IMPLEMENTATION OF SAFETY MEASURES TO COUNTER A DRIVER'S DROWSINESS

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

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Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

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Fall 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 31st December 2022.

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Abstract/ Executive Summary

People often suffer from drowsiness if they drive for prolonged hours. As a result, they are unable to take proper decisions while driving which could lead to severe accidents, even fatalities. This is a global issue which needs to addressed and to combat this dreadful affair, we have proposed three different methods which may be used to reduce the number of road accidents and at the same time save the environment from nature damages and economic losses caused by driving while being drowsy. It not only clinches the safety of the driver but the passengers as well as the pedestrians on roads. There are different way of detecting drowsiness while driving such as using image processing, usage of eye blink sensors, pulse monitoring system as mentioned in this paper. Furthermore, there are other approaches in addition to the mentioned approaches to detection drowsiness and with the help of these techniques, we can make a difference in creating a safer environment to live in.

Acknowledgement

We are indebted to Dr. A.S Nazmul Huda, our ATC Coordinator and Associate Professor in the Department of Electrical and Electronic Engineering at BRAC University, Nahid Hossain Taz and Raihana Shams Islam Antara, Lecturer, in the Department of Electrical and Electronic Engineering at BRAC University for their constant guidance, support and mentorship which helped us complete our Final Year Design Project. Their exquisite guidance with the project selection, system designing and execution has been pivotal towards the completion of our project. Furthermore, their support and encouragement has uplifted huge pressure off our shoulders thus allowing us to work more efficiently. As a team, we have all put a lot of effort to finish this project competently.

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List of Acronyms

EAR	Eye Aspect Ratio
MAR	Mouth Aspect Ratio
GSR	General Safety Regulation
HMI	Human Machine Interface

Glossary

EAR: Eye Aspect ratio is the ratio of the summation of two vertical distances over the horizontal distance of the eye socket.

MAR: Mouth Aspect ratio is the ratio of the summation of two vertical distances over the horizontal distance of the mouth.

GSR: General Safety Regulation is applied to the driver for ensuring the safety of the people and its surroundings. Drivers must follow these set of rules and regulations in order to drive a vehicle.

HMI: Human Machine Interface is a system which must be available inside a vehicle. HMI is required to connect the driver with the machine, in our case, a vehicle. This will allow the driver to receive any sort of alerts in case of an emergency.

Chapter 1: Introduction [CO1, CO2, CO10]

1.1 Introduction

People have been working a lot more than they did in the prior few decades. As a result, we frequently compromise our sleep, which makes us feel worn out, exhausted, and drowsy. When it comes to driving, the driver's mental and physical health is crucial. Driving while tired is a very risky activity since it affects our ability to make critical decisions while driving: diminished attention, decreased attention span, and inadequate information processing [1]. Additionally, in the case of public transportation, along with the driver, drowsiness may have a substantial impact on a number of passengers. Moreover, because of their sleepiness, pedestrians often become victims of such traffic tragedies. One of the major contributing factors in recent traffic accidents that have resulted in severe physical harm and fatalities as well as significant financial loss is due to driver tiredness [2]. A driver's judgment can be hampered by insufficient sleep since it affects their cognitive and psychomotor abilities. Other than lack of sleep, numerous factors including long commute, restlessness and mental pressure can contribute to driver’s weariness. As a result, we developed a project involving a driver's drowsiness detection for the protection of human life and to lower the frequency of accident occurrences. Since prior safety measures and transportation systems are unable to prevent road and traffic hazards [3].

1.1.1 Problem Statement

Drowsiness is something which is difficult to control for most people. Drowsiness is defined as excessive fatigue or tiredness, and as a consequence a person remains unable to keep his eyes open and gradually loses focus. It can be affected by a multitude of factors, including a lack of sleep, long periods of monotonous driving, and an excessive workload. Drowsiness of a driver has resulted in several road accidents all over the world. According to AAA Foundation (American Automobile Association), road fatalities have increased from 16% to 21% due to drowsy driving in 2022 alone [4]. For countries such as Bangladesh, where traffic rules and regulations are not properly maintained by drivers, poses a huge risk when it comes to road accidents. In the year 2021, at least 5088 people have faced their demise in 5472 road accidents [5]. A lot of these accidents go unreported as a result we do not have a clear image of the actual number of road accidents that occur. Factoring in driving while being drowsy to the preexisting risky driving conditions in Bangladesh makes the driving situation menacious to the driver, the passengers, the pedestrians and as well as the pedestrians. Many of these fatalities may have been prevented if driver drowsiness was closely observed and drivers were given warnings in advance. In recent years, driver drowsiness has been one of the primary causes of traffic accidents, resulting in catastrophic bodily injuries and deaths, as well as huge financial loss. According to the National Safety Council, about $100 billion is the cost of the damage done to the surroundings which does not even incorporate the damages being done to properties [6]. From a very surface level, we can deduce how expensive drowsy driving is as it not only incurs financial losses but as well as cost of our lives. Taking all these into consideration, we emerged a project regarding the drowsiness detection of a driver for the safety of human life and reducing the number of accident occurrences. Also, the majority of traffic accidents are caused by a driver's failure to manage sufficient rest while driving, the driver feels drowsy that leads to inability to handle the car. Therefore, we are implementing a system which uses image processing to understand the facial features of the driver and to detect any early signs of drowsiness potentially saving the driver from any sort of danger due to not paying attention on the road.

1.1.2 Background Study

Road accidents due to callousness of drivers are increasing day by day. A predominant amount of these accidents are caused by drivers who are in a sleepy or drowsy state. Any sort of road accidents are dangerous but road accidents due to drowsy driving are far more dangerous than other situations. This is because the drowsy drivers have a delayed reaction and their ability to take control of the situation is lower than usual. This results in a deteriorated driving performance, leading to vehicle crashes, environmental damages and puts people’s lives in danger. However with the advancement of technology, it is a necessary step to ensure the safety of the driver. One aspect of safety would be detecting any signs or symptoms of drowsiness of the driver before it gets too late. There are various techniques with which drowsiness can be detected but in spite of these techniques, not all of them are effective or sufficient in alerting the driver. There are mainly five techniques which are utilized by researchers. These techniques are listed below [7]:

I) Image Processing Based Technique
II) EEG (Electroencephalograph) Based Technique
III) Artificial Neural Based Technique
IV) Vehicular Based Measures
V) Subjective Measures

I) Image processing based technique uses the facial image of the driver to detect any symptoms of drowsiness. It detects the amount of the eyes also called the eye aspect ratio (EAR) to determine how much of the eye is opened indicating drowsiness or sleepiness. This technique can be further classified into three sub-categories. First sub-category would be eye blinking based technique which typically measures the number of blinks made by the driver or the time taken by the driver to make one blink. In this technique, the location of the irises and the conditions of the eyes are tracked over time to assess the frequency and length of blinking. Generally, when a person is drowsy or sleepy, they tend to make irregular blinks or no blinks at all. The second sub-category is the template matching technique where the system where an alarm system is activated if a person’s eyes are closed for a certain duration of time. The third sub category is the PERCLOS technique. PERCLOS stands for percentage of eye closure. This technique provides a score that determines whether the driver is sleepy or not. In general, a human blinks about 12 times per minute. In other words, one blink every 5 seconds. The fourth sub technique is the yawning based technique which measures the mouth aspect ratio (MAR). This technique calculates the amount of mouth that is wide open. Usually when people are drowsy, they tend to yawn a lot as a result the MAR increases and if the MAR value is above a certain threshold, it indicates that the person is drowsy [8][9][10].

II) EEG based technique comprises a helmet that the user must wear to collect data from the brain. The helmet contains a multitude of electrode sensors and needs to be placed properly to get accurate readings to determine whether a person is in an active, drowsy or sleepy state. However, this technique is very intrusive as the person has to wear the helmet at all times to get readings [11].

III) Artificial neural based technique uses neurons to detect whether the driver is drowsy or not. This technique uses bio-behavioral features of the driver such as brain activity, reaction time, heart activity etc. to detect any symptoms of drowsiness. A minimum of one neuron is required for this technique however using a maximum of three neurons gives us the highest accuracy which is about 98% [12].

IV) Vehicular based measures consist of two measures which are the steering wheel movement (SWM) and standard deviation of lane position (SDLP). Using a steering angle sensor, the steering wheel movement can be measured. When a driver is sleepy compared to when they are awake, there are typically less micro corrections made to the steering wheel by the driver. This technique calculates the degree of these micro corrections made to the steering wheel and determines the state of the driver. When it comes to standard deviation of lane position, the position of the car with respect to the lane of road is detected using an external camera, typically attached to the car. However, this technique may not be applicable for every country of the world, especially Bangladesh [13] [14].

V) Subjective measures using the driver's subjective assessment is used to determine the level of tiredness, and numerous methods have been devised to convert this assessment to a drowsiness index for drivers. The Karolinska Sleepiness Scale is the most widely used to calculate the drowsiness of the driver. It is a scale ranging from 1 to 9 with 1 stating that the driver is extremely alert and 9 stating that the driver is very sleepy [15][16].

1.1.3 Literature Gap

In the above sub-chapter we have mentioned the various different methods for detecting the drowsiness of the driver. However, the bigger question arises whether those methods and models are reliable or not for commercial purposes. There are different challenges which must be considered in order to implement the drowsiness detection systems. Firstly, the accuracy of each model must be considered. The accuracy of each model must be very high in order to use drowsiness detection systems practically. Secondly, data size is an important parameter as we must review how much data needs to be stored in order to use these systems. Next, we must consider the cost of these devices. Even after the initial investment on these devices, how much more needs to be spent to maintain these drowsy detection systems. Another key aspect that we need to bear in mind is the privacy of the user as well as how well these systems can adapt in different situations such as driving in a dark environment or in any case of data losses [17].

Despite these challenges, there are some methods which are actively looked upon by researchers for further development. The first step of developing these models are taken under subjective measures and these measures are categorized into four segments: physiological, behavioral, vehicle-based, and hybrid [17].

Physiological measurements mainly consist of EEG (Electroencephalography), ECG (Electrocardiography) and EOG (Electrooculography). These methods have proven to have the highest accuracy in detecting drowsiness as external parameters such as the condition of road, the amount lighting available are not required to detect drowsiness [18]. But these methods would mean the user has to wear a certain device to themselves as a result of the user being reluctant to wear these devices to a certain extent. In terms of behavioral measures such as using cameras to detect drowsiness using facial features such as the eyes and mouth. This method has been very popular for detecting drowsiness in recent years but a deep learning model is required for this approach and researchers are constantly looking to implement a model that is best suited for the driver [19]. In terms of vehicle-based measures, it has proven to be least accurate as it might not detect drowsiness properly at all times. Bangladesh is a very populated country using vehicle-based measures such as steering wheel movement and standard deviation of lane position [20][21] might not be feasible as people are constantly crossing the roads without following any rules and hence the driver might have to abruptly change their lanes but the system might detect that the driver is being drowsy. And lastly hybrid based measures might be able to provide us the most accurate results since it is a combination of different approaches [22]. For example, implementing a system which detects the facial features of the driver to detect any signs of drowsiness and alongside this if vehicle lane changing technology is used accordingly, the system could give us a better picture of whether the driver is drowsy or not. Hybrid systems might be the future of drowsiness detection systems as it is an area which is being heavily researched on but no concrete solution has been found using the hybrid system and hence, it is currently under development. Considering all these parameters and situations, we have designed a system which might be better applicable for developing countries such as Bangladesh with the limitation of technology.

1.1.4 Relevance to current and future Industry

Volvo Cars was the first car company in the world to launch a drowsiness detection system called “Driver Alert Control”. This was launched in 2007. This drowsiness detection system basically tracks the movement of the car and it checks whether or not the driver is controlling the vehicle. If the vehicle is not being controlled, it is an indication that the driver is drowsy or sleepy and hence, an alarm system would go off alerting the driver [23]. Soon after this, Mercedes launched their drowsiness detection system called “Attention Assist” in 2009. Up until today, many car companies such as Honda, Ford, Hyundai, Nissan etc. all have developed their own drowsiness detection system to assist the driver in any case of an emergency.

Bangladesh is a country who mainly imports cars from countries such as Japan, South Korea. In case of Bangladesh, it is difficult to maintain a drowsiness detection system since the roads are not proper and the traffic rules are not maintained. However, compared to the past few decades, people tend to follow the traffic rule more these days than they used to in the past.

Walton is the first ever Bangladeshi conglomerate to receive a trademark certificate for the production and marketing of automobiles [24]. It is expected within the next decade, Walton will be producing automobile vehicles as a result Bangladesh will be less reluctant to import every car from Japan and South Korea but rather they will be making their own cars. Road accidents are very common in Bangladesh but with a Bangladeshi company already taking charge of producing automobiles, implementation of drowsiness detection system will encourage more and more people to drive cars that are made in Bangladesh. Implementing a hybrid drowsiness detection system inside vehicles driven in Bangladesh will ensure the safety of the citizens of Bangladesh. Furthermore, a lot of people usually commute from one city to another in Bangladesh, as a result they spend a lot of time travelling. Since people regularly commute to different cities, sometimes they even have to use the highways to travel from one place to another. This makes people worried due to driving long distances and with fatigue coming into the act. Commuting from one city to another especially would be very risky due to the traffic rules not properly maintained. Implementing a drowsiness detection system in these vehicles would ensure the driver and as well as the passengers safety and hence people would not hesitate to travel longer distances when needed. This could very well mean people would be more open to job opportunities outside their town or city as a result the GDP (gross domestic product) of the country would increase.

1.2 Objectives, Requirements, Specification and constant

Driving is a complex work that needs the driver's whole focus, concentration and attention. One of the most significant ways of keeping oneself safe in cars is the engagement between driver and vehicle occurs through assessing and assisting one another, nevertheless such engagement among driver and vehicle can be hampered due to drowsiness. This can be reduced by detecting the early symptoms of fatigue which would eventually turn to drowsiness. The development of a drowsiness detection system that captures the essential elements of the driver's tiredness in detecting the level of drowsiness is currently ongoing. With the advancement of technology, drowsiness can be detected by various technological solutions, therefore our primary goal is to eliminate tiredness through technical improvements and creative thinking.

1.2.1 Objectives

The primary objectives of the drowsiness detection system are listed below:

- To reduce the drowsiness issue of a driver.
- To ensure safety of a driver while driving.
- To ensure safety of the passengers and pedestrians from the collateral damage of Driver’s irresponsibility.
- To reduce the number of road accidents.
- To bring the concept of new technological advancement in reducing drowsiness.
- To avoid environmental damage of nature and economical damage of assets caused Through the accident.
- To ensure proper financial expense in a minimal way to implement the project.

1.2.2 Functional and Non-Functional Requirements

Every project has certain requirements that are needed to be fulfilled in order for the project to become fruitful. Therefore we categorized our project into two different categories.

Non Functional Requirements:

- **Circuit construction:** Our circuit does not require large spaces to construct and yet it is solving a huge global concern. Moreover, the circuit is easy to connect as complex connections are not required.
- **Spacing inside the vehicle:** Little space is required to set up any of our design approaches inside the vehicle. Our project uses an image processing method that needs to be placed in the vehicle's dashboard at the middle or somewhere closer to the steering wheel so that it can identify the facial structure of the driver.
- **Easier maintenance:** After installing the device inside the car, there is little to no maintenance unless one of the components malfunctions. Since the longevity of the raspberry pi is about 7 to 10 years.
- **Distance of the device:** Subsequently, as our project is based on the detection of the eyes and mouth, hence the device has to be placed within a certain parameter. We tested our device and our system works at fairly long distances, so we need to ensure the driver is not too close or too far away from the camera module.

Functional Requirements:

- **Alarm system:** Our circuit must be connected to a piezo buzzer/ speaker so that in case of an emergency, the driver or the people inside the vehicle can be alerted.
- **Powering up the system:** Our design has certain power requirements such as to run the raspberry pi, we need to supply about 15 watts of power and using a buck converter, we can connect the raspberry pi easily to the vehicle.
- **Software requirement:** Our project needs to be set up with either an operating system or an IDE (Integrated Development Environment) which code the system accordingly.

1.2.2 Specifications

- With the help of our project, we have the chance to put practical fixes into practice in order to solve the issue of driving when fatigued.
- Using an image based algorithm, which analyzes facial features including eye closure, blinking rate, and yawning which determines the fatigue of the driver.
- To make the driver attentive, a buzzer is used to alert the driver.

Table 1.1. Hardware components and specifications

Hardware Components	Model	Specification	Comments
Raspberry pi	Raspberry pi 4	CPU:- Quad Core Cortex-A72 64 bit @1.5GHz Memory:- 4GB LPDDR4-3200 SDRAM Storage:- microSD Camera:- 2-lane MIPI CSI Connectivity:- BLE Gigabit Ethernet	Used to process the image given as the data
Raspberry pi camera	Raspberry Pi Camera Module V2	Resolution:- 8 Megapixel Sensor resolution:- 3280x 2464 pixels Weight:- 3g Sensor image area:- 6.287mm x 4.712mm	Captures the face of the driver which is the input data.
Raspberry pi Display	Touch Display 5	Voltage:- 5V 5-inch LCD display	Results are shown on the display.
HDMI cable	Micro HDMI	HDMI cable type D 6.4 mm × 2.8 mm	To connect the display to the raspberry pi.
Buzzer	5V active piezo buzzer	Voltage: 5V Diameter: 12mm Pin Pitch: 7.6mm Height: 9 mm Current: <250mA	To alert the driver
Adapter	AC/DC adapter power supply	Wattage:-15 watts Input Voltage:- 5V Current rating:- 3A Connector type;- barrel connector	To power up the raspberry pi

Micro SD Card	Transcend 64GB	Storage capacity:- 64GB Flash memory type:- micro SDHC	To operate the raspberry pi using raspbian.

Software Components:

- Python 3 Language
- Raspberry Pi OS
- Thonny IDE

Miscellaneous Components:

- Male to Female wires
- API system is used to alert the driver by sending messages to the driver's emergency contacts if the driver is drowsy or sleeping. This is an additional feature which would give us a more accurate result.

1.2.3 Technical and Non-technical consideration and constraint in design process

Technical considerations and constraints:

- Since our project uses machine learning as the main algorithm, specifically the use of image processing, therefore a universal eye aspect ratio was in need that would be able to detect drowsiness on different individuals.
- In our project we needed some libraries which had to be imported. This includes libraries like OpenCV, Dlib which are compatible with our 68 landmark model.
- To reduce the input output lag, fps should be taken into consideration. To increase the frame rate per second to get better results, a raspberry camera module was used which was compatible as well as some changes were made in the code.
- As raspberry pi is a single board cpu which requires a decent cooling system to get better output results without damaging the device.

Non-technical considerations and constraints:

- Due to global pandemic which greatly impacted the supply chain as well as the increasing demand of computers lead to the crisis in the chip industry. This made the price of raspberry pi unstable and harder to find.
- Additionally the project requires to record drivers hence it was only ethical if their consent was taken under consideration when taking data for accurate results. It was essential to provide them with the policies before taking consent.
- One of the important aspects of our project was the setup of the device. It was essential to place the device in such a way that would detect the driver's eyes and mouth regardless of the position the driver is in.

