PPG since it lights the skin and tracks changes in light absorption. The perfusion of blood to the skin's dermis and subcutaneous tissue is monitored using a traditional pulse oximeter. By lighting the skin with a light-emitting diode (LED) and then measuring the amount of light that is either transmitted or reflected to a photodiode, it is possible to determine the change in volume brought on by the pressure pulse.

Packaging material made of polymeric foil (polyolefins) treated with carbon black to make it relatively electrically conductive is called Velostat, also known as Linqstat. It is used to safeguard objects or gadgets that are vulnerable to electrostatic discharge damage. It was created by Custom Materials, which is now a division of 3M. Desco Industries Inc. has registered Velostat as a trademark in the United States (4,964,564). On January 2, 2015, Desco Industries acquired the assets of the 3M Static Control division.

Piezoresistive, the velostat alters resistance in response to pressure or bending. For instance, the force required to measure 25 mm2 of fresh Velostat sandwiched between two electrodes is around 9 kN. However, when 3 Newtons of force are applied, the resistance is reduced to 1 k. These resistances are generally halved for material that has been utilised.

Due to its low cost and piezoresistive characteristics, velostat is frequently used to create low-cost pressure or flex sensors for microcontrollers. When the driver has a loose grasp or is not holding the steering wheel, the suggested system sounds an alert. A voltage divider can detect when weight is added to or withdrawn from the steering wheel since the Velostat's resistance decreases when pressure is applied.

The 10-bit Analog-to-Digital Converter (ADC) MCP3008 is perfect for embedded control applications because it offers good performance and low power consumption in a tiny size. The MCP3008 enables the addition of 10-bit ADC functionality to any PIC® microcontroller thanks to its successive approximation register (SAR) design and industry-standard SPI serial interface. The MCP3008 comes in 16-pin PDIP and SOIC packages and offers 200k samples per second, 8 input channels, low power consumption (5nA normal standby, 425A typical active), and these features.

A computer can be remotely controlled via the Remote Frame Buffer protocol (RFB) with the help of Virtual Network Computing (VNC), a graphical desktop sharing system. It relays the graphical screen updates while transmitting keyboard and mouse input from one machine to another over a network.

VNC is platform-independent; clients and servers are available for various GUI-based operating systems as well as Java. A VNC server can have multiple clients connected at once. The ability to view files on one's work computer from their home computer or vice versa as well as remote technical support are common applications for this technology.

You can operate your Raspberry Pi from anywhere thanks to VNC (Virtual Network Computing), which enables remote desktop control from another computer or mobile device without the need for a monitor.

For the Raspberry Pi line of small single-board computers, Raspberry Pi OS (formerly Raspbian) is a Unix-like operating system based on the Debian Linux distribution. It was initially created independently in 2012, and since 2013, the Raspberry Pi Foundation has built it and distributed it as the main operating system for these boards.

For the Raspberry Pi with ARM CPUs, Raspberry Pi OS is highly optimized. All Raspberry Pi models save the Pico microcontroller support it. The desktop environment in Raspberry Pi OS is a customized version of LXDE with the Openbox stacking window manager and a distinctive look. A copy of the Wolfram Mathematica computer algebra system, VLC, and a lightweight Chromium web browser are all included in the default package.

4.3 Summary

This Chapter describes about the software requirements like datasets, os, methods, Algorithms used for exection of the system and also defines about the integrity of requirements, design process of system. Such as datasets used for implementation,Raspberry pi operating system supported for execution and camera sensor for calculating EAR and MAR aspect ration, Smart watch for for heart beat monitoring and velostat pressure sensor for hand grip holding capacity.

Chapter 5

Architecture and System Design

System design is the process of defining a system's components, including modules,architecture, components, and their interfaces and data, based on the specified requirements. System design aims to divide up a huge system's requirements among its hardware and software parts. Following the completion of the system requirements study, the system design activity begins. The programme modules should be arranged in a way that makes the system straightforward to create and modify. The scale and complexity of programmes are dealt with by developers using structured design strategies. For developers, analysts write instructions on how to write code and how to put parts of code together to make programmes. A software system's design strategy is the method used to create it. It is possible to create software systems using a variety of methods.

5.1 Facial analysis

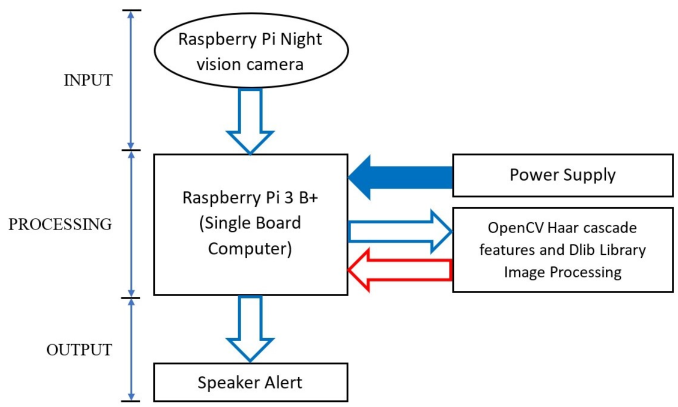

Figure 5.1: Facial Analysis Block Diagram

The above figure 5.1, shows Raspberry pi Night vision Camera is used as an input device to capture real-time eye movement or blinking.
Raspberry Pi 3 B+ is used as microprocessor to integrate input and output components/devices and to accomplish image processing using Haar cascade classifier and Dlib library. A Bluetooth speaker is used as output device to alert the driver if drowsiness is detected.

5.2 Heart rate analysis

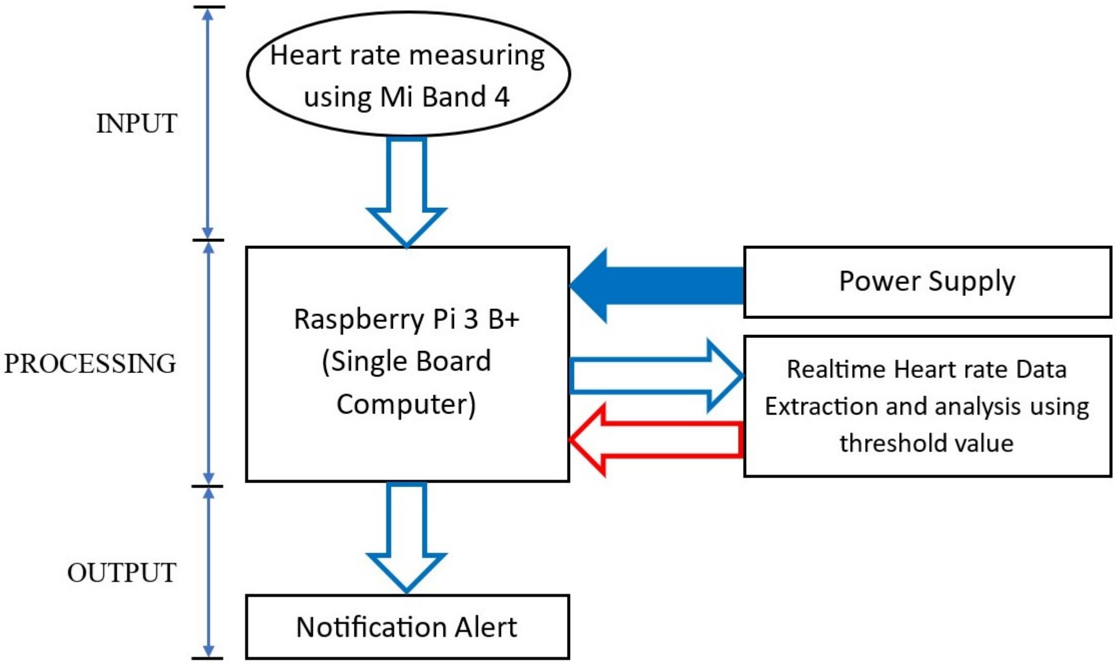

Figure 5.2: Heart-Rate Analysis Block Diagram

The above figure 5.2, shows Mi Band 4 with Heart rate (HR) sensor is used as another input device for Real-time Heart rate variation (HRV) sensing and data collection.
Raspberry Pi 3 B+ is used as microprocessor to integrate input and output components/devices and to accomplish Heart rate (HR) data processing based on threshold. A Bluetooth speaker is used as output device to alert the driver if drowsiness is detected.

5.3 Steering grip analysis

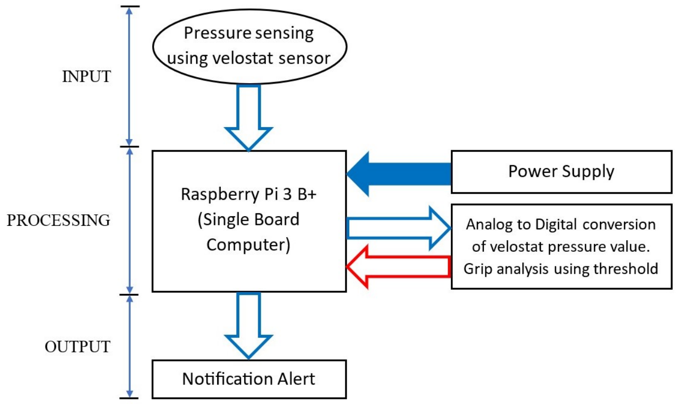

Figure 5.3: Steering Grip Analysis Block Diagram

The above figure 5.3, describes Velostat is piezoresistive; its resistance changes with flexing or pressure. This characteristic of velostat is used as pressure sensor for sensing steering grip of driver. Raspberry Pi 3 B+ is used as microprocessor to integrate input and output components/devices and to identify driver steering grip by processing the velostat sensor data based on threshold. A Buzzer / Bluetooth speaker is used as output device to alert the driver if The steering grip is weak.

5.4 System Architecture Data flow Diagram

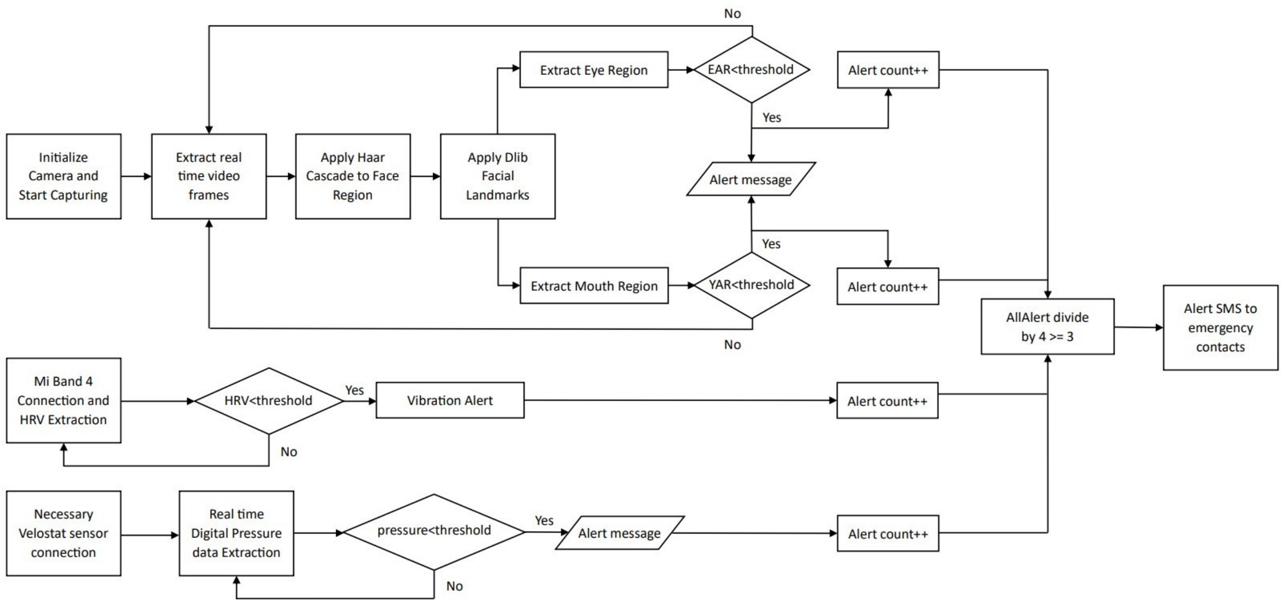

Figure 5.4: Combined system approach of Camera, Heart- Rate, and Pressure Sensor Flow chart

The method of the suggested sleepiness detection system is shown in the flowchart figure 5.4, above. Three modules make up the system. The system first initializes the Raspberry Pi Night vision camera, harvests the real-time video frames, and then uses Viola-Jones to play the music. To extract the face region from video frames, the Haar cascade feature is used. After that, the Dlib facial landmarks are applied to the facial region to extract the EAR and MAR (Eye Aspect Ratio and Mouth Aspect Ratio, respectively). A driver is alerted and a specific alert counter for each EAR and MAR, such as EAlert and YAlert, is incremented by one if the obtained EAR and MAR are higher than the threshold.

The Mi Band 4 connection is simultaneously initialized by the system to retrieve real-time driver Heart Rate (HR) data. Any time the collected HR data is compared to the threshold, the system notifies the driver by sending an alarm notice to the Mi Band 4 if the HR is below the threshold. One is added to the HAlert alert counter.

The velostat's connections have been made and validated. The suggested system converts analog pressure data from the Veloster pressure sensor to real-time digital data using an ADC called MCP3008 in this manner. When the received pressure data falls below the threshold, the collected data is compared to the threshold, and the driver is notified. One is added to the TAlert alert counter.

For delivering an SMS Alert to contacts for emergencies via a third-party messaging platform, the system employs a predetermined computation. The calculation is performed by adding up all alarm counters (EAlert, YAlert, HAlert, and TAlert) and dividing the result by 4. When the residual is more than or equal to 3, the suggested system sends the message.