1.2.4 Applicable compliance, standards, and codes

Table 1.2. Applicable standards and codes for different components required for our system

Device	Standard	Definition
Camera Module	IEEE P2020	Aims to identify and assess automotive image quality attributes.
	IEEE 208-1995	Procedure for determining the video resolution of the camera system.
	IEEE 610.4-1990	Thorough understanding of the glossary used in the field of image processing
Raspberry Pi	IEEE 694 1985	The main intent is to define common standards such as provide a list of instructions for mnemonics and description for assembly language syntax.
	IEEE 855-1990	The objective is the interface between application programs and their operating environments. Within the parameters of the services that the various operating systems offer, it is intended to be compatible with the majority of the systems commonly used in microcomputer contexts.
	IEEEC37.231-2006	The implications of using and managing firmware updates for equipment connected to protection. The number of revisions required has increased drastically hence there is no standard method that deals with all the issues that arose.
Artificial Intelligence	P2247.3	Categorizes methods of evaluating adaptive instructional systems by offering regulations and methodologies. The usage of this in artificial intelligence is the best practice.
	IEEE 2941 2021	For optimal AI model inference, storage, dissemination and maintenance by developing improved AI interference, programming format and enclosed format.
	IEEE 2755-2017	Recent years have seen the emergence of a

		brand-new family of software-based intelligent process automation solutions. To encourage consistency and clarity in the language used as well as there aren't any accepted definitions of concepts, capabilities, phrases, technologies, types, etc. because this form of automated capability is relatively new.
Power Adapter	IEEE 1823-2015	The power supply range should be greater than 10W upto or less than 240W. Communications between the power adapter and the power-using device may be used to organize power distribution and establish identity.
Alerting System	IEEE1224.1-1993	The terminologies used to define application program interfaces (APIs) based on electronic messaging systems are not specific to any one programming language. There is a general-purpose API that allows a user agent (UA) or message storage (MS) to access the capabilities of a message transfer system (MTS) or a simple MS, respectively.
	P9274.4.1	The best practice for the implementation of an experienced API describes the technical usage, background information and description of the profile on API best practice for data protection and security. This gives useful information, compliance and testing related matters.

Drowsiness detection system is a fairly new concept especially in Bangladesh. So there must be a set of rules and regulations which must be complied in order to install drowsiness detection systems in any vehicle. General Safety Regulation (GSR), EU introduced Driver Drowsiness and Attention Warning (DDAW) in 2019. DDAW implies a system that analyzes the vehicle's systems to determine the driver's level of awareness and alerts them if necessary [25].

Manufacturers will be required to provide a thorough dossier that clearly explains how their system functions and how it was tested and validated to provide the expected outcomes. There are some specific requirements which must be followed by manufacturers and those are the system human machine interface (HMI), when the driver should be warned by the system and specified guidelines that guarantee the manufacturer's and/or supplier's validation tests are reliable and valid. These requirements include both visual and audible warnings. In terms of visual warnings, the systems must work properly both at day and night. The system should also be steady without any flashings and the symbols used in the system or the display should be followed using ISO (International Organization for Standardization) references. In case of audible warnings, it should be simple to recognize. If there are voice alerts, the audio must be consistent with the text being displayed as well as the audio warning needs to be played for a certain period of time so that the driver actually understands the audio warnings and takes action accordingly [25].

1.3 Systematic Overview/summary of the proposed project

Drowsiness driving is an impending issue affecting individuals as well as the whole community. During this state, a person is unfocused and it hampers his/her ability to make a judgment. To uproot this problem we have designed a counter measure which acts as a safety system. For this system to work it is vital to detect the early signs of drowsiness in order to avoid calamities. One of the significant changes that takes place, when one is drowsy is that the yawning and the eyelid droops. Drowsiness detection system using image processing, rather than taking one parameter we are working with multiple signals of early stage fatigue. This is an algorithm based on the facial detection of the driver, where we landmarked the eyes and mouth. So if the driver yawns or if he/she closes their eyes the system will alert them as a precaution. The aim of our project is to reduce accidents due drowsiness, which is often neglected as one of contributing factors leading to road accidents. Apart from emphasizing on the development of the system, we have taken the driver's consent under consideration as well as tried to keep the system budget friendly but at the same time give better results. In addition to using a buzzer to warn the driver, we have taken a step further by sending text messages to emergency contacts of the driver in case he/she is drowsy.

1.4 Conclusion

Since Bangladesh is a developing country, usage of technology on a daily basis is very rare. Incorporating such highly advanced design and integrating it into the local's life would be a challenge. Most of the long commuters are either truck drivers or bus drivers who are not that well educated. By making them aware and informed of the benefits might resolve this issue. Even though the initial cost of the device is on the expensive side, which is not feasible for everyone. But after purchasing it, there is little to no maintenance unless components like the camera or the adapter malfunctions. The reason for the device's high price is the microprocessor which has a lifespan of about 7 to 10 years. As the rate of accidents that takes place is quite high in Bangladesh, insurance companies can encourage Uber or Pathao riders to be affiliated with this product by subsidizing the price on premium insurance. Government authorities like Bangladesh Road Transportation Authority, BRTA should advise bus and truck companies to station it in each of their vehicles. By taking these necessary steps, it would help reduce a significant number of the tragedies.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

Driving requires the whole focus, concentration, and attention of the driver because it is such a complex task. The interaction between the driver and the vehicle, which takes place through simultaneous observation and cooperation, is one of the most important ways to keep oneself safe when driving. However, this interaction can be hindered by tiredness. By recognizing the early signs of exhaustion before they progress to drowsiness, this can be minimized. The development of a drowsiness detection system that accurately assesses the key components of a driver's exhaustion while determining the degree of drowsiness is now under process. Our main objective is to eliminate fatigue by technical advancements and innovative thinking since with the development of technology, sleepiness can be eliminated by numerous technological solutions. Our drowsiness detection project's primary goals are to lessen driver drowsiness, assure driver safety while driving, protect passengers and pedestrians from unintended consequences of the driver's irresponsibility and reduce overall tiredness issues, limit the number of accidents on the road, introduce the idea of new technology improvement in reducing drowsiness, prevent environmental damage to the environment and economic damage to assets caused by the accident, and assure correct financial expense in a minimal method to execute the project.

2.2 Identify multiple design approach

In our project, we have the chance to put practical solutions in place to solve the issue of driving when fatigued by three multiple approaches:

- Drowsiness Detection System using Heartbeat Sensor
- Drowsiness Detection System using Eye-Blink Sensor
- Drowsiness Detection System using Image Processing

We will utilize a heartbeat sensor, and if the heartbeat differs from usual, a signal is delivered to the driver telling them to stay awake. Additionally, a sensor that counts the number of times the driver blinks his or her eyes can be utilized to warn them when drowsiness is detected. Additionally, drowsiness can be detected and the driver is warned using image processing, which analyzes changes in facial expressions including eye aspect ratio, eye blink ratio and yawning. This entire project will give us the benefit of achieving our motive and purpose in a pragmatic way.

In our first design approach, which is a drowsiness detection system using a heartbeat sensor, here the car's steering wheel is attached with the heartbeat sensor. The driver's grip is utilized to measure and record the heartbeat while also detecting the driver's heart rate. The buzzer sound and vibrational motor are activated along with the LED blinking as a warning to the driver, and an alerting message is also displayed on the OLED display if the heartbeat detected falls below the threshold value set (60–80 bpm) that indicates the driver might seem to be falling asleep or has started feeling drowsy. The sensor measures the heart rate in real-time and compares it to the threshold.

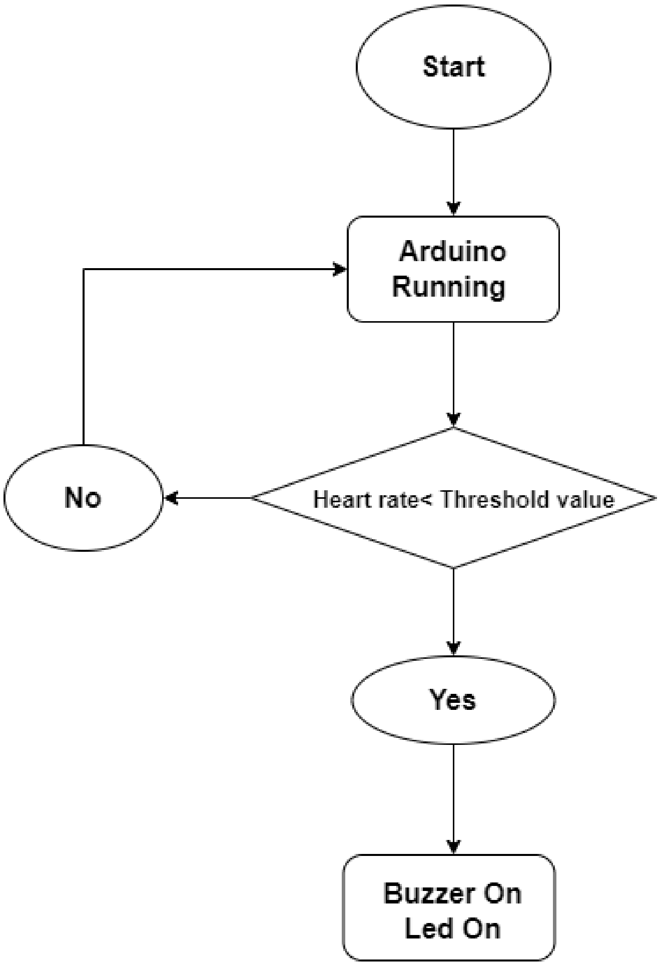


Figure 2.1: *Flowchart of the system using blink sensor in the steering wheel*

In our second design approach which is a drowsiness detection system using an eye blink sensor where we used an RF transmitter connected to an eye blink sensor to determine whether a driver is wide awake or not. Here, usually the rate at which someone's eyes would typically blink slows down when they're sleepy. Additionally, we blink less frequently when our eyes become heavy. In comparison to the threshold value specified in the system, the blink sensor will continue to track whether the user is blinking frequently or not. A warning that the user may not be in a fit state to drive is given if the user's current number of blinks falls below the threshold value of the number of blinks. As a result, an alarm system is attached to the blink sensor, which produces a high output. The alarm system will sound whenever the blink sensor produces a high output, alerting the driver to cease driving immediately.

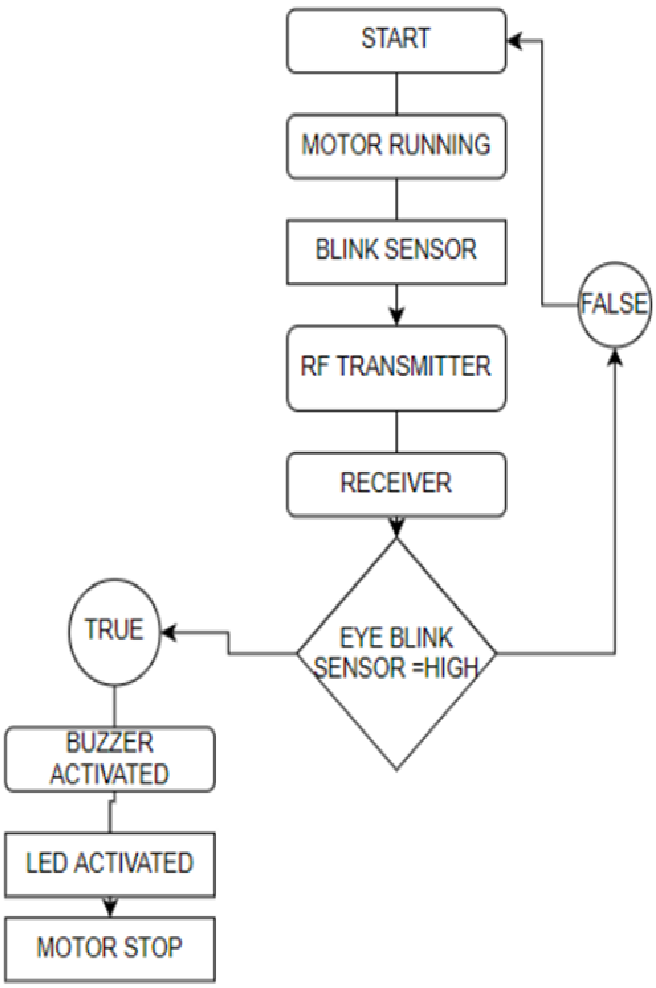


Figure 2.2: *Flowchart of the system using eye blink sensor*

In our third design approach which is drowsiness detection system using image processing. The process of drowsiness detection by image processing is shown in the following flowchart. The user's face is first recognized by the camera when it is first turned on. Then, using the 68 landmark model, the landmarks are put on the face to capture the facial anatomy. The output states of our approach are chosen depending on the face at the stage of face detection in accordance with the facial structure. The program will examine the active state first, followed by the sleepy state and finally the sleepiness state. There is no drowsiness detected when the user is discovered to be awake, therefore the loop begins again. On the other hand, if the user is determined to be asleep or drowsy, the buzzer will activate and begin alarming; if not, the loop will repeat.

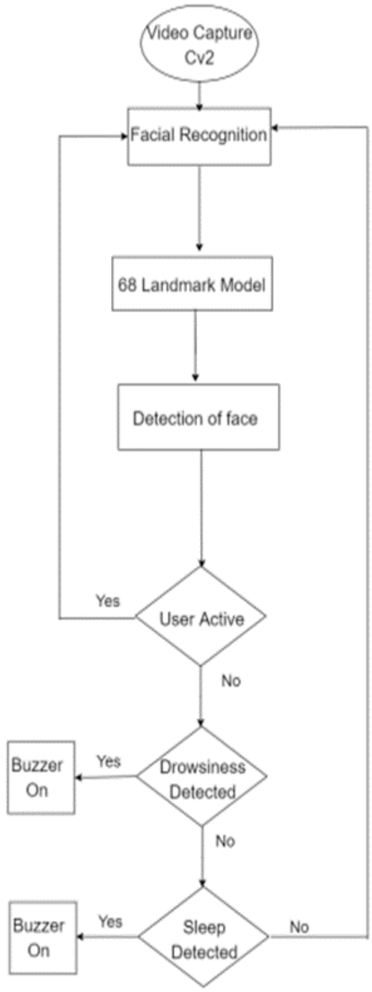


Figure 2.3: *Flowchart of the system using image processing*

2.3: Describe multiple design approach

Approach 1: Detection using heartbeat sensor

Here, we have imported the libraries for the Arduino and the heartbeat sensor into the software proteus to utilize this approach.

Figure 2.4: *Pulse Sensor XD-58C*

Pulse Sensor XD-58C specifications: The pulse sensor's LED peak wavelength is 515 nm. It needs a 3.3V/5V power supply. The pulse sensor's output type is analog. At 3.3V power supply, an output signal ranges from 0 to 3.3/ 0 to 5 volts (at 5V power supply).

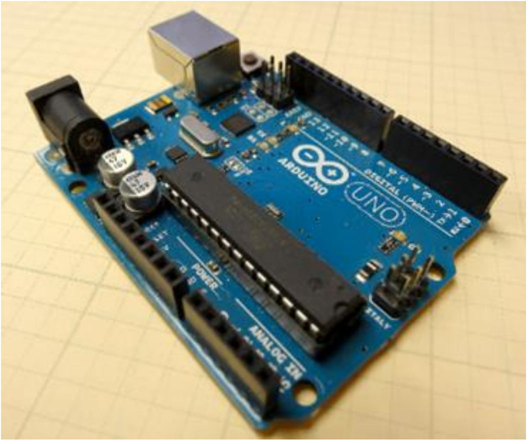


Figure 2.5: *Arduino Uno R3*

Arduino Uno R3 specifications: It is a microcontroller based on the ATmega328P. The Arduino's operating voltage is 5V. The 7V to 12V input voltage range is recommended. The i/p voltage ranges from 6 to 20 volts. It has 14 Digital input and output pins. Additionally, it has 6 Digital input and output pins (PWM). There are six analog i/p pins. Each I/O pin requires a 20 mA DC current, while the 3.3 V pin requires a 50 mA DC current. The boot loader uses 0.5 KB of the 32 KB of Flash Memory space. SRAM is 2 KB in capacity and EEPROM is 1 KB. The CLK runs at a 16 MHz frequency.

The primary goal of this system is to find the driver's pulse rate. When the pulse falls below a certain threshold, the system continuously analyzes the heartbeat rate. A driver's pulse rate often fluctuates between 45 to 65 beats per minute (BPM) when they are drowsy [26]. Despite the fact that BPM differs from person to person and gender to gender, we created a system that is universally relevant to everyone, thus we put the threshold number at 65 BPM. Green LEDs have also been employed to indicate the driver's condition, and an alarm system has been installed to notify the driver when necessary. An Arduino is linked to the heartbeat sensor, which requires a voltage of 5V to function properly. The Arduino is linked to an alarm system that will notify the driver, a green LED that will indicate the driver's present state, and a virtual terminal that will display continuous readings of the driver's pulse rate.

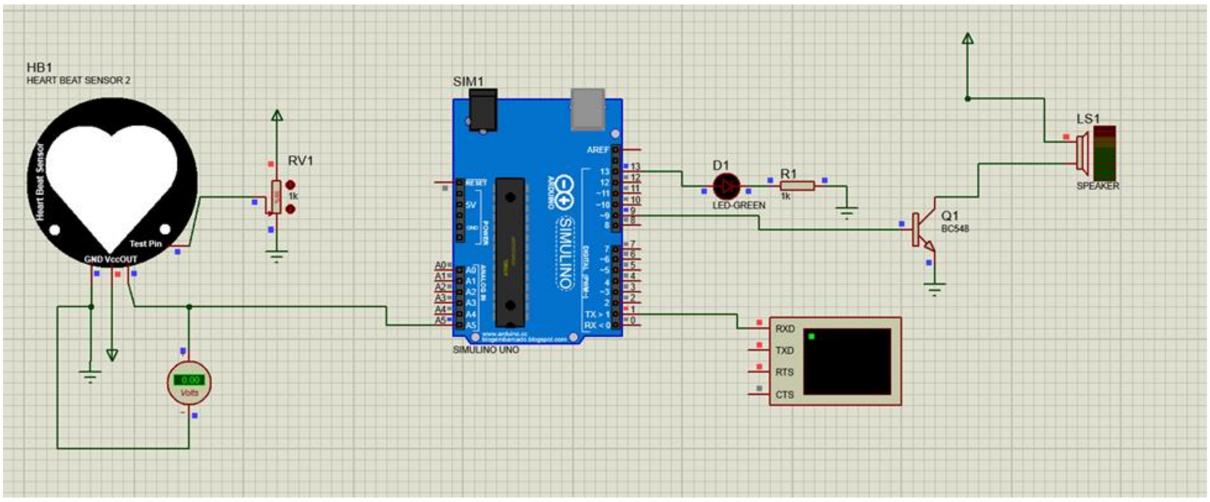


Figure 2.6: *Circuit representation of Drowsiness detection using heartbeat sensor*

Test case 1: When the driver is in a normal state:

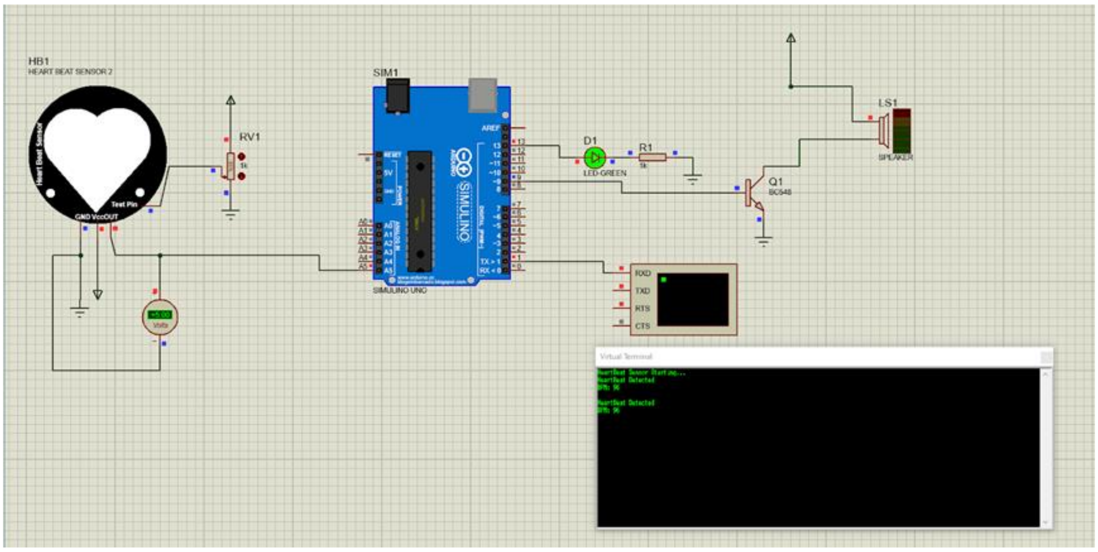


Figure 2.7: *Circuit representation of drowsiness detection using heartbeat sensor at an active state*

From the scenario above, it is clear that there is no urgency because the green LED light is blinking. The alarm system won't go off since the driver's pulse rate is being continuously checked and is showing a high pulse rate, which shows that the driver is awake and alert and not tired. The virtual terminal has recorded and shown a 96 BPM pulse rate. This indicates that the user is currently active because it is higher than the BPM threshold value that we specified.

Test case 2: When the driver is in a drowsy state:

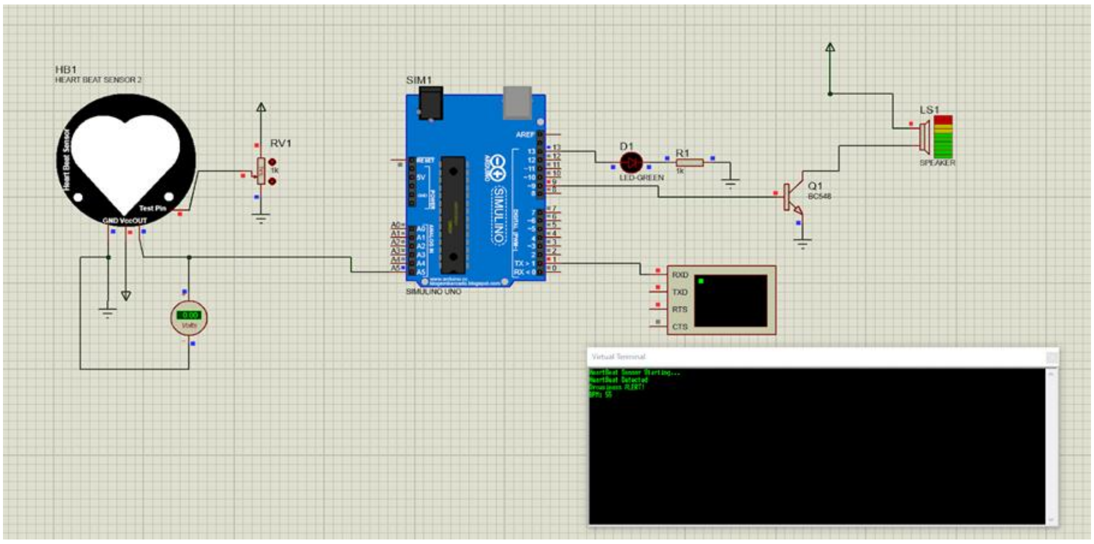


Figure 2.8: *Circuit representation of drowsiness detection using heartbeat sensor at a drowsy state*

We can observe that the BPM value is currently showing 55 BPM from the case above. This value is less than the initial threshold that we established. This would indicate that the driver is either already sleepy or on the verge of falling asleep. As a result, the buzzers are engaged to warn the driver to take control of their car and the green LED turns off to indicate danger [27].

Approach 2: Detection system using eye-blink sensor

In this approach, we attached an eye blink sensor to the Arduino to measure how long it takes the user to blink their eye.

Figure 2.9: *IR Sensor*

IR Sensor specifications: The IR Sensor requires 5VDC to operate. There are 3.3V and 5V I/O pins. A mounting hole is present. The IR sensor has a 20 centimeter range. The supply current is 20 mA.

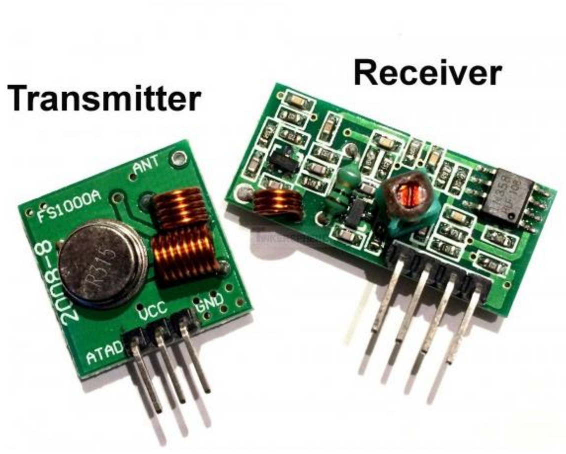


Figure 2.10: *RF transmitter receiver pair*

RF transmitter receiver pair specifications: The RF transmitter receiver pair's wide input supply ranges from 2.5V to 12V. 433 MHZ is the operating frequency. The transmission ranges from 300 to 500 meters. The operating temperature of an RF transmitter receiver pair is between 20°C and 60°C. The size is 11x16x5.5mm.

We used an infrared sensor with a transmitter and receiver to make our system function properly because it was impossible to obtain an exact library for an eye-blink sensor [28].

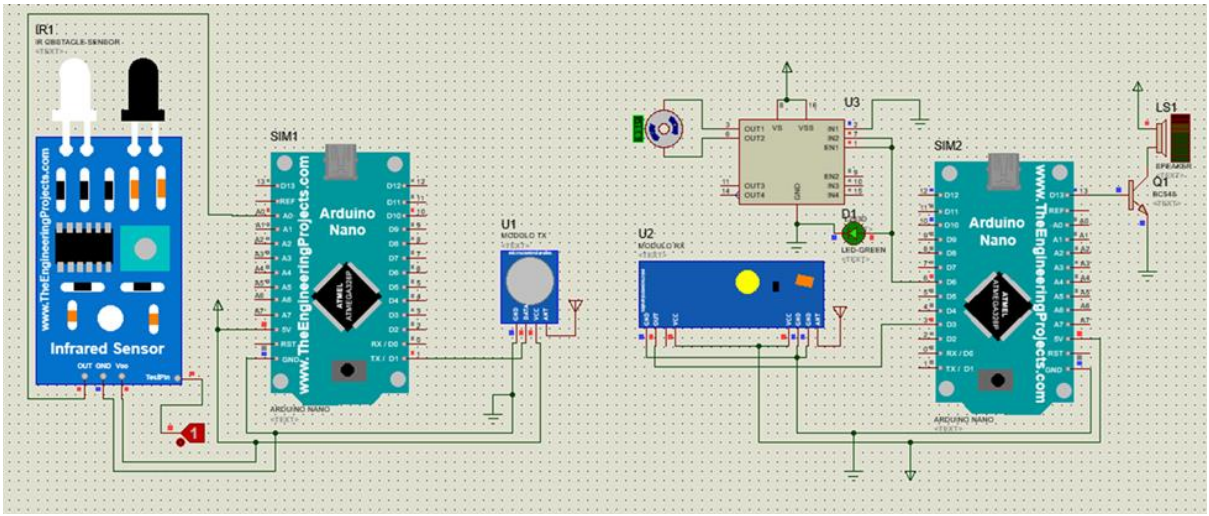


Figure 2.11: *Circuit representation of the drowsiness detection system using IR sensors*

In this design, two distinct Arduinos have been used, one of which is connected to the transmitter and the other to the receiver. Instead of using a real car motor on the receiver side, we have also connected a DC motor with a relay.

Test Case 1: When the driver is in a drowsy state

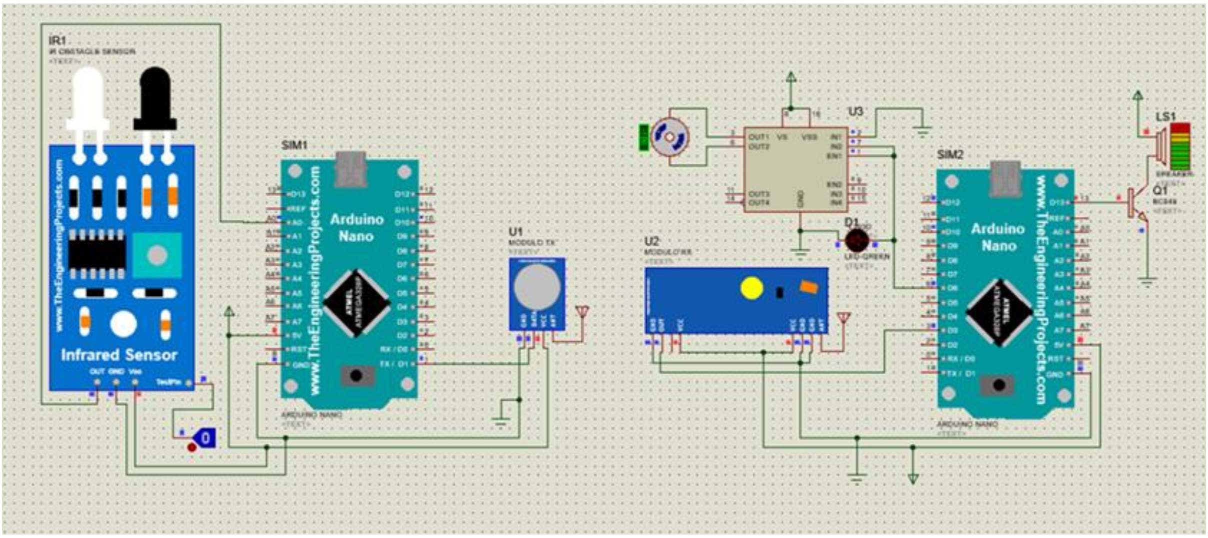


Figure 2.12: *System indicating that the user is drowsy*

The switch is set to the value "0" at the transmitter side, which shows that the user is not creating blinks in a timely manner or within the parameters that we have set. This is evident from the circuit diagram above. The signal telling the receiver to stop the DC motor and turn on the buzzer system is thereby sent. The fact that the green LED light is turning further indicates that the user may be in danger, which is another thing to keep in mind. The user must take control of the vehicle as soon as the buzzer system sounds, and they should be instantly alerted.

Test case 2: When the driver is not in a drowsy state

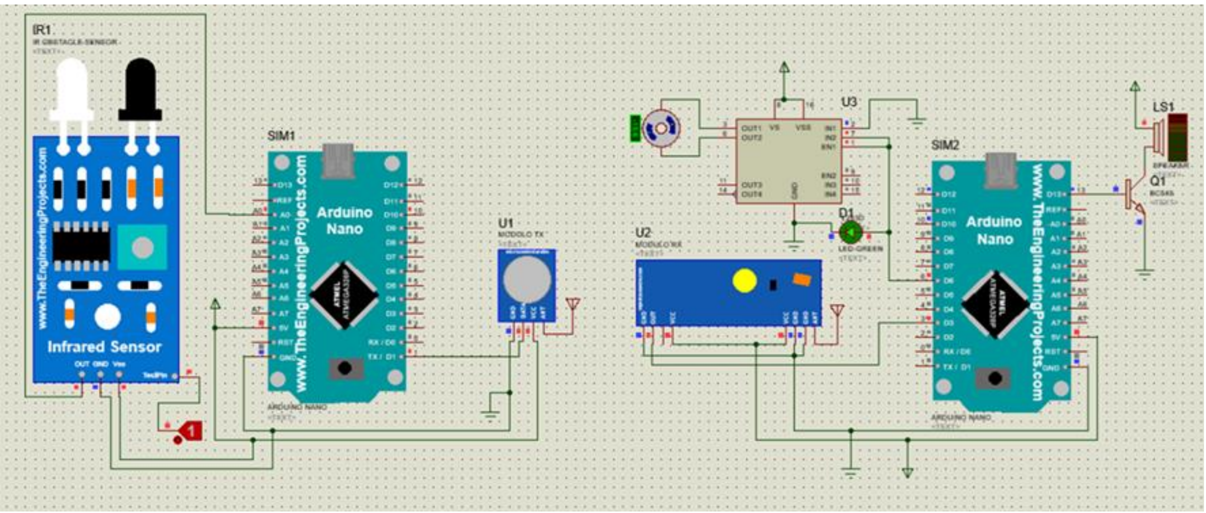


Figure 2.13: *System indicating that the user is not drowsy*

We can observe that in the above instance, the transmitter side switch is set to the value "1." As a result, the green LED is turned on, indicating that the user is not in danger. This shows that the user is blinking their eyes normally. The green LED is blinking, indicating that the motor is operating. Because the user is not showing any early indicators of drowsiness, the buzzer system will be turned on.

Approach 3: Detection using image processing

The simulation of our image processing has been conducted in the python script of the Raspbian operating system. Initially, all the necessary packages for this simulation have been installed. One of the important packages called dlib is being used. 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. On the other side, the imutils package, a collection of useful functions, was used to perform simple image processing tasks like translation, rotation, resizing, skeletonization, displaying Matplotlib images, sorting contours, and edge detection. Apart from that, OpenCV and arithmetical package for conducting the simulation has also been installed. We have employed the shape predictor 68 face landmark model, an open source trained face identification model, for our simulation purposes. This model is trained on the ibug 300-W dataset [29]. The face structure determines the points at which the landmarks are plotted. We mainly focused on the landmarks placed around both the eyes as we took the eyes as the subject for our detection. The landmark points around the left eye were landmark (43,44,45,46,47,48) and right eye were landmark (37,38,39,40,41.42) [30].

We have set data in such a way that, depending on the eye ratio, we will set the output to be active, sleeping or drowsy. The ratio was determined through some calculations which helped us to get data for different eye positions. The eye ratio was calculated by taking the ratio which is described as the sum of distances of vertical landmarks divided by twice the distance between horizontal landmarks. According to different eye positions at different distances and angles, we have tried to take an average data and set our output appropriately. From the ratio analysis what has been observed is that when a person is not sleepy or is active, the eyes are wide open, hence the distance data around each eye are found to be maximum or in larger value. On the other hand, when the person is drowsy, the eyes surrounding are somewhat found to be in closer distance which results in getting distance data around each eye to be less than in the active stage. Lastly, when a person is sleepy, the eyes are closed which results in the landmarks around each eye overlapping so as a result the distance is almost null or minimum in this case. Moreover, we have not shown the buzzer in our software simulation part, but in our hardware implementation, we will be having a buzzer as an alerting output beside the message. The buzzer will be set high as soon as the user is drowsy or sleepy.

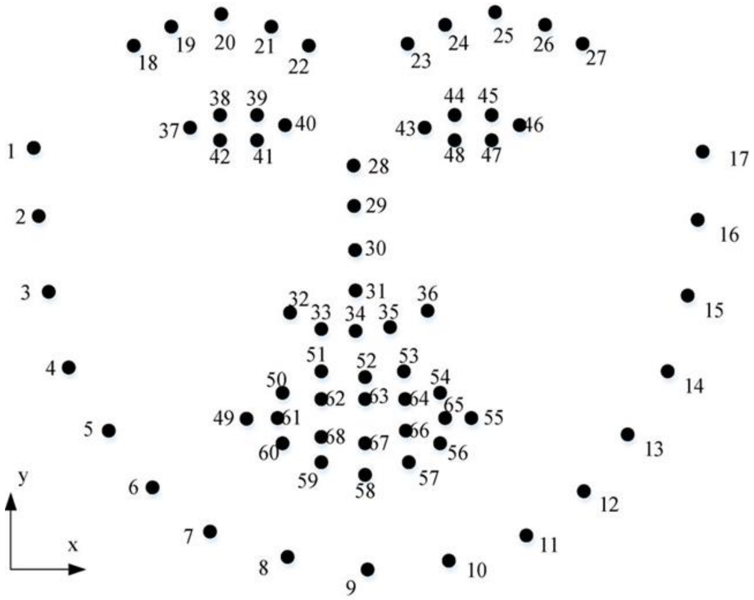


Figure 2.14: *68 Landmark coordinates marked on the facial structure*

Test cases:

The test results of our simulation were performed on all the states of active, drowsy and sleepy.

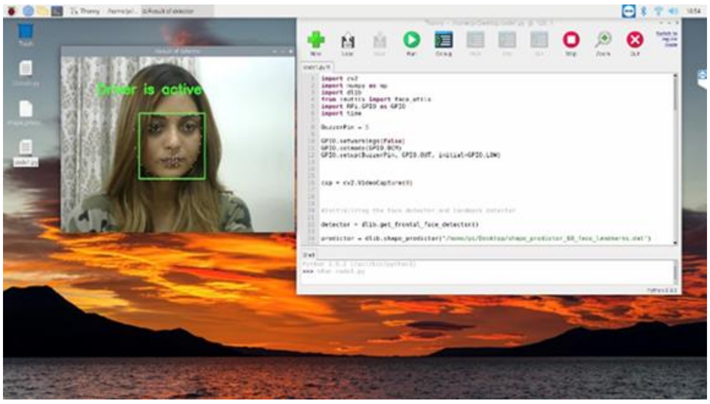


Figure 2.15: *Test result of active state*

At first, we tested our simulation on an active case. The landmarks are also being shown in the test cases of our output terminal box. The landmarks around the eyes are separated in a wider distance as observed in the picture so as a result the distance ratio is more which we represent as our active state. We have placed a message box saying “Driver is active” as observed in the picture for presenting that the user is active.

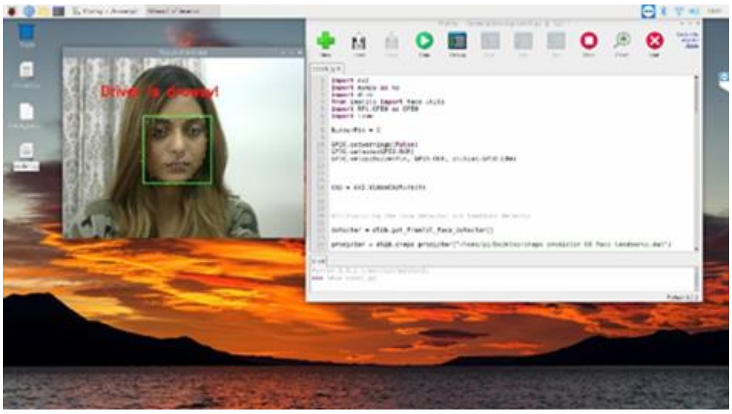


Figure 2.16: *Test result of drowsy state*

Afterwards, we have done some trials and test runs to collect a suitable data ratio for detecting drowsy state. It is observed in the picture given that we have represented a drowsy state when the landmarks are closer in distance around the eyes. The message box contained the text “Driver is drowsy!” has also been set as an alerting message for the drowsy state.

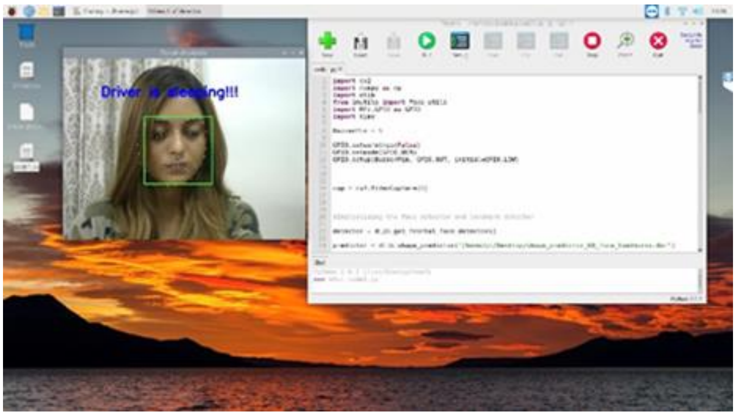


Figure 2.17: *Test result of sleeping state*

Similarly, we have done some test runs to collect a suitable data ratio for detecting sleeping state. It is observed that we have a sleepy state when the landmarks are almost null in distance or are somewhat overlapping around each eye. The message box contained the text “Driver is sleeping!!!” has also been set as an alerting message for sleeping.