5.5 Usecase Diagram of System Design

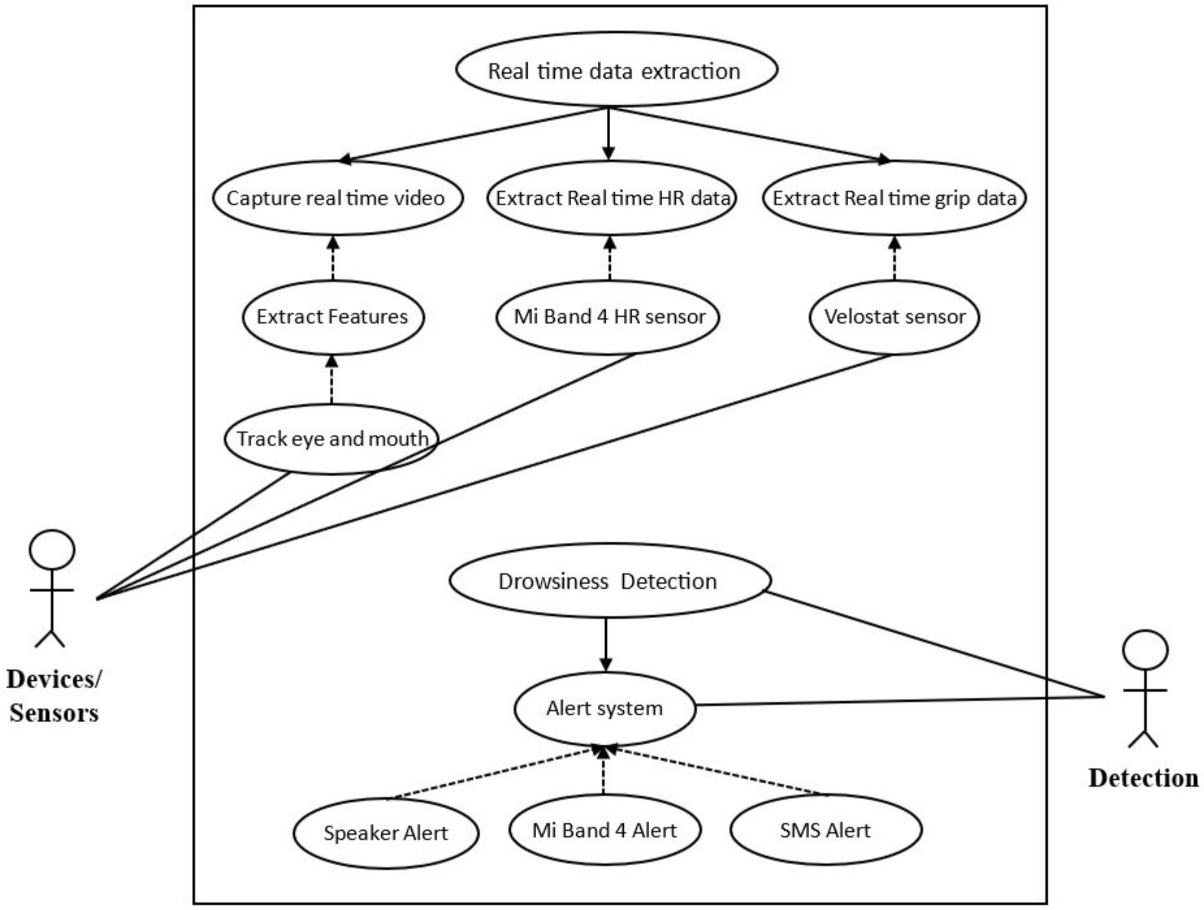

Figure 5.5: Usecase Diagram of Driver Drowsiness Detection System

1. User Interaction: Here, the term "user" refers to the driver, who serves as the main source of data for the system under consideration. To begin the detection process, the driver must be in front of the camera.

2. Data Extraction: Different data, including heart rate, steering grip strength, and eye and mouth aspect ratios (EAR, MAR), are measured using devices/sensors like the Raspberry Pi Night Vision Camera, Mi Band 4, and Velostat pressure sensor.

3. Drowsiness Detection: Once the drowsiness is detected by analyzing extracted data the system alerts the driver using a bluetooth speaker, Mi Band 4 notification, and a SMS alert to emergency contacts when the driver reaches the maximum alerts in each approach.

5.6 Sequence Diagram of System Design

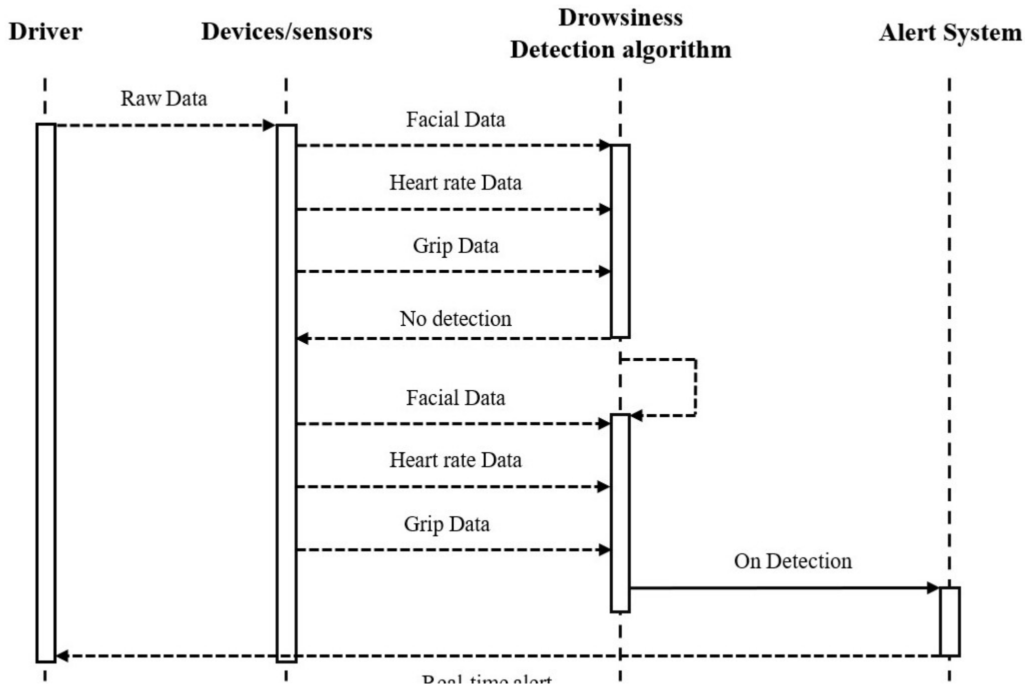

Figure 5.6: Sequential Diagram of Driver Drowsiness Detection System

In the sequence diagram shown in above figure 5.6, interactions between the four main characters Driver, Devices/sensors, Drowsiness detection algorithm, and alarm system are displayed along with the process of Drowsiness detection. First and foremost, real-time data extraction requires the presence of the driver. Once the data has been extracted utilising tools/sensors like the Mi Band 4, Velostat pressure sensor, and Raspberry Pi night vision camera. This information is used by the sleepiness detection method, which extracts faces from live facial videos and classifies the Eye aspect ratio (EAR) and Mouth aspect ratio (MAR) using OpenCV machine learning algorithms like the Haar cascade classifier and the Dlib facial landmark library. // The grip sensor and heart rate data are directly compared with the predefined threshold. Any fluctuations below the threshold are regarded as drowsy data. The detection method iterates until drowsiness is identified if the system fails to identify it through real-time data analysis. The drowsiness detection algorithm then initiates the alarm procedure after drowsiness is identified. The alert procedure is carried out for SMS alert to the emergency contacts, Mi Band 4 notification alert to the driver, and real-time speaker alert.