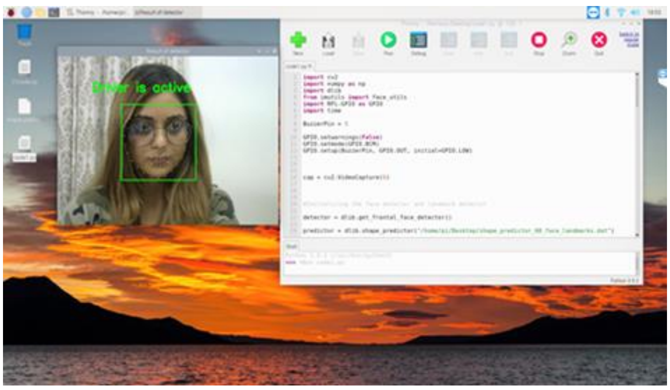


Figure 2.18: Test result by wearing spectacles

We have also tested our simulation over some difficult challenges like detecting the states wearing spectacles and the landmarks were easily being plotted around the eyes therefore the output states were showing properly.

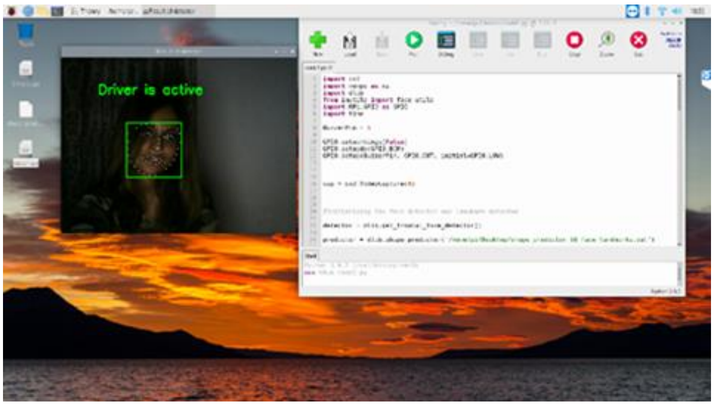


Figure 2.19: *Test result in a dark environment*

Besides, we have detected our simulation over more challenges like detecting the states wearing spectacles and it is being observed that the landmarks were set being plotted around the eyes even in such difficult situations, the output came out properly for this one as well.

2.4: Analysis of multiple design approach

Analysis of approach 1: Heartbeat sensor

Heartbeat sensors that are affordable, easy to replace, and widely accessible therefore it was utilized in this design. This design strategy can fit easily inside the vehicle and that's a bright side. The driver must firmly grasp the steering wheel to get accurate results from the pulse rate sensor design. For system protection, this setup must be kept within the vehicle in a way that prevents the circuits from becoming disconnected owing to any disturbance of the vehicle. In order to alert the driver or those within the car in the event of an emergency, this must be connected to a buzzer or speaker. Since an Arduino Uno is used in this design, it is mandatory to power the circuit using a 9V battery attached to the Arduino. The circuit must be set with an operating system or an IDE (Integrated Development Environment) that codes the system appropriately. The driver is warned depending on the results of the pulse rate detection. However, some persons who naturally have lower pulse rates will find it more difficult to distinguish their decline in pulse rate. The device may therefore produce a false positive or false negative result. Extra current can make the Arduino hot, according to the constraint analysis, although the possibility of this happening is very low; as a result, this is one of the risk factors. Despite the fact that if the Arduino is shut down, it will stop sensing drowsiness, thus we can restart it and use a cool sink if it is too hot. Additionally, we noticed that the steering wheel containing the sensor may detect a difference in the two people's heart rates if a novice driver changes positions while driving.

Analysis of approach 2: Eye-blink sensor

In general, eye blink sensors are inexpensive and widely available. Similarly like the heartbeat sensor, it can be constructed inside the vehicle with minimal space needed. The modules must be stored within the car in such a way that the circuit shall not become disconnected while vehicle movement. In order to alert the driver or those within the car, the design needs to be connected to a buzzer or speaker as well for proper warning. Moreover, an Arduino Uno is utilized in this design, a 9V battery coupled to the Arduino. The circuit needs to be programmed with an operating system to program. The driver wearing eye-blink sensor must put on a goggle for safety measures that is the eye blink sensor design has included a goggle that the driver must wear while operating the vehicle. However, the sensor which is located in the middle of the goggles can obstruct the driver's view and make driving extremely challenging, therefore sometimes it may increase the risk rather than lowering risk for pedestrians and passengers. Additionally, a battery serves as the power source which is evitable and the googles' side has this battery attached. We came to the conclusion that although goggles are useful items and their risk of happening is moderate, they may break if the driver is negligent. But it is always replaceable with new ones if damaged and the driver must switch the sensor and RF transmitter in it. In the entire process, the driver’s number of eye blinks must last for a few seconds in order to identify drowsiness based on the observation of threshold value.

Analysis of approach 3: Image processing

Image processing is the process of capturing a real time interface with an algorithm. A proper arrangement for the driver within the vehicle can be achieved with the structure without the need for wide spacing. Our device must be positioned in the center of the dashboard of the car, preferably near the steering wheel, for this image processing design in order for it to recognize the driver's facial structure. Due to the connection utilized for the microprocessor, this design is the most expensive to implement. Like any other circuit construction, it must have an operational system installed in addition to the obligatory connection of a speaker or buzzer in order to inform the driver or other passengers in the event of an emergency. The circuit needs specific power requirements such as the need to deliver around 15 watts of electricity to run the Raspberry Pi, which can be connected to the circuit with ease using a buck converter. Additionally, taking pictures at night can be challenging because it is dark inside the car and there is no way to get a clean photo without a light source. However, by using a night vision camera, the picture can be captured effortlessly. The device will cost more in total because of the costly camera. Though the best outcomes for reducing driver drowsiness make this design worth the investment. The raspbian operating system, which is needed to build the design in the raspberry pi microprocessor for better outcomes, can be used to implement the system separately for the drowsiness detection utilizing image processing. Moreover, the initial goal of vehicle design is to keep the driver from falling asleep while driving, therefore it needs to be built with compact components that fit the available space. The main goal of the suggested method is to analyze data and detect drowsiness more effectively. In order to correctly assess drowsiness, it is necessary to keep track of how often the eyes are closed and to count the ratios of the eye and mouth aspect ratios.

2.5: Conclusion:

In conclusion, we have created a safety mechanism that serves as a countermeasure. In order for this mechanism to function, it is essential to recognize the first indications of drowsiness. The heart rate varies when one is sleepy, which is one of the main alterations that occurs. An individual who is drowsy has a lower heart rate than an individual who is alert and active. We developed our initial strategy, which involves continuously monitoring the driver's pulse rate, after taking this idea into account. One of the early signs of drowsiness is a drop in blink rate, which can be integrated into an algorithm that continuously measures blink rate. The driver will receive notification if the rate decreases below the median. Despite the fact that the initial approaches are based on the early indicators of drowsiness, they are ineffective since each strategy uses one of the signs as a parameter. For our third strategy, an image processing-based drowsiness detection system, we are working with many early-stage drowsiness signals rather than just one. This algorithm was developed using the driver's face detection, and the driver's eyes and lips were identified. Therefore, the system will warn the driver as a warning if they yawn or close their eyes.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction

Our project mainly uses Artificial Intelligence (AI) to build the drowsiness detection system. So, the most important would be to train a model and use an Integrated Development Environment (IDE) to compile the code and get results from it. As for programming languages we have used Python as it is one of the most flexible and versatile languages to use for artificial intelligence. For the purpose of the project, we have used a Raspberry Pi 4 to design the system and hence, an operating system is required for the device to run. As for the operating system, we have used the Raspberry Pi operating system (previously called Rapbian).Our system also requires an IDE for python, so we have used Thonny as the IDE. Using all these tools, we have successfully implemented our project for getting result outputs.

3.2 Select appropriate engineering and IT tools

Raspberry Pi Operating System:

Raspberry Pi is a microprocessor and just like any computer, it requires an operating system to be installed for the raspberry pi board to function. The raspberry pi operating system installer needs to be mounted on a SD card and the SD has to be inserted into the raspberry pi board. After running the setup, we will be able to use raspberry pi as a microprocessor. In the figure below, depiction of the raspberry pi operating system is shown.

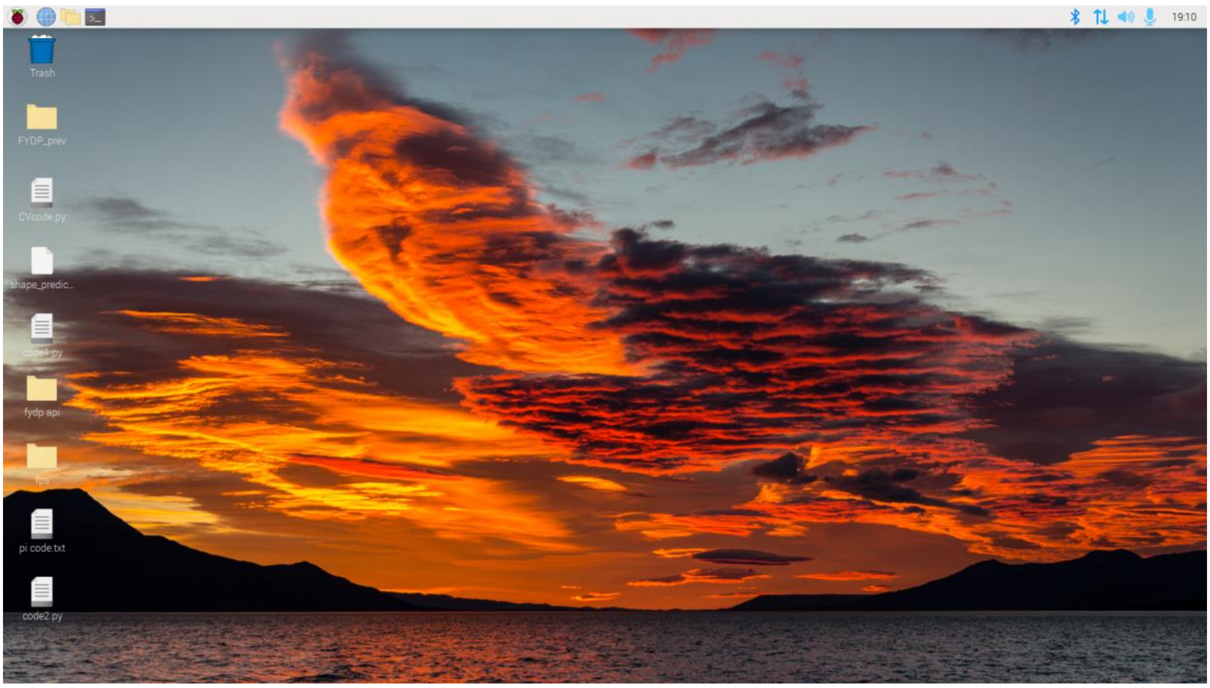


Figure 3.1: Raspberry Pi Operating System User Interface

Thonny:
Thonny is the integrated development environment (IDE) which we used to run and compile the codes needed for our project to run. Raspberry Pi by default comes with Thonny installed. It comes with the built-in python 3.9.2 version. In the figure below, the Thonny IDE interface is shown.

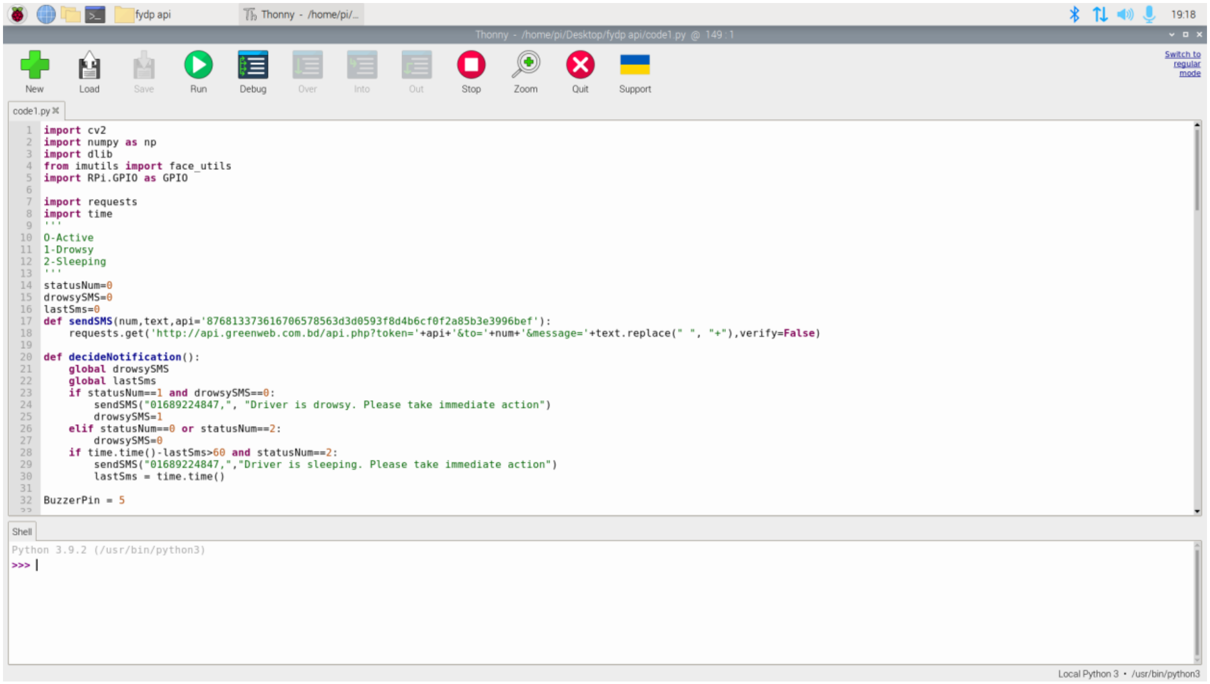


Figure 3.2: Thonny IDE User Interface

OpenCV, NumPy and Dlib:

Open CV, NumPy and Dlib all are python which needs to be imported and installed onto the raspberry pi which will be essential for our project to work properly. OpenCV is the machine learning software open source library which is mainly used for getting results and training models at real-time computer vision. NumPy is the library for operating higher level mathematical functions on arrays. Dlib is similar to OpenCV. Dlib is another open source library for machine learning software which is mainly for our 68-landmark model. Using Dlib, we are able to estimate the coordinates (x,y) of the facial features for our project.

3.3 Use of modern engineering and IT tools

Combining all these modern engineering and IT tools, we have designed our drowsiness detection system. Initially after setting up the raspberry pi with appropriate hardware tools, we ran the Thonny IDE in Raspberry Pi operating system. In Thonny IDE, we imported the OpenCV, NumPy and Dlib libraries. Initially, we programmed our system to detect the camera using OpenCV. The code is attached below.

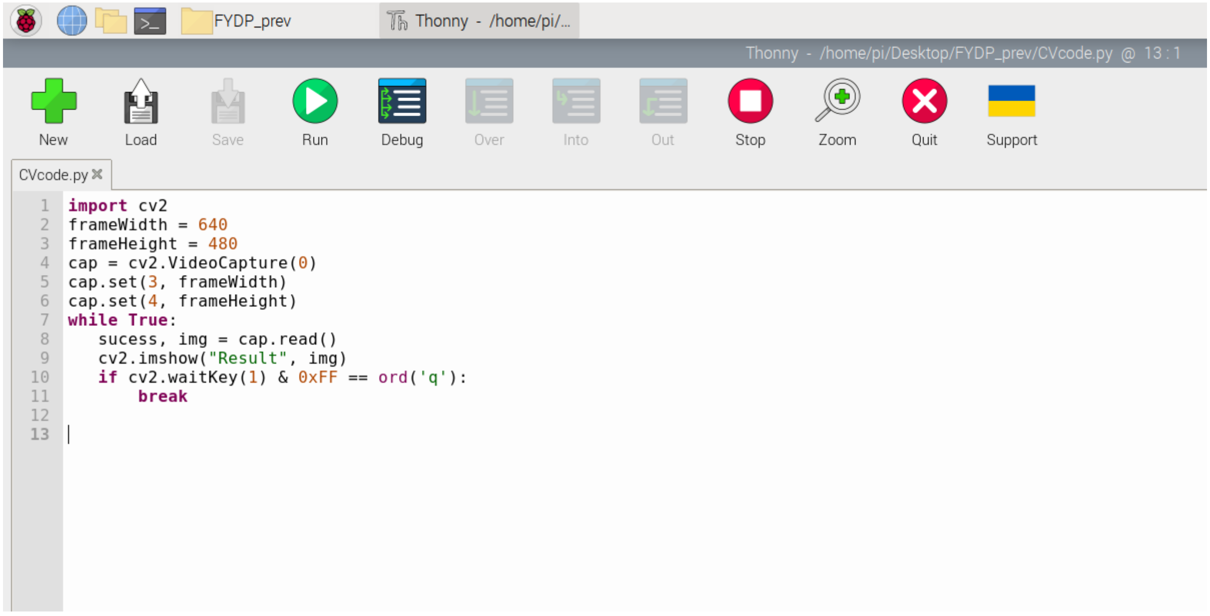


Figure 3.3: Camera Detection using OpenCV

Running this code allowed us to allow OpenCV to detect the camera which is required to detect the facial features of the driver. Then after compiling our main code, the camera was able to detect the facial features and using these modern engineering and IT tools, we were able to get the expected outputs. A few snippets are attached below indicating our expected results were displayed in the raspberry pi operating system after successful compilation of the main code.

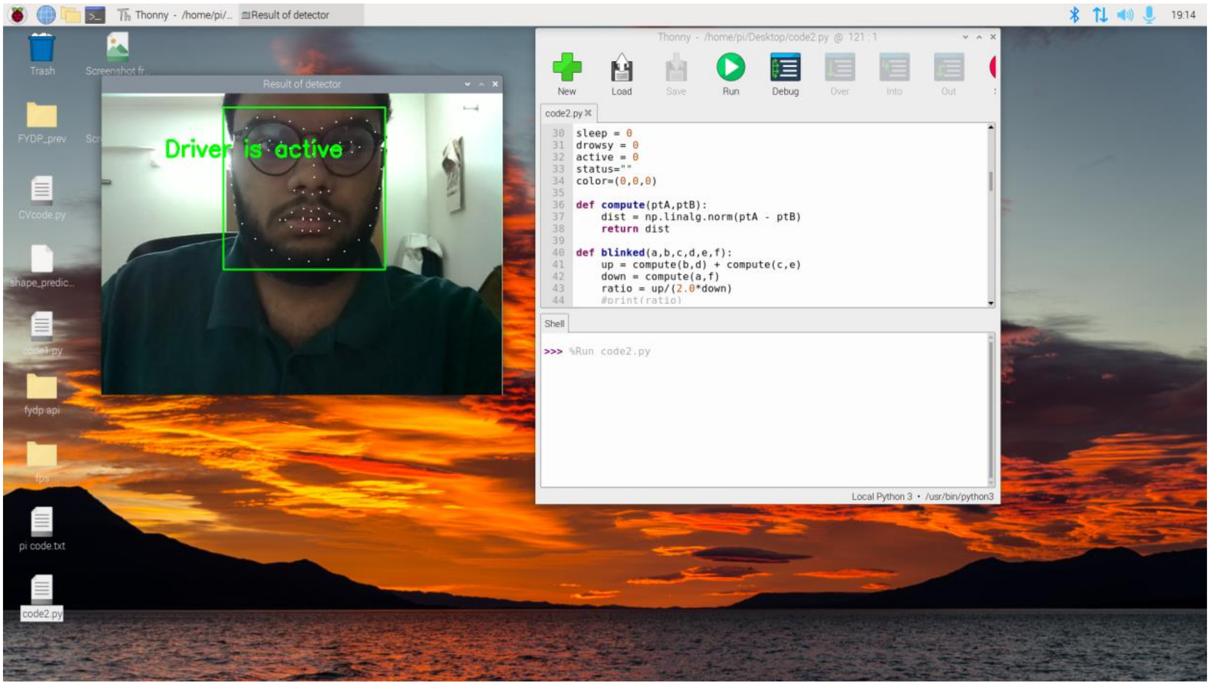


Figure 3.4: User in Active State

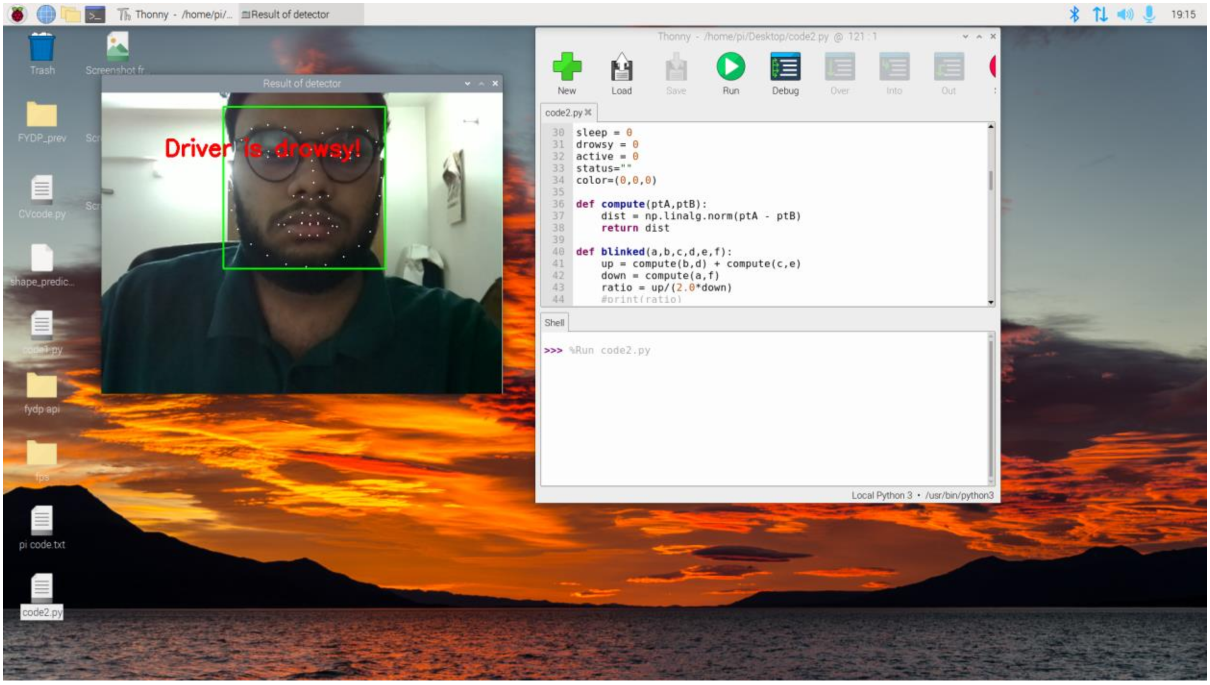


Figure 3.5:User in Drowsy State

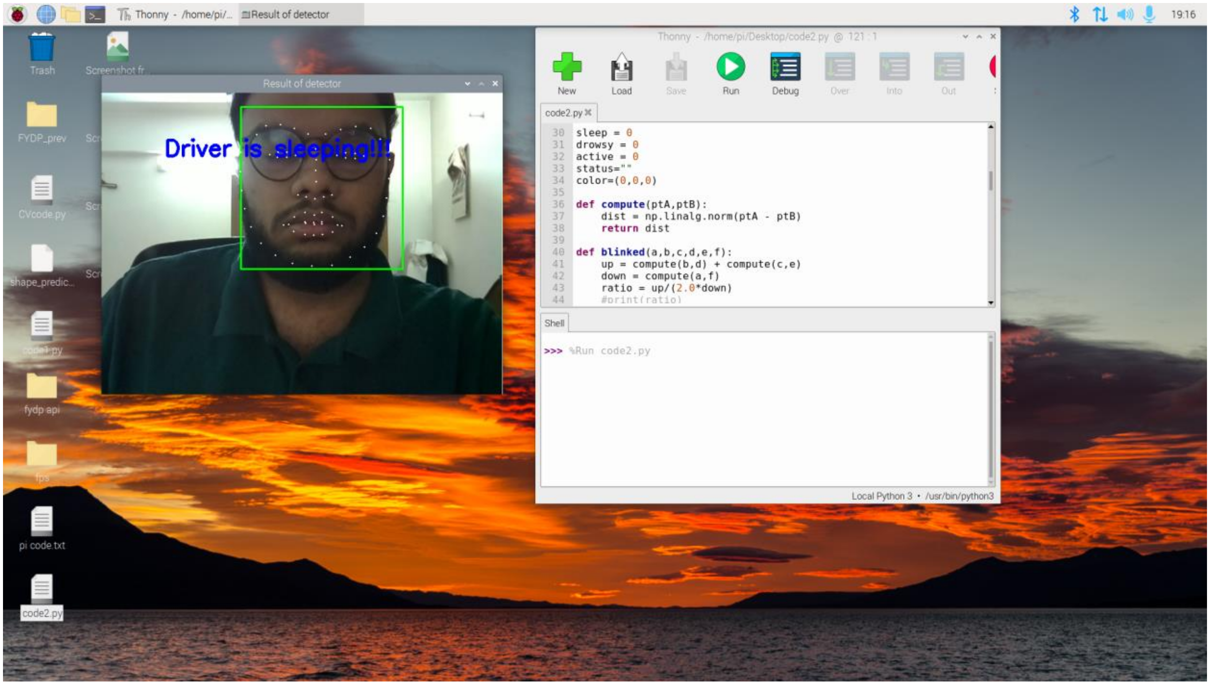


Figure 3.6: Driver in Sleeping State

Our project comprises three different states in which the driver can possibly be in: active state, drowsy state and sleeping state. With help of all these tools, we were able to implement these three required states which is the fundamental part of our project.

3.4 Conclusion

To summarize, most solutions to complex engineering problems require the usage of modern engineering and IT tools. In our scenario, we identified the problem for drivers who get drowsy or sleepy when driving for long hours and distances due to fatigue. The solution was to design a system which detects drowsiness using the facial landmarks of the driver and in order to do so, we carried out our project in raspberry pi using the raspberry pi operating system, Thonny IDE to write, run and compile the code. We have also imported some python libraries/tools (OpenCV, NumPy and Dlib) which are required to detect the facial landmarks and deduce which state the driver is in and in case of any emergency such as when the driver is drowsy or sleepy, we have programmed in Thonny in such a way that the driver gets alerted using a piezo buzzer connected to the raspberry pi board.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

The definition of drowsiness is extreme sleepiness or fatigue, which makes it difficult for a person to maintain eye contact and causes them to lose attention over time. Numerous things might have an impact on it such as not getting enough sleep, driving for extended periods of time and having too much work to do therefore countless traffic accidents are caused worldwide by drowsy driving. Among 183 countries, Bangladesh is ranked 106th for having a high number of traffic accidents. Recent data shows that in the first eight months of 2021, 3701 traffic incidents resulted in a total of 3502 fatalities and 3479 injuries [31]. According to diverse studies, drunk driving causes 10 to 30% of collisions. There are many ways to identify a driver who is drowsy, including algorithms based on behavioral cues, physiological signals, and vital signs [32]. According to recent figures, accidents involving exhaustion are thought to result in 1,200 fatalities and 76,000 injuries per year. A significant problem in the area of the accident avoidance systems is the creation of technology for detecting or preventing tiredness at the wheel [33]. Also, due to drowsiness, pedestrians are somewhat victims of such road fatalities. In recent years, driver drowsiness has been one of the primary causes of traffic accidents, resulting in catastrophic bodily injuries and deaths, as well as huge financial loss. Therefore, we have implemented approaches to detect tiredness through data mining algorithms collected by various sensors that will be saved, processed, and analyzed in real time by components capable of detecting the early signs of drowsiness.

4.2 Optimization of multiple design approach

Every solution to complex engineering problems will have some drawbacks but yet we need to find the best possible solution to our given problem in order to make this project a feasible one. Based on categories like cost, efficiency, usability, manufacturability, impact, sustainability and maintainability, we have selected the optimal design approach from the three different approaches.

When it comes to the approaches involving heartbeat and the IR sensors, we found that these sensors are typically very inexpensive but at the same time, they might not give us the most accurate results in real time. Another drawback is that these two systems need to be attached to the user in order to function. The user might be uninterested to physically attach these devices to their bodies while driving. Although these sensors might be available at all times, their inexpensive costing means that the user has to replace these sensors with new ones whenever the sensors stop working. This means that there is no room for maintainability. Since these sensors need to be replaced somewhat regularly, this implies that the user has to check whether these devices are functioning or not every time, they are operating the vehicle. Otherwise there could be massive problems if the sensors are not working while the driver is in a drowsy state.

Another possible issue is that these devices need a power connection in order to operate and on top of attaching these devices to the body of the user, they also have to endure the added weight of the power system. Finally, the eye blink sensor could be obstructing the vision of the driver while driving as the sensor is attached to the spectacles or goggles, worn by the driver. As for the heartbeat sensor, any loose grip on the device could mean inaccurate reading of the pulse rate as a result indicating wrong readings of the pulse. Overall, the disadvantages outweigh the advantages of these two design approaches as a result the drowsiness detection system using the heartbeat sensor and the IR sensor might not be suitable for practical usage, especially to those drivers driving long distances.

On the other hand, a drowsiness detection system using image processing is a user-friendly option. Although the cost is very high when compared to the other two approaches, we know that the cost of safety is much higher than the cost of any devices. Unlike the other two systems, our device does not have to be physically attached to the user but rather it is kept on the dashboard of the car. It is kept at a certain distance from the driver so that it will not be obstructing their vision while driving. The device will be constantly monitoring the eyes of the driver and will be giving the results in real time. In terms of efficiency, this method provides the highest accuracy with an accuracy of 94.50% when the driver is alert and an accuracy of 93.13% when the driver is in a drowsy state [34]. Although in terms of manufacturability, there is a slight shortage of chips in the global market, prices of raspberry pi are slightly higher than usual. Moreover, any raspberry pi is a long lasting microprocessor and does not require to be replaced frequently. It has an average lifespan of about 7 to 10 years [35]. As a result, we can blindly trust the process without having to manually check whether the device is fully functioning or not regularly. Since there is always room for improvement, to improve the system even better, we can use raspberry pi with a higher specification and a night vision camera to detect pictures with better clarity even when the lighting is low. Furthermore, using a buck converter we can lower the voltage required to run the raspberry pi and even embed the raspberry pi with the vehicle's multimedia system. In that way, only the camera will be attached to the dashboard of the car and the rest of the system will not be even visible to the user and the whole process will be an automated one.

In a nutshell, it is safe to conclude that our drowsiness detection system using raspberry pi is far superior to drowsiness detection system using eye-blink sensor or heartbeat sensor. The positive impacts and the accuracy of the drowsiness detection system using image processing outweigh the advantages of the other two systems, namely the drowsiness detection system using eye-blink sensor and heartbeat sensor. For better optimization of the image processing system, we can use a larger dataset or a better trained model for facial recognition of the driver. Using a larger dataset will ensure a better detection of the facial structure as a result the accuracy of detecting whether the person is active, drowsy or sleepy will be much higher. Better cameras such as night vision cameras will also help the accuracy for better detection. Although for our project we have used a basic air cooler and smaller heat sinks to keep the raspberry pi cool, using better air cooler and bigger heat sinks will further ensure that the temperature of the raspberry pi will be lower than usual. This will allow the raspberry pi to function properly almost without any delay, hence providing outputs closer to the real time.

4.3 Identify optimal design approach

Table 4.1. Comparison of multiple different approaches

Categories	**Design 1**	**Design 2**	**Design 3**
Component Efficiency	Inaccurate result in real time.	Inaccurate result in real time.	Gives result in real time. Alerts the driver accurately 94.5% times. In case of drowsy state the accuracy rate is 93.13% times.
Manufacturability	Sensors are cheap and available but need to be replaced often.	Sensors are cheap and available but need to be replaced often.	There is a crisis in the chip industry. Lasts longer and does not need to be replaced often.
Maintainability	Need to check often if the sensor is working or not.	Need to check often if the sensor is working or not.	No need to check the process often.
Impact	Consumers might forget or might not be interested in wearing the device.	Consumers might forget or might not be interested in wearing the device. Device damages the eye.	Ease of access to the user as the device is installed inside the car. The user does not have to wear any gadgets.
Usability	User needs to wear the device physically. Power is connected which adds weight to the device.	User needs to wear the device physically. Power is connected which adds weight to the device.	Device does not need to be attached physically, rather can be kept on the dashboard.
Sustainability	Sensors are not long lasting Arduinos are inexpensive	Sensors are not long lasting Arduinos are inexpensive	Raspberry pi is long lasting. Any cameras can be used.

Design 3 is the optimal design among all of the approaches. This design is fully based on an image processing algorithm that uses the Raspbian operating system and produces results in real time. Drowsiness detection system using image processing is a user-friendly option. The device can be stored on the driver's dashboard, which is far more favorable than the other two methods because those require the user to be physically attached to the device. In order to prevent it from blocking the driver's vision while they are driving, it is kept at a specific distance from them. The equipment will continuously track the driver's eyes and report the results in real time. The efficiency of this approach is the main consideration while choosing it. From our research, we learned that when the driver is aware, this approach has an accuracy of 94.50%, and when the driver is tired, it has an accuracy of 93.13% and this has already been mentioned in the table. Additionally, the raspberry pi's CPU is reliable and does not need to be changed frequently. It typically lives between 7 and 10 years. As a result, we don't need to frequently physically check to see if the device is completely operational or not, we can simply trust this method.

4.4 Performance evaluation of developed solution

Basically, in order to bypass a driver's drowsiness detection for safety measures, we applied three different design methods. Each of the three designs is distinctive and varies in its effectiveness. In our entire project, we have illustrated three approaches that is drowsiness detection through heart beat sensor, eye blink sensor and image processing, which helped us in the observation of a driver’s active, drowsy and sleepy stages, as our main focus is to stop the accidents that is caused through the drowsiness of a driver.

Initially, we have used heart beat sensors to measure or experiment the heart rate of a driver’s stages. This sensor can be found in both physical and online markets at a very low price. This sensor is incredibly small and compact compared to most market available modules. However, for such a minor reason, its size has no bearing on how well it works or how effective it is. The single pin, known as the out pin, is used to transmit the sensor's output. It uses pulse signals to transmit information to the microcontroller. This heartbeat sensor is completely compatible with Arduino. We used Arduino to conduct it for this reason. In addition, our research has shown that when we are sleepy, our heart rates often vary from 45 to 65 bpm, while an adult's normal resting heart rate typically falls between 60 and 100 bpm. Bpm varies from person to person and from gender to gender and also on physical conditions but we created a system that is applicable to everyone, therefore we set the threshold at 65 BPM. Our system continuously checks the heart rate, which is wired to the driver, and when the bpm falls below the threshold, we inform the driver with a buzzer and an LED to resume activity. This design's efficiency is not all that great because the sensors are not very durable and need to be replaced after a certain amount of time of use. There's also a high chance that the prototype can become imbalanced during the driver's movement, which could lead to readings that are inaccurate or that readings do not appear constantly because the connection is lost.

Moreover, we have used an eye blink sensor that is mainly an IR (infrared) sensor to measure the blink rate of a driver's stages. This sensor may also be purchased for a relatively inexpensive cost in both physical and online markets. This sensor is tiny and compact comparatively as well. Despite this minor distinction, its size has no impact on how well it works. Additionally, our approach was carried out using the Arduino microcontroller, and to properly operate our system, we used an infrared sensor (IR) with a transmitter and receiver. Two different Arduinos have been utilized in this design, one of which is connected to the transmitter and the other to the receiver. We have replaced a DC motor for a real car motor on the receiver side by wiring it in with a relay. At the transmitter side, we have set the switch to the value "0" indicating that the driver is not making blinks quickly enough or within the parameters we have established. The receiver therefore picks up the signal telling it to stop the DC motor and turns on the buzzer system. Another thing we have mentioned is that as the green LED light changes further, it may be dangerous for the driver, therefore the driver should be quickly informed when the buzzer system activates and must take control of the vehicle. This design's ability is slightly weak as the sensors normally are not very sustainable module and needs replacement after an expiry time, also like our first approach this can cause instability during driving that might fail to catch the proper blinks of eye rating or might fail to tell whether the driver is in active stage or drowsy stage due to ruination in prototype.

Furthermore, our third design approach is based on image processing that helps us to detect the stages of a driver. Image processing algorithms are quite difficult procedures. In spite of that, we have been able to interpret the complexity and implement it accurately in our design. We have used the microprocessor raspberry pi to construct this design and this is comparatively costly in the market also, there is a crisis in the chip industry but it has a greater longevity. Besides, real time results are provided through this. We have used the shape predictor 68 landmark model in this approach, an open source trained face identification model for our simulation needs. From our research, we came across the idea that on the ibug 300-W dataset, this model was trained and this model contains landmarks of facial structure that shows the right eye's landmark points are (43, 44, 45, 46, 47, 48) and the left eye's landmark points are (37, 38, 39, 40, 41, 42). As we have taken eye aspect ratio which EAR in the consideration of our subject of our detection, we concentrated highly on the landmarks surrounding both of the eyes, also the mouth aspect ratio kept little contribution. The ideology is when the eyes are wide open, the driver is active; when the eyes are partially open, the driver is drowsy and finally when the eyes are fully closed, the driver is sleeping. Besides, we have set a buzzer and API messaging system to alert driver and driver's emergency contact when the sleeping or drowsy stages arise so that the danger can be avoided. This design's coherence is the greatest because the raspberry pi is long lasting and no need to be replaced, however can be used for long run. It is guaranteed that the prototype can keep balance during the driver's movement, therefore no risk of wrong readings or connection loss. The achievement of implicit results were found using raspberry pi camera and proper power supply so even in real time interface, bare minimum latency was noticed.

To conclude, we may assume from the evaluation of each design that the image processing is the best in terms of proper efficiency, utilization across a larger time frame, and accuracy when compared to the other two designs. Therefore, if it is necessary to use one of the three techniques in real life, our own study of performance evaluation leads us to believe that we have employed a variety of algorithms to maximize their effectiveness.