5.7 Summary

By employing diagrams like block diagrams, data flow diagrams, use-case diagrams, and sequence diagrams, we are finishing this chapter by discussing several models used to depict the proposed system design. The system flow and the connections between the various components were represented by all four models. Devices/sensors, a drowsiness detection algorithm, and an alert system are all displayed together with user involvement. Finally, it displays a representation of each actor together with their actions and the whole workflow of the suggested system.

Chapter 6

Implementation

6.1 Implementation Details

6.1.1 Facial Analysis

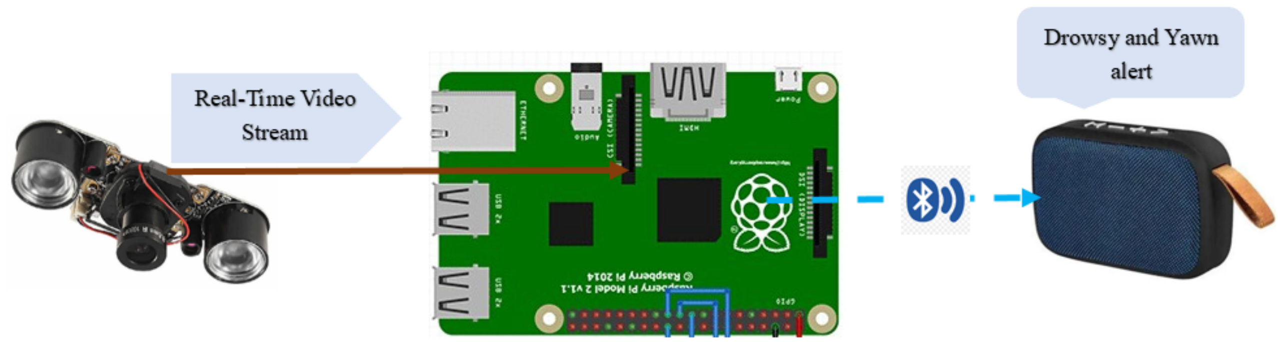

Figure 6.1: Facial Analysis using Camera Sensor

The hardware configuration for the facial analysis method is shown in the above figure 6.1, which features a raspberry pi night vision camera as an input device providing real-time video stream for the raspberry pi as a computational device using OpenCV viola-jones (Haar Features) and Dlib facial landmark library for face extraction and Region of Interest (ROI) extraction, respectively. The system also uses a Bluetooth speaker to verbally alert the driver when it detects drowsiness.

6.1.2 Heart rate Analysis

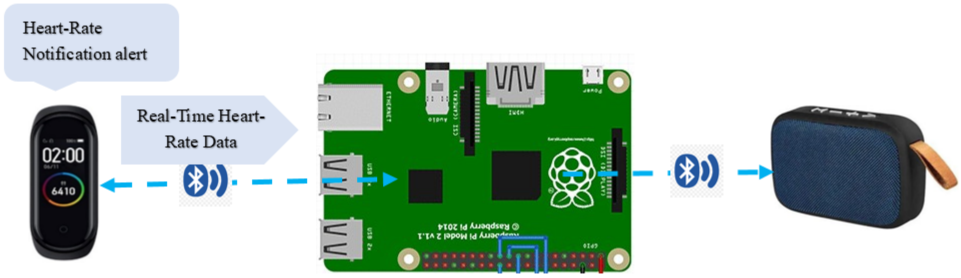

Figure 6.2: HeartRate Analysis using MI Band 4

The Mi Band 4 is shown in figure 6.2, connected to the Raspberry Pi utilising Bluetooth Low Energy, allowing for successful interaction, in the hardware configuration for the heart rate analysis method shown in the above figure. The Raspberry Pi is a computational device for heart rate analysis using a specified threshold value, and the system uses the Mi band 4 as an input device to deliver real-time Heart rate fluctuation data. The system also uses a Bluetooth speaker to verbally inform the driver when it detects drowsiness.

6.1.3 Steering grip Analysis

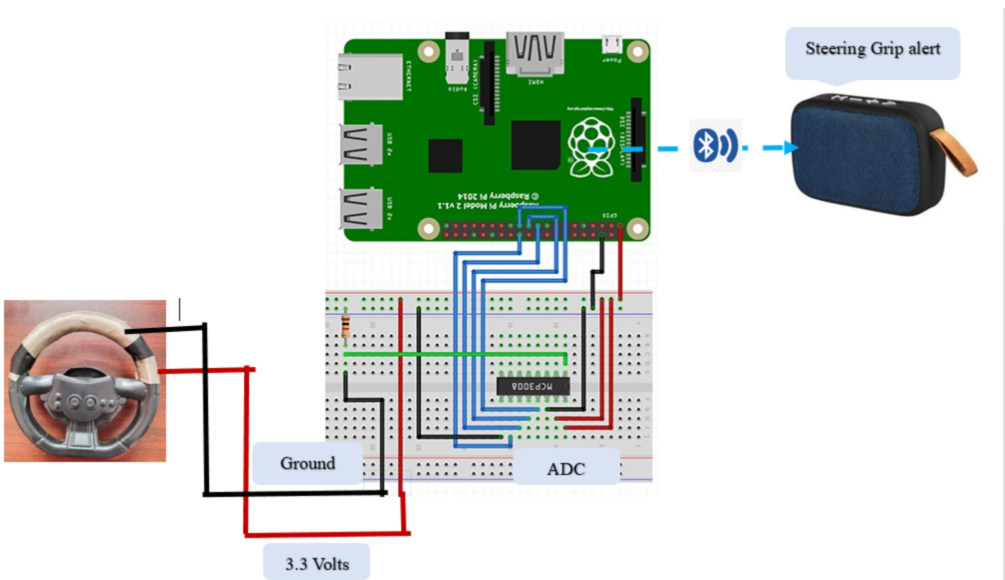

Figure 6.3: Steering grip Analysis using Velostat pressure sensor

The connection between the raspberry pi and the velostat pressure sensor is shown in the above figure 6.3, The strength of the driver's steering grip is measured using the velostat pressure sensitive sheet. Since the velostat is an analogue sensor, an analog-to-digital converter is needed. The data from the pressure sensor is converted to digital form here using the MCP3008 ADC. The calculation uses the transformed data as its input to compare the received data to a predetermined threshold in order to identify drowsiness. The output device for the vocal alert to the driver upon sleepiness detection is a Bluetooth speaker.