4.5 Conclusion

To conclude, we have shown three design approaches that serve as a safety method to eradicate this issue. Initially, the heart beat sensor works by heart beat variation when one is drowsy, an individual who is drowsy has a lower heart rate than an individual who is alert and active. Moreover, we focused on a blink sensor that counts the eye blink rate which can be incorporated into an algorithm that continuously measures blink rate. The driver gets informed as soon as the rate drops below the median. Although the initial techniques are based on the early signs of drowsiness, the sensors can't retain a strong grip when it comes to consistent performance, making them less useful. Therefore, our third strategy, drowsiness detection through image processing, heavily emphasizes detecting drowsiness in its early stages without much of an interruption or hurdle. The driver's eyes and mouth are recognized by this method using the driver's face detection. The technology will therefore alert the driver if they yawn or close their eyes. Following a thorough analysis of each system, we came to the conclusion that option three, which is based on image processing, is the most appropriate option and optimal. Our program aims to reduce accidents brought on by drowsiness, a factor that contributes to many auto accidents yet is typically overlooked. The system's development received a lot of attention, but we also worked hard to keep costs down while maintaining excellent results, while also taking the drivers' consent under consideration.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction

The final design which is image processing presents the method of detecting drowsiness of a driver. This basically takes a driver's facial images through a camera set on the dashboard and constantly takes real time captures. Moreover, tracing the facial features through image processing and classifying the driver's drowsiness level that can be active, drowsy and sleepy by pattern classifications and proper monitoring through the entire mechanism. We became aware of the fact that, when used as a general indicator of drowsiness during monotonous driving, facial expression shows the strongest linear connection with brain waves. We implemented a design analogy by using a model called 68 landmark model and that gives away results of driver drowsiness through facial muscle activity. We mainly focused on the entire facial structure that has a total of 68 landmarks and our prior significance is the eye aspect ratio that is EAR and mouth aspect ratio that is MAR. The entire design emphasizes on the fact that the driver achieves proper safety measures through in depth research and construction.

5.2 Completion of final design

This design concentrates on getting a real time interface through an image processing system. The camera is constantly monitoring and giving outcomes through algorithms and making an interaction between the vehicle and driver. The prior purpose is the prevention of accidents by detecting drowsiness of the driver.

The most significant component of this design is the microprocessor Raspberry Pi. We have used the model Raspberry pi 4 model B.

Figure 5.1: *Raspberry pi 4 model B*

Raspberry Pi is a portable, single-board computer that is lightweight and portable. The advantage of Raspberry is that it supports all types of programming such as python, C, C++. Version 4 of the Raspberry Pi includes RAM and a faster processor. Due to the abundance of GPIO pins, it further supports a number of sensors. If internal storage is insufficient for large tasks, an SD card is required. All these features make it suitable for our project as we are using python code and aiming to prevent accidents that occur through drowsiness.

Figure 5.2: *Raspbian Operating System*

It is hardware-optimized for the Raspberry Pi. More than just an operating system, it offers over 35,000 packages of pre-compiled software that are well packaged for quick installation on your Raspberry Pi.

Figure 5.3: *Python programming*

Python is the most well-known programming language for Raspberry Pi. Developers use it to create various software applications. Additionally, it is employed in machine learning, and it also finds utility in a variety of electronic tasks. As it is engaged with image processing work, we have used it for proper results.

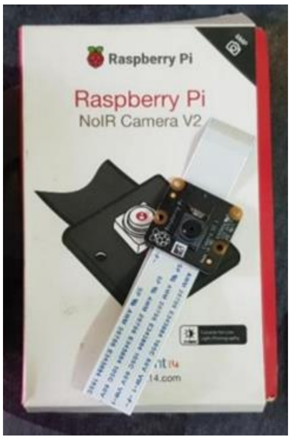


Figure 5.4: *Raspberry Pi Noir Camera V2*

Raspberry Pi Noir Camera V2 is extremely thin, weighing only 3 grams, and has an 8 megapixel still resolution. It has a Sony IMX219 sensor with a 3280 x 2464 pixel sensor resolution. All Raspberry Pi versions are compatible with it. The finest balance between size, resolution, and price was achieved by the Pi-noir-camera.

Software requirements:

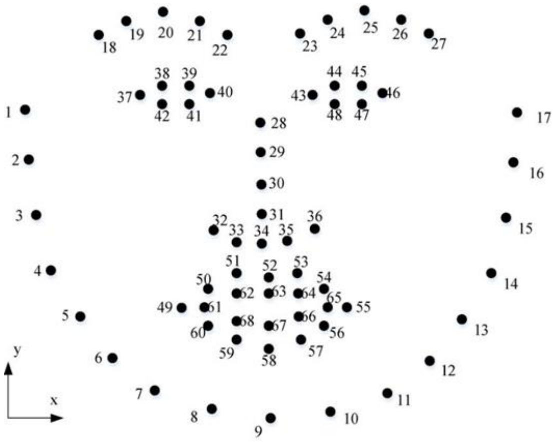


Figure 5.5: *68 Landmark Model*

For our simulations, we used the shape predictor 68 face landmark model, an open source trained face identification model. The ibug 300-W dataset was used to train this model [36]. The landmarks are plotted at specific points based on the face structure. Since we employed both eyes as the subject of our detection, we concentrated mostly on the landmarks that were surrounding them. The right eye was the landmark, and the landmark points around the left eye were (43,44,45,46,47,48) & (37,38,39,40,41.42) [37]

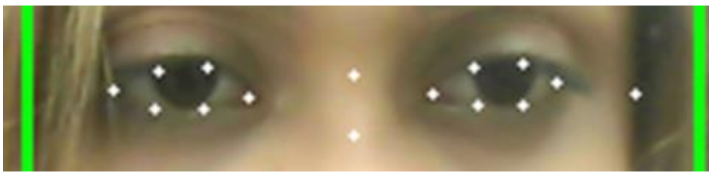


Figure 5.6: *Eye coordinates*

Finding the Eye Aspect Ratio or EAR requires using these six specific coordinates. The EAR is a formula that is discussed in Real-Time Eye Blink Detection Using Facial Landmarks by Soukupova' and ech(2016). They suggested a formula in their paper that uses the scalar quantity EAR to identify eye blink [38]. As its name suggests, the Ocular Aspect Ratio formula provides a scalar number for the degree of eye openness. Every frame that follows, the EAR is calculated, and a blink is recognized when the value of EAR drops.

EAR equation:

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

Moreover, in order to run the code in the Raspbian operating system few packages need to be installed. We had to install opencv, numpy, dlib and imutils. The opencv installation was quite difficult among all these packages.

Figure 5.7: *OpenCv installation*

The package contains more than 2500 optimized algorithms, including a wide range of both traditional and cutting-edge computer vision and machine learning techniques. These algorithms can be used to find related images from an image database, detect and recognize faces, identify objects, categorize human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to create high-resolution images of entire scenes, follow eye movements, remove red eyes from flash-taken photos, identify scenery, and create markers to overlay. This package installation was one of the most significant processes of this design.

Other important packages: The 68 coordinates (x, y) that map the facial locations on a person's face are estimated using the dlib. It is a facial detector for a landmark that makes use of trained models. On the other hand, simple image processing tasks including translation, rotation, resizing, skeletonization, displaying Matplotlib images, sorting contours, and edge detection were carried out using the imutils package, a collection of helpful functions.

Design layout: We have used a monitor for output display purposes and connected it through an hdmi cable with the raspberry pi. The power of the raspberry pi was supplied through a power adapter rating 15.3 W, 5.1 V and 3A. We have used a basic air cooler and smaller heat sink to keep the raspberry pi cool. Besides, we attached the camera Noir V2 with the camera port of raspberry pi. Additionally, we have connected a mouse and keyboard to the USB port of the raspberry pi. Also, a buzzer was connected for alerting purposes to one of the GPIO pins of the raspberry pi microprocessor.

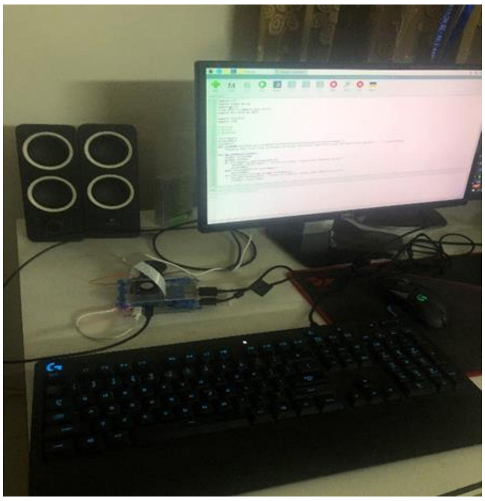


Figure 5.8: *Hardwire design*

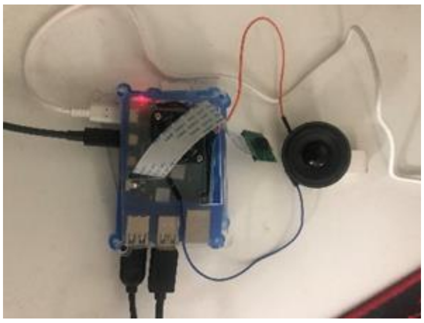


Figure 5.9: *Close up connection with raspberry pi*

We have adjusted the design in such a way that will indicate whether the driver is awake, asleep, or drowsy. We were able to obtain data for various eye locations by using certain calculations to calculate the ratio. We have attempted to average data from several eye positions at various distances and angles in order to establish our output suitably. According to the ratio study, when a person is awake and alert, their eyes are wide open, and as a result, the distance data around each eye are discovered to be maximal or in greater value. On the other hand, when a person is sleepy, it is discovered that the area around their eyes is significantly closer, which causes the distance data around each eye to be smaller than during the active period. Last but not least, when a person is tired, their eyes are closed, which causes the landmarks around each eye to overlap. As a result, in this situation, the distance is minimal or almost nonexistent.

Figure 5.10: *Active stage*

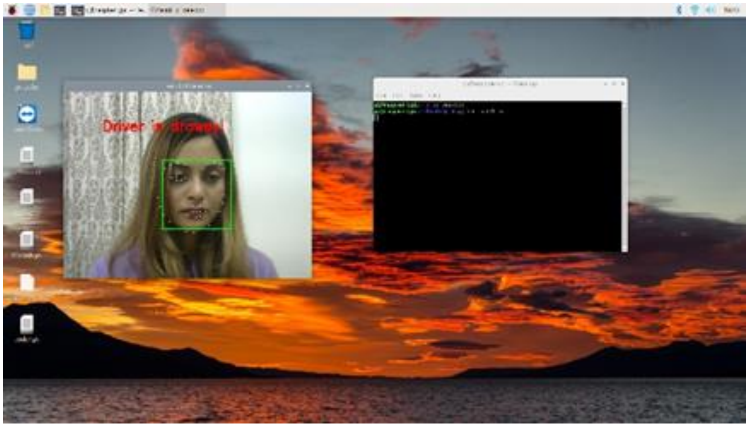


Figure 5.11: *Drowsy stage*

Figure 5.12: *Sleepy stage*

The user interface of our image processing design. This picture illustrates the entire concept of our optimal design connection and processing properly.

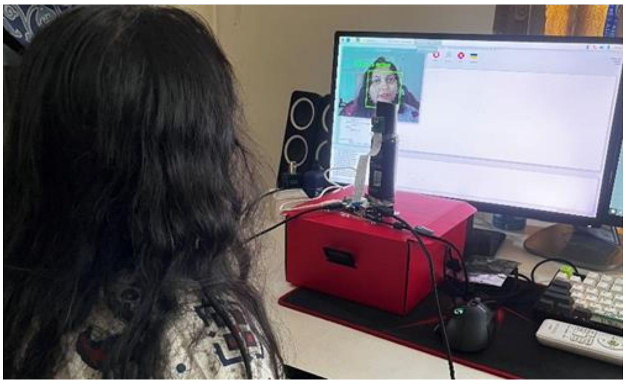


Figure 5.13: *User interface*

Additionally, we have added another implementation in our design at last and that is API connection. An API, or application programming interface, is a piece of code that permits communication between two software components. Recent software programs are being distributed across numerous servers, interacting with back-end tools via standardized interfaces. In order to generate additional money, or what is known as the "API economy," software applications share a portion of their data and business logic through APIs. Every year, the number of APIs increases significantly.

Through this API, we send a warning to the emergency contact person while the driver becomes drowsy or sleepy in order to notify them so that actions can be taken instantly to make the driver alert to become active so that no accident occurs.

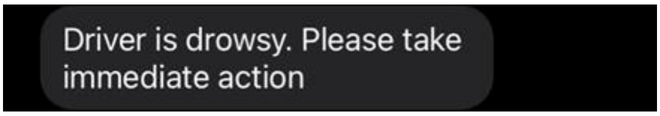


Figure 5.14: *Alerting message when drowsy*

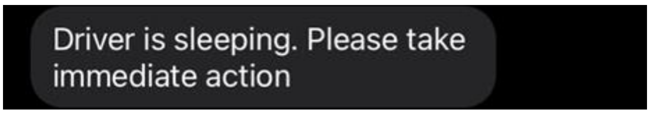


Figure 5.15: *Alerting message when sleepy*

5.3 Evaluate the solution to meet desired need

The main desired need of drowsiness detection are to lessen driver tiredness, assure the safety of the driver while driving, protect passengers and pedestrians from unintended consequences of the driver's negligence, and decrease the frequency of traffic accidents, to implement the project with the least amount of financial expense possible while bringing the idea of new technology innovation in minimizing drowsiness, avoiding environmental damage to the environment and economic loss to assets caused by the accident. If the sleepy drivers are notified in advance, some fatal incidents can be avoided. There are several drowsiness detection techniques that track drivers' levels of tiredness while they are on the road and alert them if they are losing focus. Image processing's function is to identify the driver's face, after which it extracts an image of the driver's eyes to check for signs of fatigue. One of the finest strategies for assisting drivers to alert them to drowsy driving circumstances is real-time drowsy driving detection. A system like this one for detecting the behavioral state of the driver may be able to detect drowsiness in the driver's early conditions and assist prevent misfortune of accidents from happening [39].

Image processing is basically an algorithm system of real time constant capturing of images of humans. In this specific design, we have focused on the trained model called 68 landmark model that captures the entire face structure through 68 points, however our prior focus is eye aspect ratio which has 6 points and slightly on mouth aspect ratio which has 17 points. Therefore, based on the eye and mouth aspect ratio, we are getting our following outputs active, drowsy and sleepy. The camera is constantly capturing the real time interface of the driver's face and giving away outcomes. We have used this model on different people and observed their ratios on every stage. Basically, we have used people for testing purposes and kept distinguishing their 3 stage ratios and took an approximate or most shown result for each stage of every individual. The table and graph shown below explains the scenario of our testing cases. We have tried to set up a threshold in our code for each stage based on the average ratio of the six test subjects. Additionally, we have set up an emergency notification through which the system gets to alert the emergency contact people of the driver. That API and its system makes a connection between two applications and it is used here effectively for neglecting drowsiness of a driver.

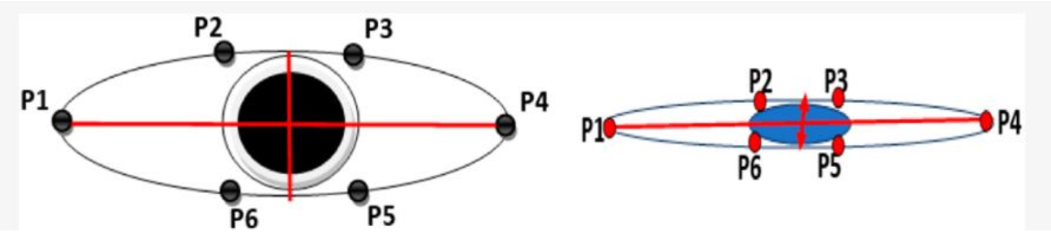


Figure 5.16: *Facial landmarks (P1, P2, P3, P4, P5, P6) of open and closed eyes for EAR algorithm*

Model	EAR for active	EAR for drowsy	EAR for sleepy
1	0.313548	0.216556	0.127827
2	0.362635	0.233354	0.112342
3	0.358856	0.249844	0.135619
4	0.327514	0.226371	0.129723
5	0.349271	0.231674	0.137642
6	0.354172	0.241825	0.124852

Figure 5.17: *Table for EAR test cases*

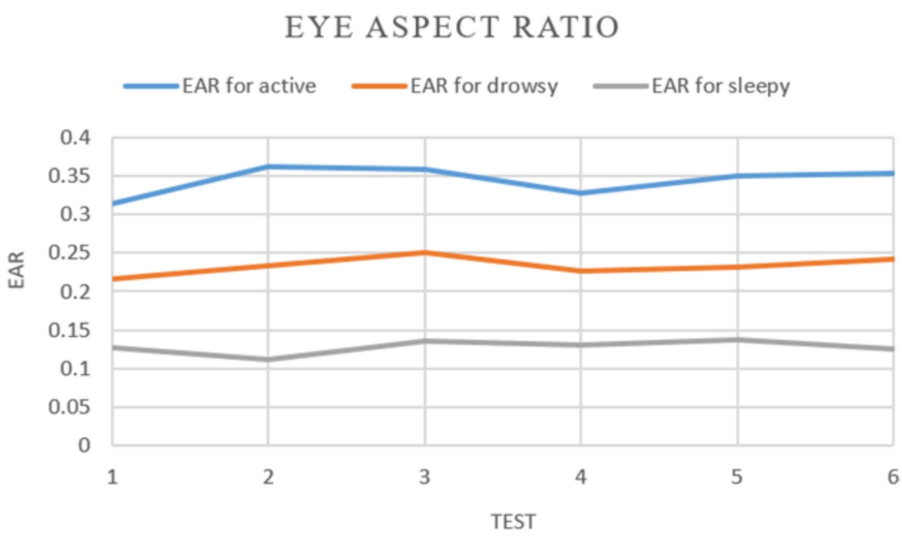


Figure 5.18: *Graph of EAR vs test subject*

From our evaluation on the entire approach, we have tried attempting all possible solutions for a driver concerning drowsiness detection and hence have been able to reduce the occurrence of accidents, and save the passengers, and also ignore the economic damage.

5.4 Conclusion

To sum up, in order to identify a driver's drowsiness and warn them in time to avoid any accidents or financial losses, we have created an implementation in this design that is both cost-efficient and highly effective. Our entire prototype can be put in any kind of vehicle, alerting the driver while avoiding interfering with their regular duties and maintaining high levels of accuracy. Utilizing cutting-edge IT and engineering techniques, we have performed difficult engineering. Our design philosophy is the solution for those drivers who become drowsy and sleepy from long hours of driving and insufficient rest. We completely ran it on a Raspberry Pi, using 68 landmark models to help us identify facial landmarks, and using EAR, we were able to obtain the desired results. Through this design, we could accomplish our purposes, which is to lessen drowsiness, ensure safety, and limit the frequency of accidents in order to save lives.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

Each project has its own set of effects when initially launched, which simultaneously makes it unreliable and strong. It contains an impactful solution to prevent accidents and casualties on the road. After analyzing, we have categorized the impacts into segments such as societal, cultural, safety, and health, legal. These segments are elaborately discussed below. Additionally, the SWOT analysis helps get a better intel of the project. The strength of this project includes most accurate detection of sleepiness and alerting the driver and vehicle passenger. Bulkiness, inconvenient wear, incorrect data processing, and inability to capture the data are the weaknesses we observed in our project. If we compare then our project's strength is much higher than the weaknesses it has as all projects and solutions have some weaknesses within it.

6.2 Assess the impact of solution

Societal, cultural, safety, health and legal, these impacts are reviewed below

- **Societal:** Due to traffic accidents, not only individuals are being impacted rather the entire community suffers as public properties like roads, vehicles are damaged which results in economic damage. In our country, these incidents are quite frequent. Accidents affecting individuals who are playing a vital role in each of their family. Death of such members turns the future of younger members of the family into darkness. This family's future becomes unstable and unreliable due to the road accident. We always see people with disabilities on roads begging for money. They are victims of road accidents and have lost their ability to work as a normal human being. If we successfully implement our project in all public/private transport then we can decrease this incident significantly.

- **Cultural context:** To successfully integrate the usage of microcontrollers and microprocessors in our daily lives to ensure our safety. Microcontrollers capture inputs, process it and generate certain outputs. Usually microcontrollers are financially cheap. But the tasks they perform are incredible. Microcontrollers can perform many tasks within a few moments that may ease our life. They are small in size thus making them compatible for practical usage. On the other hand, microprocessors perform complicated data processing such as machine learning, neural network, image processing etc. This project helps to utilize microcontrollers and microprocessors to solve real world problems like traffic accidents and can get maximum performance from the devices.

- **Safety:** By designing such a device, the security of pedestrians and other passengers inside the vehicles on roads are ensured. The main motive of this project is to ensure safety on the road for both pedestrians and passengers. Road accidents are a nightmare essentially for people who are commuting through the road as there is no assurance.

Accidents are not exclusive to people only but it also damages vehicles. Road accidents damage vehicles severely, which costs us economically. To solve this dangerous problem, we have taken the help of image processing. Nowadays, Image processing is being used in many fields. To make it more powerful, different types of neural networks are being used to train the data. As a result, it provides us with the most accurate results with minimal errors. We have also used built in trained functions to detect drowsiness through the camera. It captures the videos of drivers in the car and processes the image and based on the output it alerts us when the driver is drowsy or sleepy before occurring any accident.

- **Health:** Many traffic accidents that took place which were not fatal but injured the victim badly with severe bodily injury. Drivers who are suffering from insomnia can be treated which would further enhance road safety. We often see people with amputated body parts, most of the time they are the victims of road accidents. They face many challenges in their daily life. By alerting the people in the vehicle these incidents can be reduced. Drowsiness may appear due to less sleep, weakness, mental stress etc. When the system alerts the driver, he/she can take some initial steps such as taking breaks or drinking caffeinated drinks which would re-energize them.

- **Legal:** Most of the accidents are not intentional rather happen due to the lack of sleep and inattentiveness of the driver which makes them a lawbreaker. As our body is trained to sleep at night, drivers especially traveling at night are sleepy during their journey. Most of the traffic accidents happen because of driver's negligence. Our alert system helps the drivers abide by the law. It detects drowsiness immediately and alerts the passengers as well as the vehicle owner by sending a message.

SWOT Analysis:

Table 6.1. SWOT Analysis of the optimal design approach

Strengths ● Prevents accidents ● Does not cause any road damage ● Safer for pedestrians ● Car owners are notified about the whereabouts of drivers wherever they go	**Weakness** ● Camera may get dusty ● Expensive device ● Range of the frames per second is limited ● Inappropriate angle of the camera setup will not detect drowsiness
Opportunity ● Global growth ● Implementation in public transport ● More modern machine learning method can be applied	**Threat** ● Malfunction of the device ● Inaccurate data processing ● Can be overheated

I. Potential Strengths:

Our goal was to reduce the road accident rate in this project. Our system can detect sleepiness regardless of which state the driver is in, whether the driver is wearing glasses or not, whether the driver is operating the vehicle in a dark environment. As a result, this will ensure the safety of drivers at any cost and will prevent any damages being done to the surroundings. Moreover, the pedestrians will be safe on the roads if the drivers are being more alert at all times especially when the drivers are in a vulnerable position. Furthermore, we have used an emergency text messaging system which will notify anyone listed as an emergency contact. This is achieved using an API server and programming our system in a certain way.

II. Tentative weaknesses:

Raspberry pi uses videos as input data and gives output to alert. Camera captures the input data, so it is important to ensure that the camera can take the proper video of the driver. However, there are good chances that the camera might get dirty. So in order to receive proper inputs, the camera needs to be cleaned if not regularly, yet less frequently. Our Raspberry pi module is slightly expensive but comparing it with its functionality and benefits, the high price is somewhat justified. Another weakness is the limited frames per second produced by the camera. So we need to ensure that the device is maintaining a low temperature. Lastly, we need to ensure that the camera is placed at an angle which is able to detect the facial features of the driver.

III. Possible opportunity:

Our project has plenty of opportunities for development. In the case of Bangladesh, public transport drivers do not properly follow the traffic rules and regulations as a result, they are always at a risk of causing accidents.. By implementing our system on all public transportation vehicles, it will reduce the accidents significantly. There could be a possible market for selling drowsiness detection devices since these devices are reducing the number of road accidents, saving the vehicle the driver is operating and the surroundings.

IV. Tentative Threats:

The device needs to be turned on at all times in order to alert the driver in case the driver starts to get drowsy. As a result, the device gets heated, the performance starts deteriorating and this might result in a delay for achieving proper outputs.

6.3 Evaluate the sustainability

The main components of our project is the Raspberry Pi microprocessor. This generally lasts about 5-7 years without any issue. There are different versions of raspberry pi and any version can be used for this project but the more improved and advanced version has been used to obtain this design. In a nutshell, our project is very sustainable in the long run as no maintenance is required for the design approach, little and inexpensive maintenance might be required depending on the condition and quality of the components for long duration usage.

1. Environmental Sustainability: Our project is environmentally sustainable because it does not emit any harmful gases into the atmosphere. As a result, no damage is being done to the environment.

2. Economical Sustainability: Driver Drowsiness is a common issue especially for those who have to drive for long hours. It will not only save lives of the driver or pedestrians which is priceless but also it will save further damages to the vehicle or the roads in which the vehicle is being operated. Even though the initial cost of the project is high over time the cost becomes bearable since the longevity of raspberry pi is about 7 to 10 years as well as it requires little to no maintenance. The government can mandate the usage of such devices for accident prevention as a result economically it will be both beneficial for the people and the government.

3. Social Sustainability: Introducing and mandating the usage of this technology will lead to a lot of companies trying and inventing an improved version of our project as a result, more specialized companies will be interested in building accident prevention devices. This will generate more employment in the job sector.

6.4 Conclusion

By preventing drowsiness of the drivers, mortality rate in road accidents can be reduced. Implementing this device in cars, pedestrians and other vehicles on the road would have security by avoiding any unfortunate situation. Our project has various impacts including health, societal, legal and safety. If we analyze the impacts and SWOT analysis then mostly the impacts are positive compared to the disadvantages.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

Management is important to accomplish any task. Any engineering project requires team effort, planning, team management and maintaining timelines to be successful. Project failure is inevitable in the absence of a sound plan, effective management, and team orientation. It takes more than one person to complete the process of turning an idea into a proposal and then into an actual prototype. It always takes a lot of minds working together to accomplish something that seems unattainable at first. This engineering endeavor also involved a team. As a result, we organized the duties that were allotted to each member of our group and showed them in a Gantt chart. The project was completed on time and according to this schedule. However, we did help each other out when we needed to in order to make each and every step as successful as possible. During a project, there are several things that need to be considered. Projects have many steps to complete including selecting topics, literature review, various approaches of solution, using the latest technology, impacts, weaknesses, forthcomingness etc. To successfully implement the project we arranged assigned tasks and a Gantt chart which describes the dates, duration, and task name with the involved member. This Gantt chart helped us a lot to successfully finish the project as we stuck to the routine and helped each other to do our best.

7.2 Define, plan and manage engineering project

In the table below, we have displayed the tentative project plan of our final year design project:

Table 7.1. Tentative project plan of final year design project for the year 2022

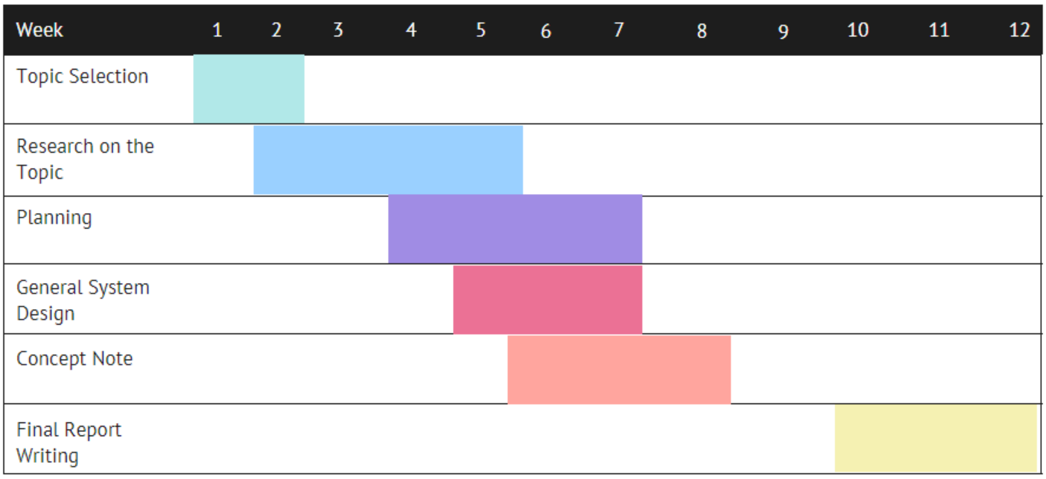
Tentative Project Plan			
EEE 400P			
Task	Start Date	End Date	Duration (Days)
Problem Identification	10/02/2022	15/02/2022	5
Topic Review and Finalization	16/02/2022	23/02/2022	7
Concept Note Preparation	24/02/2022	30/03/2022	36
Project Proposal Report	1/04/2022	20/04/2022	20
EEE 400D			

Task	Start Date	End Date	Duration (Days)
Simulation of Blink Sensor Circuit	02/06/2022	20/06/2022	19
Simulation of Heart Beat Sensor Circuit	21/06/2022	29/06/2022	9
Simulation of Raspberry Pi Model (Image Processing)	21/06/2022	21/08/2022	62
Analysis of Data	22/08/2022	30/08/2022	9
Final Adjustments	1/09/2022	11/09/2022	11
EEE 400C			
Task	Start Date	End Date	Duration (Days)
Selecting and Testing Components	1/10/2022	7/10/2022	7
Designing Sub Systems	8/10/2022	15/10/2022	8
Testing the system to match with Outcome	16/10/2022	25/10/2022	10
Joining Sub Systems	26/10/2022	05/11/2022	10
Simulation Demonstration Preparation	06/11/2022	12/11/2022	7
Project Final Report	12/11/2022	13/12/2022	32

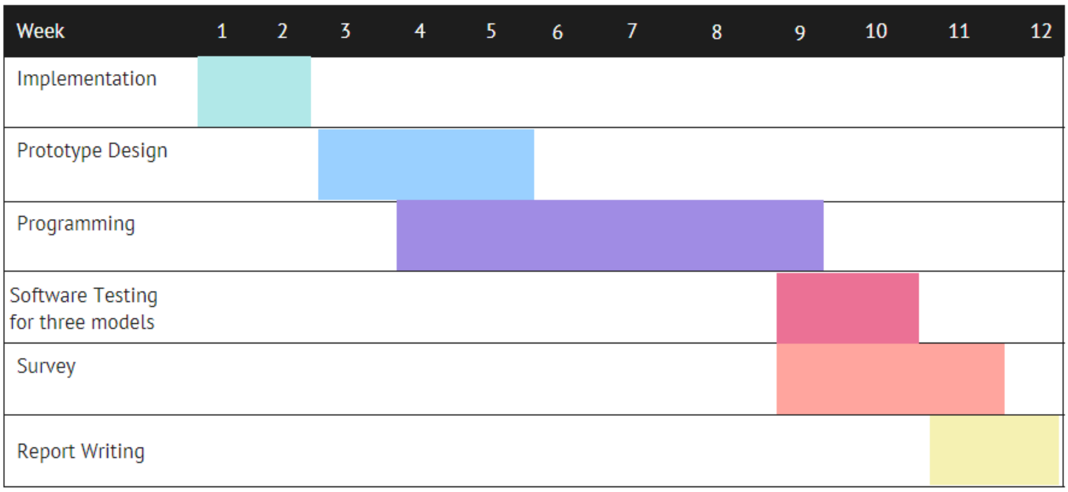
Gantt chart:

Table 7.2. Gantt chart followed throughout the final year design project semesters

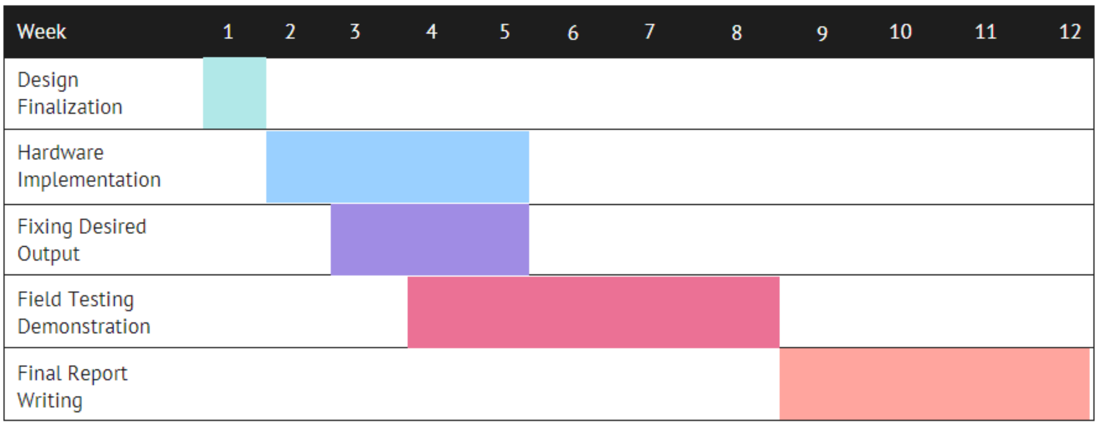
EEE 400P



EEE 400D



EEE 400C



7.3 Evaluate project progress

After observing the tentative project plan and actual workflow, a brief comparison is given below

Table 7.3. Tentative project plan of final year design project for the year 2022

Duration	Tentative Plan	Actual Progress	Progress Status	Comment
1/10/2022 - 7/10/2022	Confirming optimal design and plan the workflow	1. Optimal design confirmed and workflow distributed	Completed	N/A
	Assembling and testing components	Raspberry Pi, monitor, camera, buzzer assembled	Completed	N/A
8/10/2022 - 15/10/2022	Designing Sub System	Adding API System	Partially Completed	Done with code but not with hardware implementation
16/10/2022 - 25/10/2022	Testing the system to match with outcome	Our sub system was able to synchronize with the main code and it was sending the notification	completed	N/A
26/10/2022 - 5/11/2022	Joining sub system	Joining the API system with main hardware was done	Completed	N/A
6/11/2022 - 12/11/2022	Simulation Demonstration Preparation	There was slight delay with our simulation	Completed	Was able to minimize the delay
11/11/2022 - 20/12/2022	Project Final Report	Draft submitted to ATC Panel on 15th December. Actual paper submitted to respective ATC on 20th December.	Completed	N/A

7.4 Conclusion

The tasks and names of the allocated people for each task were first included in a timeline chart. This was discussed, accepted by all members, and then distributed. Following the timeline chart, the tasks stated in 400P were completed without difficulty. As a result, 400D performed the same process, and the Gantt chart was given to all of the members. Everything proceeded methodically and smoothly as intended when it was followed. In order to obtain findings that are as satisfactory at 400C, we are currently repeating the identical scenario.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

A project is economically feasible when both the stakeholder and the customer are in agreement as investing in a loss project is financially and economically risky. Projects that are usually adopted globally are financially lucrative. The implementation cost is necessary to extrapolate as it gives us a better idea over how profitable the design will be over the period. Further analysis will give us a better picture and possible profitability of the project and how beneficial it will be for the stakeholders. Our approach to some degree has a high investment since Raspberry pi is somewhat expensive. In Bangladesh, there is hardly any safety measure that would prevent or counter drowsiness hence executing this design will give us a higher notch and the project more appealing to both the stakeholders as well as the customers.

8.2 Economic analysis

Road accidents are fairly common in Bangladesh and road accidents due to drowsy driving are increasing even more every day. As every day progresses, it is almost becoming mandatory to implement safety measures to keep the driver awake as it not only is going to save the driver but the vehicle passengers and pedestrians as well. Although the price of our project on drowsiness detection is nothing compared to the price of our lives yet people may have a point regarding the price of this drowsiness detection system due to its high cost. In retrospective of the road accidents happening in Bangladesh, the overall costing of this drowsiness detection should be subsidized by the government. In doing so, people will be encouraged to have drowsiness detection systems in their vehicles. For example, the government could subsidize the drowsiness detection system for the first few months after it gets launched onto the Bangladeshi market and soon after that it could be mandated to use it in the car as it ensures the safety of the people inside and outside of the car. In doing so, people will not only be encouraged to have a drowsiness detection system set up in their vehicles but also they will be economically benefited as the government is subsidizing the product.

8.3 Cost benefit analysis

The prices mentioned in the table below are the current market prices of each major component of our drowsiness detection system.

Table 8.1. Cost analysis of the main components of our drowsiness detection system

Component	**Price in BDT**
Raspberry Pi 4 (8 GB)	24,500
Power Adapter	1450
Raspberry Pi Camera Module V2	880
Casing	600
Cooling Fan	150
Heat Sinks	70
Memory Card (64 GB)	1250
Piezo Buzzer	40
Wires	5
API Texting Service	65
Total Project Cost	**29,010**

Due to shortage of chip production globally, the price of raspberry pi boards have increased over the last few years. The above prices are subjected to price changes in the future. However, it is a onetime investment as raspberry pi does not need to be replaced for years. The other components such as cooling fan, heat sinks, and buzzer are fairly inexpensive in comparison to the raspberry pi, so those can be replaced without any hassle whenever required. In addition to the reliability of the raspberry pi board, if the government decides to subsidize the drowsiness detection system initially, then the user has to bear the minimum costing of the drowsiness detection system, making it a lucrative and a viable option. Our project focuses on the safety of the driver which should not be compromised despite the slight price increase of the raspberry pi boards.

8.4 Evaluate economic and financial aspects

There are multiple versions of raspberry pi boards such as 2GB, 4GB and 8GB versions. We have used the 8GB version for building our drowsiness detection system. The 2GB and 4GB versions are relatively cheaper than the 8GB version but to get the best system, we had to use the 8GB version as a result price has increased slightly. We have also used the original power adapter rather than cheaper versions because the original raspberry pi power adapter gives us the true voltage value which is required for the raspberry pi to run properly. However, we have used the raspberry pi v2 camera module which is inexpensive but for better picture quality and image compression, we can replace the camera with raspberry pi v2 NoIR camera. That would increase the costing by a margin of 4000 BDT but it will ensure better safety as this raspberry pi v2 NoIR camera is better for detecting the face of the driver at very low lights or in a dark environment. Overall, we have tried to keep the costing minimal without hampering the quality and performance of the drowsiness detection system.

8.5 Conclusion

In short, we can conclude that our drowsiness detection system is not the cheapest as well as not the most expensive project. With the help of the government and the car companies, people can easily afford our drowsiness detection system. We have designed the drowsiness detection system in such a way that people get the value for money without spending too much and without compromising their safety.

Chapter 9: Ethics and Professional Responsibilities [CO13, CO2]

9.1 Introduction

Ethics usually refers to the terminologies that include integrity, equity, obligation and attentiveness. In project management ethics we prioritize the previous terms and it is critical to ensure that the decision-making process is honorable and that decisions are made with the best interests of all parties in mind, rather than the individual, during the creation of a project. Sharing information as a professional with the stakeholders as well as an individual customer will help us avoid potential conflict in the future. By keeping all these in mind, we tried to formulate a design where ethics and professional requirement. Furthermore, we conducted and obtained research from various sources which has a proper citation. Finally the main thing is that we never missed out in giving credibility to the resources we utilized in order to achieve an honest outcome for our project.