6.2 Implementation Workflow

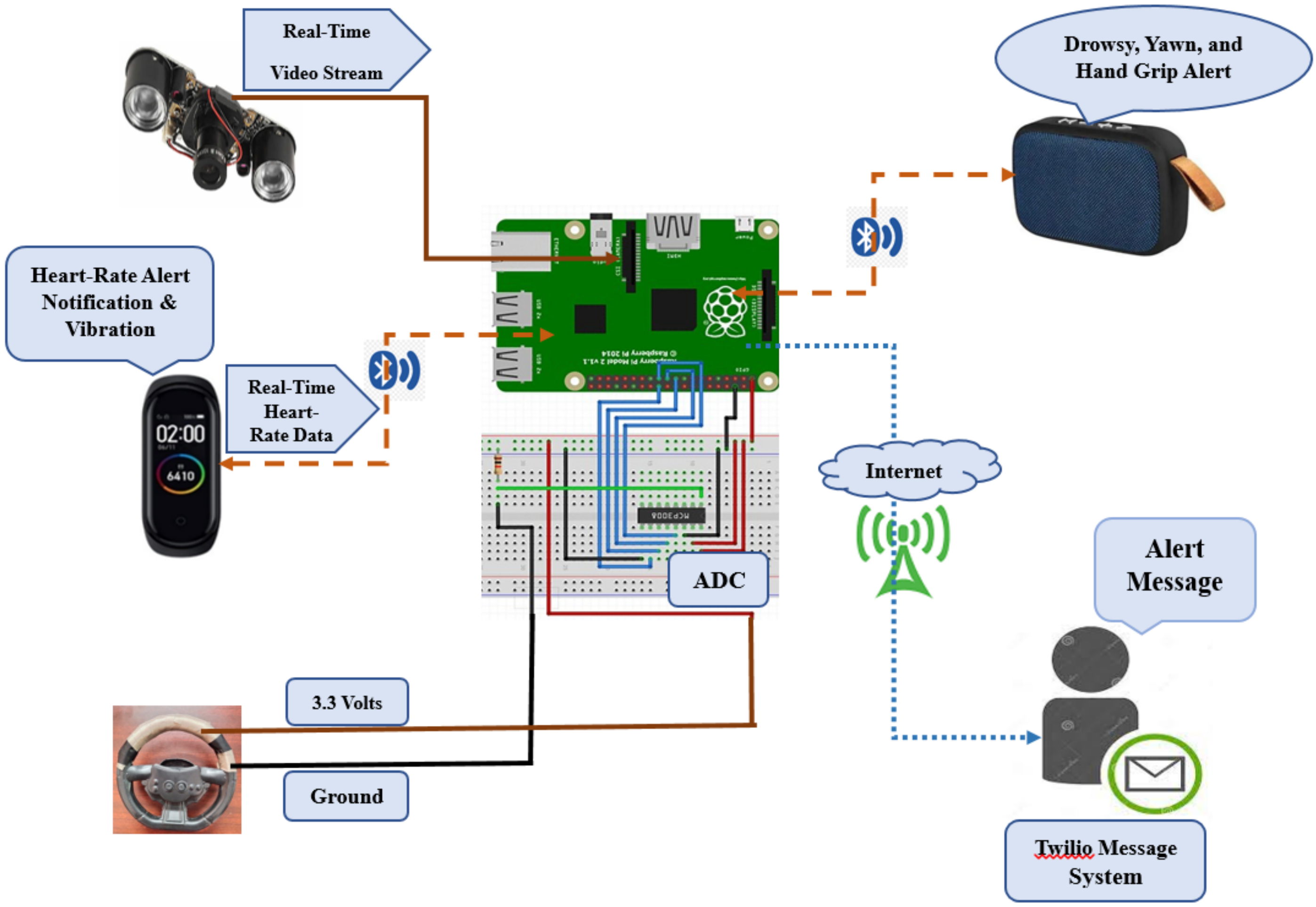

Figure 6.4: Drowsiness detection system combined approach workflow

- step 1: Real time video streaming, The first step involves the extraction of live stream video whereas in a non-intrusive approach, monitors the eye aspect ratio and ear aspect ratio if it crosses threshold value the vibrator will give alert message.

- step 2:Real time Heart Rate Data, The second step involves the heart rate monitoring, The threshold value is given for woke up range(60-100)per sec if the heart rate sensor monitor if heart rate range goes below threshold alert is given through vibrator.

- step 3: Steering grip monitoring, The third step involves hand grip pressure analysis were velostat conductive sheet is wrapped around the steering wheel, If the driver losses the control on streeing wheel the alert will be given through bluetooth speaker and Mi Band 4.

- step 4: The alert will be given three times upon three modules if driver not woke up automatically text message is sent through emergency contact.

6.2.1 Modules used and Screenshots

There are few modules which play an important role in execution process they are Open CV Haar cascade Algorithm and Dlib.

- Open CV Haar Cascade only recognises the matching shape and size, it cannot be utilised for face recognition. The cascading window and cascade function are used in the Haar cascade. It makes an effort to compute characteristics for each window and categorise positive and negative data.A pair of two adjacent rectangles that are located above the eye and the cheek area are thus a typical Haar feature for face detection. These rectangles are placed in relation to a detection window, which in this case serves as a bounding box for the target object—the face.

- Dlib facial landmark used in our to detect to facial regions. A pre-trained facial landmark detector offered by Dlib is capable of detecting 68 points on a face. Each face feature is mapped with a series of points, as seen in the image above. The points from 49 to 68 can be used, for instance, to locate a month in the face. The dlib is used to estimate the location of 68 coordinates (x, y) that map the facial points on a person's face. It is a landmark's facial detector using pre-trained models. This process has been displayed below figure 6.5, how it works in our project.

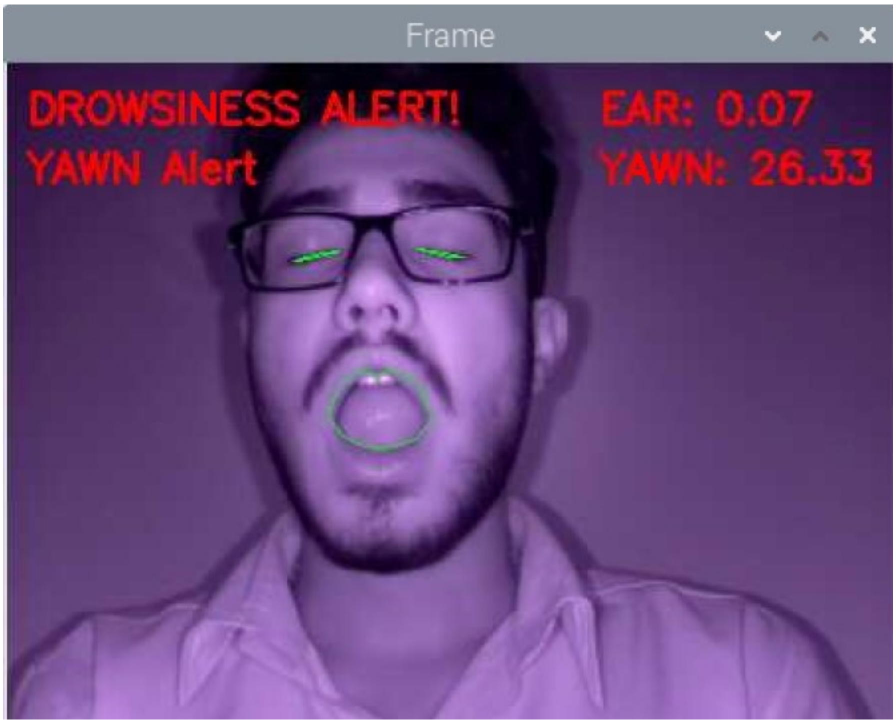

Figure 6.5: Output of Open CV and Dlib

Haar cascade(Viola-Jones Face Detection) algorithm that can detect objects in images, irrespective of their scale in image and location. This algorithm is not so complex and can run in real-time. As below figure 6.6, shows the working principle of drowsiness detection system.

Algorithm: Viola-Jones Face Detection Algorithm

```
Input: original test image
Output: image with face indicators as rectangles
for i ← 1 to num of scales in pyramid of images do
    Downsample image to create image_i
    Compute integral image, image_ii
    for j ← 1 to num of shift steps of sub-window do
        for k ← 1 to num of stages in cascade classifier do
            for l ← 1 to num of filters of stage k do
                Filter detection sub-window
                Accumulate filter outputs
            end for
            if accumulation fails per-stage threshold then
                Reject sub-window as face
                Break this k for loop
            end if
        end for
        if sub-window passed all per-stage checks then
            Accept this sub-window as a face
        end if
    end for
end for
```

Figure 6.6: Working principle of Viola-Jones Face Detection

Dlib Facial landmark algorithm that can monitor the Eye aspect ration and Mouth Aspect ration shown in below Figure 6.7.

Algorithm: Dlib Face Landmark Detection Algorithm

```
Input: original test image
Output: image with facial landmarks
for scale in pyramid of images:
  downsampled_image = downsample_image(image)
  integral_image = compute_integral_image(downsampled_image)
  for shift_step in num of shift steps of sub-window: do
    for stage in num of stages in cascade classifier: do
      for filter in num of filters of stage: do
        filter_output = filter_detection_sub_window(integral_image, filter)
      end for
        accumulate(filter_output)
      if accumulation fails per-stage threshold: then
        reject sub-window as face
        break
      end if
    end for
    if sub-window passed all per-stage checks: then
      facial_landmarks = detect_facial_landmarks(sub-window)
      draw_landmarks(image, facial_landmarks)
    end if
  display_image(image)
  end for
end for
```

Figure 6.7: Working of Dlib Algorithm

6.3 Summary

This chapter includes a step-wise implementation of the proposed system. Here we have explained in detail how each module is working their functionalities. Also, we have shown how each module are performed. The various modules used to detect the Drowsiness of the Driver as shown in this chapter.

Chapter 7

Testing

A driver sleepiness detection system can be put through a variety of tests to make sure it is reliable and effective. Here are a few prevalent test kinds that can be used:

1. Unit Testing: Verify the correctness and functionality of individual components or modules within the driver drowsiness detection system. This can include testing specific algorithms or sensor integration.

2. Integration Testing: Test the integration of different components, such as cameras, sensors, data processing modules, and alert systems, to ensure they work together seamlessly.

3. Functional Testing: Validate the functional requirements of the driver drowsiness detection system. This involves testing the system's ability to accurately detect and classify drowsiness indicators, such as eye closure, head position, or steering behavior.

4. Performance Testing: Assess the system's performance under different conditions, including testing its responsiveness, processing speed, and accuracy in detecting drowsiness events within specified time frames.

5. Usability Testing: Evaluate the user-friendliness and ease of interaction with the driver drowsiness detection system. This involves assessing the clarity of alerts, ease of system configuration, and overall user experience.

6. Compatibility Testing: Ensure the driver drowsiness detection system is compatible with the intended hardware and software environments, such as specific cameras, operating systems, or vehicle models.

7. Security Testing: Assess the system's security measures to protect against potential vulnerabilities or unauthorized access. This can include testing for data encryption, secure communication protocols, and user authentication mechanisms.

8. Reliability and Stability Testing: Evaluate the system's stability and reliability over an extended period of time. This can involve running the system continuously or simulating prolonged usage to identify any potential issues or failures.

9. Environmental Testing: Test the system's performance under various environmental conditions, such as different lighting conditions, varying temperatures, or background noise levels, to ensure reliable operation in real-world scenarios.

10. User Acceptance Testing: Involve end-users or stakeholders in validating the effectiveness and usability of the driver drowsiness detection system in real-world driving scenarios. This helps gather feedback and ensure the system meets their requirements and expectations.

The system is tested using the test cases listed in the table below with regard to testing the available testing variations. The test cases have unique objectives that must be considered and achieved by adhering to the procedures for testing the particular feature. There are expected results, which are the outcomes that the test case is likely to produce. The determining factor for the actual output is the anticipated results. The test case is said to have passed or failed if the actual output matches the anticipated outcome.

Test Case No.	Test Case	Objective	Steps	Expected outcome	Actual outcome
1	Sensor Integration	Verify the integration of Raspberry Pi 3 B+, Raspberry Pi night vision camera, Mi Band 4, and Velostat.	1. Connect the Raspberry Pi 3 B+ to the night vision camera, Mi Band 4, and Velostat. 2. Ensure that the Raspberry Pi can successfully communicate with all the connected sensors. 3. Verify that the sensor data is being received and processed by the Raspberry Pi.	All device and sensor data is received and processed by raspberry pi.	All device and sensor data is received and processed by raspberry pi.
2	Facial Analysis	Validate the accuracy of facial analysis for drowsiness detection.	1. Capture image or video clips with different facial expressions representing drowsiness and alertness. 2. Capture the images or video using the Raspberry Pi night vision camera in different mode i.e., Day and Night. 3. Run the facial analysis algorithm and verify if it accurately detects drowsiness indicators such as eye closure and yawn.	The facial analysis is accurate and drowsiness detection is done correctly and efficiently.	The facial analysis is accurate and drowsiness detection is done correctly and efficiently.

3	Heart Rate Analysis	Ensure the heart rate analysis accurately detects drowsiness.	1. Wear the Mi Band 4 and ensure it is connected to the Raspberry Pi. 2. Collect heart rate data during different states of drowsiness and alertness. 3. Analyze the heart rate data using the predefined threshold and validate if it can reliably detect drowsiness based on heart rate variation.	The Heart Rate Analysis is done efficiently and drowsiness detection is done correctly based on heart rate variation.	The Heart Rate Analysis is done efficiently and drowsiness detection is done accurately without any faulty detection.
4	Steering Grip Analysis	Validate the steering grip analysis for drowsiness detection.	1. Attach the Velostat sensor to the steering wheel. 2. Collect real time steering grip data during different states of drowsiness and alertness. 3. Analyze the steering grip data using the predefined threshold and verify if it accurately detects changes in grip pressure indicative of drowsiness.	The Steering Grip Analysis is done accurately and drowsiness detection is done correctly based on steering grip variation.	The Steering Grip Analysis is done accurately and drowsiness detection is successful based on the threshold value.

5	Real-Time Detection and Alert	Test the real-time detection and alert mechanism of the system.	1. Simulate drowsiness scenarios, such as closing eyes or showing signs of fatigue. 2. Ensure the system detects the drowsiness indicators and triggers an appropriate alert, such as visual or audible warnings. 3. Verify that the alert is timely and effectively notifies the driver to take corrective actions.	Real time drowsiness detection and alert.	Real time and accurate drowsiness detection and alert.
6	System Robustness	Test the system's performance and reliability under various conditions.	1. Subject the system to different lighting conditions, including low light or bright sunlight. 2. CIntroduce background noise or distractions to simulate real-world driving environments. 3. Validate that the system can still accurately detect drowsiness and generate alerts despite challenging conditions.	The system detects drowsiness in both day and night light conditions accurately and with any other disturbance in the driving environment.	The The system detects drowsiness in both day and night light conditions accurately and with any other disturbance in the driving environment.

Table 7.4: Test case table

7.1 Summary

Here, we have covered that Testing is a very important aspect that provides assurance that the proposed system is working efficiently in different environments, conditions, test cases, etc. So there are plenty of testing types present to test the system functionalities working correctly. We have written test cases to test the various functionalities and did a comparison of expected results with actual results to check the accuracy of the system. We have described them in this chapter. Finally, we have shown our system testing outputs in this chapter figures covered.

Chapter 8

Experimentation and results

8.1 Facial Analysis - Day time

Figure 8.1: Facial data extraction at day time

The figure 8.1, above illustrates the extraction and classification of face features—namely, the Eye Aspect Ratio (EAR) and the Mouth Aspect Ratio (MAR)—during the day under ideal ambient lighting.

8.1.1 Eye closure analysis

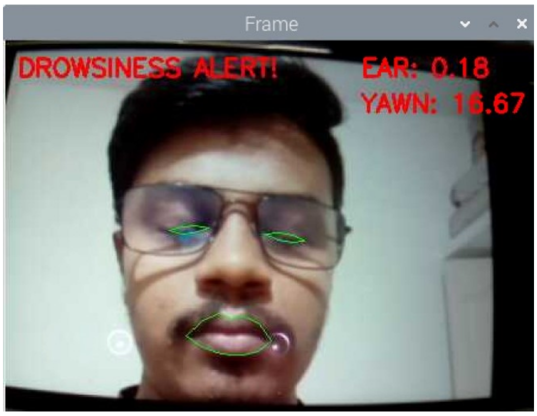

Figure 8.2: Eye closure alert

The figure 8.2, above shows sleepiness alarm on Eye closure for a specific amount of time. This experiment was carried out in daytime and uses a bluetooth speaker to transmit verbal alert.

8.1.2 Yawn analysis

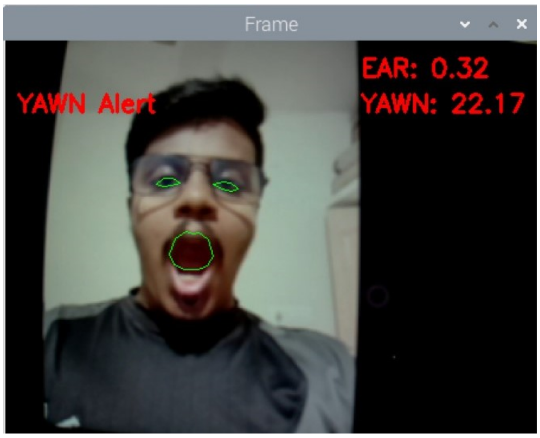

Figure 8.3: Yawn alert

The figure 8.3, above shows sleepiness alarm on Yawn for a specific amount of time. This experiment was carried out in daytime and uses a bluetooth speaker to transmit verbal alert.

8.1.3 Eye closure and yawn analysis

Figure 8.4: Eye closure and Yawn alert

The figure 8.4, above shows sleepiness alarm on both Eye closure and Yawn for a specific amount of time. This experiment was carried out in daytime and uses a bluetooth speaker to transmit verbal alert.

8.2 Facial Analysis - Night time

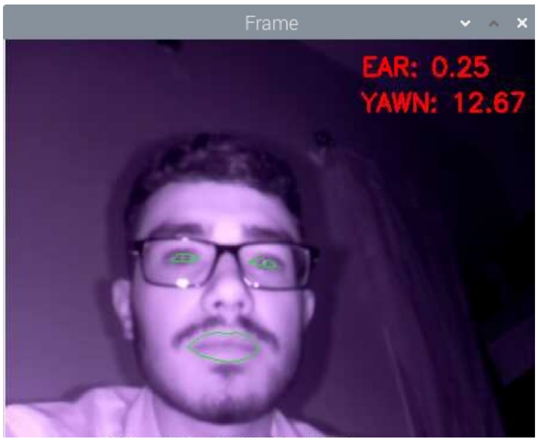

Figure 8.5: Facial data extraction at Night time

The figure 8.5, above illustrates the extraction and classification of face features—namely, the Eye Aspect Ratio (EAR) and the Mouth Aspect Ratio (MAR)—during night with the help of Raspberry pi night vision camera.

8.2.1 Eye closure analysis

Figure 8.6: Eye closure alert

The figure 8.6, above shows sleepiness alarm on Eye closure for a specific amount of time. This experiment was done in the night time and uses a bluetooth speaker to transmit verbal alert.

8.2.2 Yawn analysis

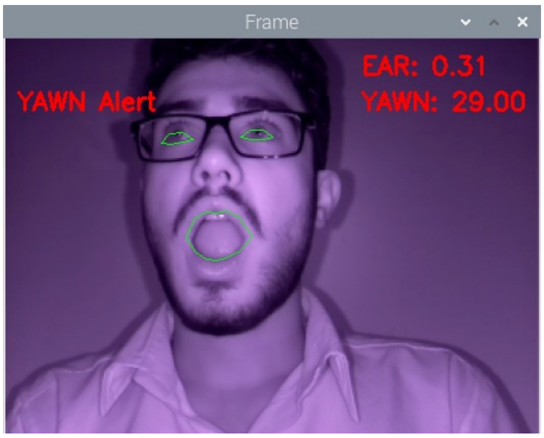

Figure 8.7: Yawn alert

The figure 8.7, above shows sleepiness alarm on Yawn for a specific amount of time. This experiment was done in the night time and uses a bluetooth speaker to transmit verbal alert.

8.2.3 Eye closure and yawn analysis

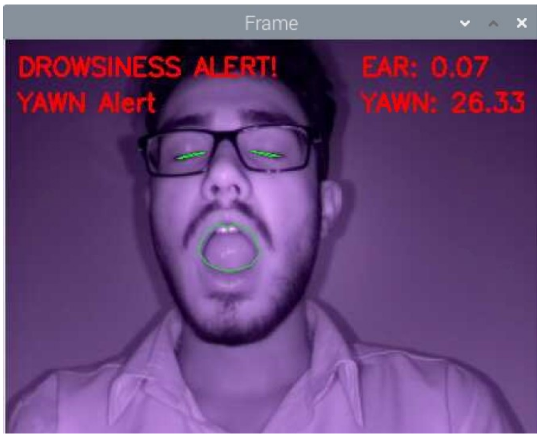

Figure 8.8: Eye closure and Yawn alert

The illustration figure 8.8, above displays a sleepy alarm on both eye closure and yawning for a predetermined period of time. This experiment used a bluetooth speaker to transmit verbal alert, and it was carried out at night.

8.3 Heart rate Analysis

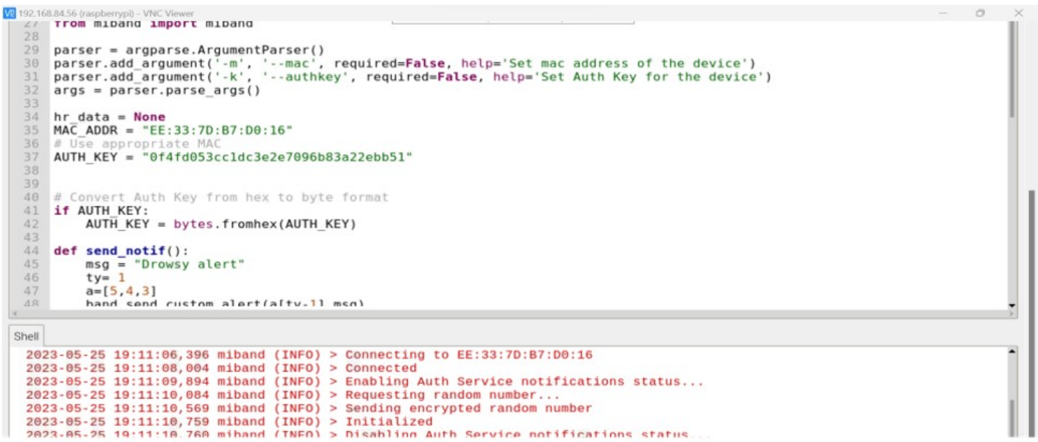

Figure 8.9: Mi Band 4 connection

The figure 8.9, above illustrates the connection successful of Mi Band 4 and Raspberry pi.

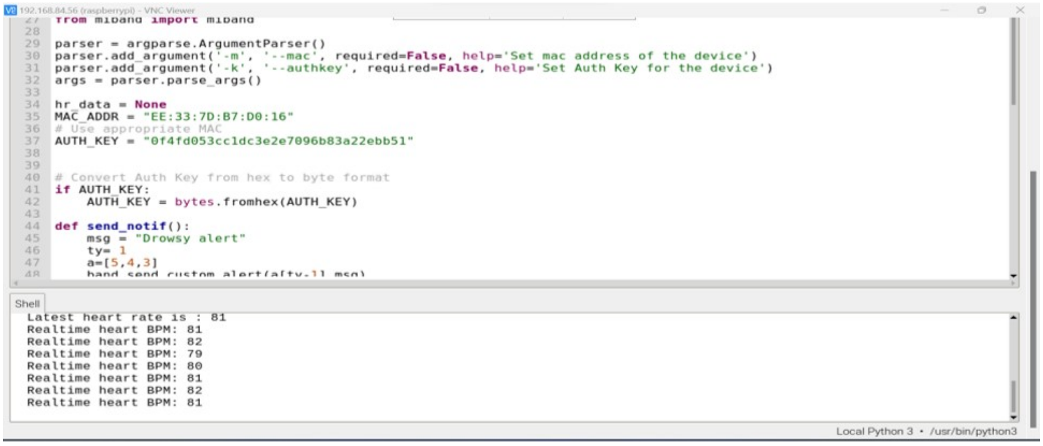

Figure 8.10: Heart rate data extraction

The above figure 8.10, illustrates real time Heart rate data extraction from the Mi Band 4 after successful connection between Mi Band 4 and Raspberry pi.

8.3.1 Heart rate Alert

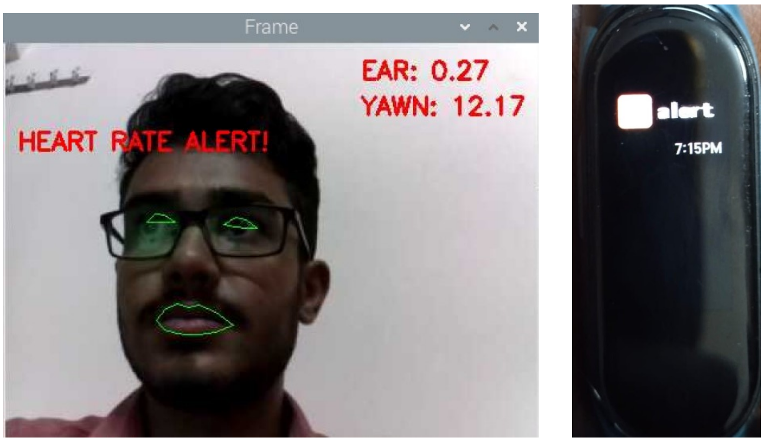

Figure 8.11: Drowsy alert on low Heart rate

The illustration shown in figure 8.11, illustrates an alert that is issued when a driver's heart rate dips below a threshold, indicating that the driver is fatigued or drowsy. The Mi Band 4 gets notified of the alarm by sending it a "Drowsy alert" notification.

8.4 Steering grip Analysis

Figure 8.12: Velostat pressure sensor setup

The velostat pressure sensor system is depicted in the figure 8.12, above. It consists of three layers of sandwiched pressure sensors, two of which are woven conductive fabrics that are placed above and below the velostat pressure-sensitive material. An Analog-to-Digital converter, the MCP3008, which converts analogue sensor data into digital data in real time is used.

Figure 8.13: Velostat grip data extraction

The figure 8.13, depicts successful pressure sensor data extraction.

8.4.1 Steering grip alert

Figure 8.14: Alert on low steering grip

The system's alarm following the detection of low steering grip is shown in the above figure 8.14, A bluetooth speaker is used to broadcast a spoken warning.

8.5 Summary

Finally in this chapter we have shown the execution results of our system or our working model and how it is feasible for all environmental conditions.

Chapter 9

Conclusion

The system successfully distinguishes blinking from sleeping and operates well during both day and night. It uses a real-time video stream from a Raspberry Pi night vision camera.
Smart Watches are discrete and convenient wearable technology. Driver drowsiness is identified using the heart rate sensor built into the smart watch, which also measures heart rate variability (HRV).
Sensors that respond to touch, force, or pressure are known as tactile sensors.It can be applied to steering such that if the driver loses control of their hands, a buzzer will sound to inform them.
This project uses a camera module, smart watch, and pressure-sensitive conductive sheet as part of an integration technique that uses numerous approaches to detect driver drowsiness.
The alert is provided by a vibrator built into the Mi Band 4 that will activate in the event that drowsiness is detected, a Bluetooth speaker is used to provide a voice alert highlighting the precise area where drowsiness is detected, and a third-party messaging platform is used to send an alert message to an emergency contact.

9.1 Future enhancement

The system uses major approach such as facial analysis, heart rate analysis, and steering grip analysis for drowsiness detection. This can be considered as crucial aspects through which drowsiness can be detected. Although some other aspects like vehicular based techniques:
(1) Driving Lane technique: In which the vehicle driving lane is analyzed for any faulty driving through which driver drowsiness can be predicted,
(2) Steering wheel technique: In which the steering wheel handling is analyzed for any sudden pull or faulty handling of the steering through which driver drowsiness is predicted.

The system is successful in classifying blinking from sleeping by providing frame length to ignore blinking. The system detects drowsiness when the yawn threshold is met however it does not classify talking from yawning which can be implemented using audio detection which can be used to classify talking from capturing real-time audio.

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