9.2 Identify ethical issues and professional responsibility

In our project, the microprocessor is the most expensive component, in order to reduce the overall cost which is common practice. As one of our targeted audience is not well educated therefore scamming them by giving them cheap products would be unethical. Furthermore, as the common people in Bangladesh are not that well educated as well as the technology that is being used in our project is fairly new, so before promoting our design to consumers we will have to give clear ideas and knowledge about the product. To advertise about the design, among the audience requires teamwork to complete tasks like carrying out tutorial sessions to inform people about our electronic device and as well as promoting it to encourage people to purchase the product. In order to avoid miscommunication and the group to become successful it is important to share responsibilities in addition to putting efforts in individual assignments that can help minimize negligence. The main method of our is based on the detection of the face which is considered as an invasion of privacy if consent is not taken. Hence consent form should be provided to the drivers stating all the clauses. Subsequently, as we are working with sensitive information like personal data of individuals, it is very important that we have a strong cyber security in case of a breach in our system. This will give our consumers reassurance about our product. It is important to treat all the customers equally regardless of the quantity of products they bought. Discriminating among the high-scale and low-scale consumer is unethical. For example, in the case of a bus company purchasing the product in bulk and at the same time an individual buying one or two of the same electronics, it would be unethical to disregard and not prioritize the individual's order. This can be considered as negative marketing and might impact the image of the company. Therefore it is necessary to fairly treat our customers. This might lead to customers losing their faith in the company and its policies. So handling this type of situation is very critical and therefore requires professionals to be hired. Promoting the product in an ethical way without making false claims is necessary. This is a fairly known scheme which can help getting a reach but only for a short period of time. Therefore having a loyal customer from the beginning to help the product get better recognition.

9.3 Apply ethical issues and professional responsibility

Even though our project is fairly safe and does not require much maintenance, electronics products should be monitored frequently in case of malfunction. Since our project is based on a safety measure that is why we need to make sure that the system functions as close to real as possible. The following list shows the ethical way we tried to eliminate the issues:

A. Even though the microprocessor that is the raspberry pi has longevity of about 7 to 10 years but components like camera, buzzer which are comparatively has possibility of malfunction therefore it is important to suggest customers to check the device regularly especially before commuting at night or at longer journey.

B. Since we are taking personal information of the driver, it is therefore our duty to take the consent of the driver. That is why we conducted an initial survey of where we talked to 44 drivers. We clearly explained the project to them and asked them for their opinion. The result of the survey is given below:

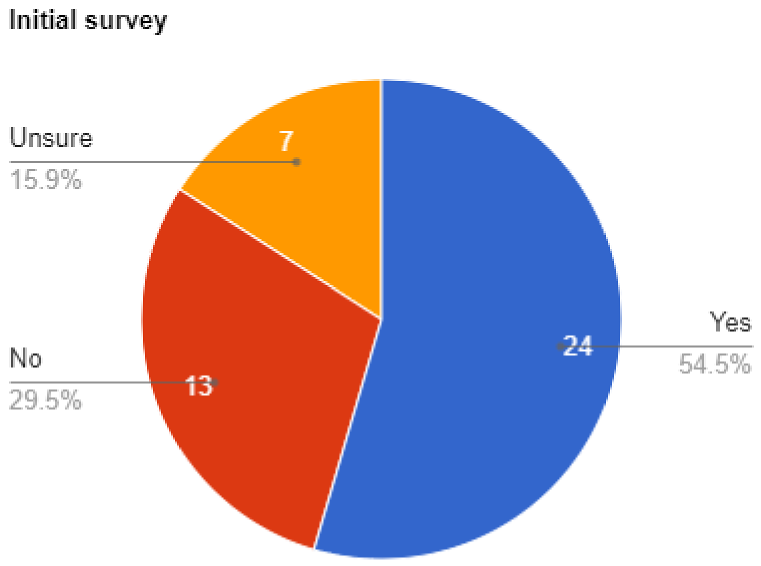


Figure: 9.1 Initial survey pie chart

C. Being honest regarding the product is essential since the product is based on a safety measure and people's life is at stake. Making sure the API system is functioning and the customers are getting alerted in case of an unexpected situation. Failure to alert the consumer on time might lead to a catastrophic situation.

D. During the tutorial regarding the electronics it is our duty to discuss the pros and cons about the product. Hiding the details about the product or making claims that are not true would be unprofessional as well as unethical. This would create miscommunication between the consumer and the provider.

E. If possible, taking possible certification from government officials will make the product more reliable to the people. To avail the certification it is important to show true data and conduct intensive research to back our claims of the product. Falsifying the data will only hinder the product.

If all the above points are followed the project will be overall more ethical and morally appropriate. This will make the clients satisfied and rely on us more. Responsibilities can be shared among a team of people so that one person is not burdened with all the work which might not give desired results. In order to achieve success, professionalism must be demonstrated at every stage of the process. This include hiring experts who have studied in this sector are important

9.4 Conclusion

In the case of any project, the truth of it is expected. Especially about the results and the parameters that are being considered. Any project's most important component is delegating tasks to team members and cooperating with them to produce good outcomes. However, we had to remember to adhere to ethical principles while working. There were no unethical actions, such as fabricating data and failing to properly cite the study that we used. To ensure the authenticity of our work, this was done with great care. To avoid such cases plagiarism is being checked using various online tools.

Chapter 10: Conclusion and Future Work.

10.1 Project summary/Conclusion

Bangladesh is a developing nation, hence daily technology use is extremely uncommon. It would be difficult to include such a highly sophisticated design and make it work in the local culture. The majority of those who commute a significant distance are either untrained truck drivers or bus drivers. This problem might be solved by making them aware of and informed about the advantages. Financial losses caused by road incidents and inconvenience that it caused can overall be avoided by this device.

Multiple approaches to this problem were taken under consideration. This includes approaches with sensor based designs. Firstly in our approach one which is drowsiness detection using a heartbeat sensor, which monitors the pulse rate. The algorithm was designed in such a way that it would alert the driver if the pulse rate is below the threshold indicating the drowsy state. One of the main drawbacks of this approach, was its inability to differentiate deviation in individuals with lower blood pressure as well as the device having to be worn which is an inconvenience for users.

The second approach uses an eye blink sensor to detect drowsiness. The design is based on the algorithm which supervises the blink rate of the driver. In drowsy state the blink rate would reduce as an individual’s eye gets heavy. If blink rate is below the threshold indicating infrequent blinking meaning drowsy state. The constraint of this design was that the device was bulky and its potential risk of damaging the eye of the user. The feasibility of both these approaches is slim since to detect heartbeat the driver needs to have a firm grip similarly to detect eye-blink the driver needs to wear the goggles.

Therefore, analyzing all the approaches we concluded that approach three is the most optimal. Drowsiness detection using Image processing uses the algorithm, 68 landmarks which detects facial features like eyes and the mouth of the driver. Parameters like eye aspect ratio and mouth aspect ratio determine the state of the driver. Even though this is much more expensive than other approaches it has major advantages which includes how compact the device is and can be placed on the dashboard as well as it being able to detect in low light.

The prototype was designed to generate the desired output. Data were taken in different conditions. To overcome the input out lag and get a better fps compatible camera was used along with changes in the code were made. This would help us get results as close to real time as possible. The overall cooling system includes thermal cooling paste, cooling fans were added to protect the device and maximize the usage. Furthermore, other than detecting and alerting the driver using a buzzer the API system alerts the user’s close ones, taking it a step further.

This system would prevent accidents but would not eliminate it completely since negligence is another factor of it. As the world is getting busier so are the people therefore compromising proper sleep is far more common than we realize. So a technology should be used to detect the early symptoms of it.

10.2 Future work

The best feature of working with technological projects is that it always evolves and advances over time. The goal is to update our project in accordance with the most recent technological advancements so that it expands our market reach. Some of the improvements that we can introduce to the design is listed below:

- One of the ways of improving the project is by adding better features to the existing design rather than incorporating higher technology. For example in our project we only added a text message alerting system using API system to modify it we can use the GSM module with GPS module. This would not only fulfill the purpose of alerting the driver using texting it would send the location of the driver. In a rather unfortunate situation, the emergency contact can inform the authorities with the driver's location.
- Instead of following and designing the product using one single approach we can combine one or two different systems of drowsiness which would reduce the chance of error or any malfunction of the device. For example physiological methods using Electroencephalography (EEG), electrocardiography (ECG), and electrooculography (EOG) have been shown to have the highest accuracy in detecting drowsiness since they do not depend on external factors like the state of the road or the amount of lighting. So incorporating this method with the shown proposal will overall give the optimal result.
- As technology is ever evolving, therefore in the future there will be better processors and better camera modules with better frame rate compression. Using the latest technology will help us reduce the delay and the detection will be as close to the real time as possible.

Chapter 11: Identification of Complex Engineering Problems and Activities.

The discussed proposal included a few complicated engineering operations and was issued in a number of areas, including competing resources and analyses, innovation, codes and regulations, and others, of which a few have been identified and characterized with in-depth explanation in the proceeding:

11.1: Identify the attribute of complex engineering problem (EP)
Attributes of Complex Engineering Problems (EP)

Table 11.1. Selection of attributes of complex engineering problem with reference to our project proposal

	Attributes	**Put tick (√) as appropriate**
P1	Depth of knowledge required	√
P2	Range of conflicting requirements	
P3	Depth of analysis required	√
P4	Familiarity of issues	√
P5	Extent of applicable codes	√
P6	Extent of stakeholder involvement and needs	√
P7	Interdependence	

Note: Project must have P1, and some or all from P2-P7

11.2: Provide reasoning how the project address selected attribute (EP)

P1. Depth of knowledge required:

The proposed project requires in-depth knowledge and proficiency in numerous complicated engineering fields. Our design requires a microprocessor like Raspberry pi so it is important to have a clear grasp about it as well as a detailed understanding of python. We also need basic ideas about machine learning, since image processing is used. This mostly involves the prediction and detection of the objects.

P3. Depth of analysis data:

In image processing we are working the ratio of the eye which is known as the eye aspect ratio, there has to be a universal parameter which will work for everyone. Therefore, data is taken from multiple people from which we took the average value for all of the states mentioned in our project. Time is also an important factor which has to be selected very carefully taking multiple scenarios under consideration.

P4. Familiarity issues:

As Bangladesh is a developing country, there is not an abundance of products that are manufactured in the country and most of it has to be imported. There is a global crisis in the chip industry. All these reasons are responsible for the rising price of the microprocessor as well as the pandemic during which importing products were hard.

P5.Extend of practical codes:

For the practical use of this design there are certain requirements, standards and laws that are followed globally set by IEEE and other international organizations like IEC,ISO. Failure to follow these standards will create problems to avail certification. So while implementing the design it is best to monitor it so that none of the applicable codes are missed or ignored.

P6.Extend of stakeholder involvement needs:

Since our project is based on car safety, related companies like car insurance companies, online taxi service like Uber and Pathao can be affiliated with this product. So that they can provide better service to their customers. But there is no direct stakeholder who is investing in the product.

11.3: Identify the attribute of complex engineering activities (EA)

Attributes of Complex Engineering Activities (EA)

Table 11.2. Selection of attributes of complex engineering activities with reference to our project proposal

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	√
A2	Level of interaction	√
A3	Innovation	
A4	Consequences for society and the environment	√
A5	Familiarity	√

Note: Project must have some or all of the characteristics from attributes A1 to A5

11.4: Provide reasoning how the project address selected attribute (EA)

A1.Range of resource:

For the proposed project, there are several papers that are available for thorough knowledge for the hardware implementation. We used the pre-trained model known as 68 landmarks which has prior data of facial features including the eyes and the mouth. For our design we need to install libraries like OpenCV, Numpy and Dilb which are available on the internet with instructions. To build the prototype, components like raspberry pi, buzzer and cameras are widely available on the market.

A2.Level of interaction:

In order to enhance the project, hardware creation, and information assimilation, the project has demanded significant social engagement on a large scale. The initial survey that we conducted among drivers required us to talk to drivers and take their opinion and views under consideration. Talking to potential stakeholders and conducting tutorials for the consumers required interaction on a broader spectrum.

A4.Consequences for society and the environment:

Since this safety measure is not only saving lives of individuals, it is also potentially saving the society from financial loss that include destruction of the roads and pavements. This is rather a positive consequence which is beneficial for the environment due to its lack of emission of greenhouse gases.

A5.Familiarity:

Even though this project is being done by few individuals but not executed well on a large scale. Inclusion of a text message alerting system with the help of API system is fairly unknown for this project. Despite this, the residents are ignorant of the systems, their features, and the advantages they offer, which validates the motive behind our project.

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Appendix

Related codes:

Code for OpenCV to detect camera:

```
import cv2
frameWidth = 640
frameHeight = 480
cap = cv2.VideoCapture(0)
cap.set(3, frameWidth)
cap.set(4, frameHeight)
while True:
  sucess, img = cap.read()
  cv2.imshow("Result", img)
  if cv2.waitKey(1) & 0xFF == ord('q'):
      break
```

Main code of the drowsiness detection system:

```
import cv2
import numpy as np
import dlib
from imutils import face_utils
import RPi.GPIO as GPIO

import requests
import time
'''
O-Active
1-Drowsy
2-Sleeping
'''
statusNum=0
drowsySMS=0
lastSms=0
def sendSMS(num,text,api='87681337361670657856 3d3d0593f8d4b6cf0f2a85b3e3996bef'):

requests.get('http://api.greenweb.com.bd/api.php?token='+api+'&to='+num+'&message='+tex
t.replace(" ", "+"),verify=False)

def decideNotification():
   global drowsySMS
   global lastSms
   if statusNum==1 and drowsySMS==0:
```

```
        sendSMS("01731970548,01710854159,01721168151", "Driver is drowsy. Please take
immediate action")
        drowsySMS=1
    elif statusNum==0 or statusNum==2:
        drowsySMS=0
    if time.time()-lastSms>60 and statusNum==2:
        sendSMS("01731970548,01710854159,01721168151","Driver is sleeping. Please take
immediate action")
        lastSms = time.time()

BuzzerPin = 5

GPIO.setwarnings(False)
GPIO.setmode(GPIO.BCM)
GPIO.setup(BuzzerPin, GPIO.OUT, initial=GPIO.LOW)



cap = cv2.VideoCapture(0)


#Initializing the face detector and landmark detector

detector = dlib.get_frontal_face_detector()

predictor =
dlib.shape_predictor("/home/pi/Desktop/shape_predictor_68_face_landmarks.dat")


#status marking for current state

sleep = 0
drowsy = 0
active = 0
status=""
color=(0,0,0)

def compute(ptA,ptB):
    dist = np.linalg.norm(ptA - ptB)
    return dist

def blinked(a,b,c,d,e,f):
    up = compute(b,d) + compute(c,e)
    down = compute(a,f)
```

```
    ratio = up/(2.0*down)
    #print(ratio)
    if(ratio>0.29):
        return 2
    elif(ratio>0.17 and ratio<=0.29):
        return 1
    else:
        return 0



while True:
    _, frame = cap.read()
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces = detector(gray)
    face_frame=frame

    #detected face in faces array

    for face in faces:
        x1 = face.left()
        y1 = face.top()
        x2 = face.right()
        y2 = face.bottom()
        face_frame = frame.copy()

        cv2.rectangle(face_frame, (x1, y1), (x2, y2), (0, 255, 0), 2)
        landmarks = predictor(gray, face)
        landmarks = face_utils.shape_to_np(landmarks)
        left_blink = blinked(landmarks[36],landmarks[37],landmarks[38], landmarks[41],
landmarks[40], landmarks[39])

        right_blink = blinked(landmarks[42],landmarks[43],landmarks[44], landmarks[47],
landmarks[46], landmarks[45])



        #Now judge what to do for the eye blinks


        if(left_blink==0 or right_blink==0):
            sleep+=1
            drowsy=0
            active=0
```

```
            if(sleep>3):
                statusNum= 2
                status="Driver is sleeping!!!"
                GPIO.output(BuzzerPin,GPIO.HIGH)
                color = (255,0,0)
        elif(left_blink==1 or right_blink==1):
            sleep=0
            active=0
            drowsy+=1
            if(drowsy>4):
                statusNum= 1
                status="Driver is drowsy!"
                color = (0,0,255)

                GPIO.output(BuzzerPin,GPIO.HIGH)
                time.sleep(1)
                GPIO.output(BuzzerPin,GPIO.LOW)
        else:
            drowsy=0
            sleep=0
            active+=1
            if(active>3):
                statusNum = 0
                status="Driver is active"
                GPIO.output(BuzzerPin,GPIO.LOW)
                color = (0,255,0)
        decideNotification()

        cv2.putText(face_frame, status, (100,100), cv2.FONT_HERSHEY_SIMPLEX, 1.2,
color,3)


        for n in range(0, 68):
            (x,y) = landmarks[n]
            cv2.circle(face_frame, (x, y), 1, (255, 255, 255), -1)
    #cv2.imshow("Frame", frame)
    cv2.imshow("Result of detector",face_frame)
    key = cv2.waitKey(1)
    if key == 27:
        break
```

FYDP Fall 2022 Summary of Team Log Book/Journal

	Final Year Design Project (C) Fall 2022		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	SHEIKH FAIYADH ZILLUR (19321005)	sheikh.faiyadh.zillur@g.bracu.ac.bd	01689224847
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ATC Details:			
ATC 6			
Chair	Dr. A.S. Nazmul Huda	nazmul.huda@bracu.ac.bd	
Member 1	Nahid Hossain Taz	nahid.hossain@bracu.ac.bd	
Member 2	Raihana Shams Islam Antara	raihanashams.antara@bracu.ac.bd	01742414402

General Notes:

1. In addition to detail journal/logbook fill out the summary/key steps and progress of your work
2. Reflect planning assignments, who has what responsibilities.
3. The logbook should contain all activities performed by the team members (Individual and team activities).

FYDP (C) Fall 2022 Summary of Team Log Book/Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
29/09/2022	1.Faiyadh 2.Faiza 3.Srejoni 4.Atoshe	Task1: Meeting with Dr. Nazmul sir to confirm the optimal design of our project	1.Faiyadh 2.Faiza 3.Srejoni 4.Atoshe	N/A as it was an introductory meeting.with Dr. Nazmul Sir
				Task 1: Completed. .
30/09/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Choosing and buying components for the optimal design	1. Faiyadh	No meeting with ATC Task1: Partial
05/10/2022	1. Srejoni	Task 1: Learning coding for the optimal design	1. Srejoni	No meeting with ATC Task1: Partial
06/10/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Meeting with Antara madam to discuss further improvements on the optimal design	1.Faiyadh 2. Faiza 3. Srejoni 4. Atoshe	Suggestions noted by us Task1: Partial
07/10/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Learning coding for the optimal design	1. Srejoni	No meeting with ATC Task1: Partial
08/10/2022	1.Faiyadh 2.Srejoni	Task 1: Learning coding for the optimal design	1. Srejoni 2. Faiyadh	No meeting with ATC Task1: Partial
09/10/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Buying the additional hardware parts to improve the optimal solutions	1.Faiyadh 2. Faiza 3. Srejoni 4. Atoshe	No meeting with ATC Task1: Completed
12/10/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Learning coding for the optimal design	1. Srejoni 2. Faiyadh	No meeting with ATC Task1: Partial
13/06/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Providing updates to Dr. Nazmul sir	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task was approved by Dr. Nazmul Sir Task1: Completed
19/10/2022	1. Faiyadh 2. Srejoni	Task 1: Hardware setup Task 2: Programming	1. Faiyadh 2. Srejoni	No meeting with ATC Task1: Complete Task 2: Partial
20/10/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Providing feedback to Antara madam regarding the final hardware tools and programming	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task was approved by Antara madam Task1: Complete
29/10/2022	1. Srejoni	Task 1: Debugging the code	Task 1: Srejoni	No meeting with ATC

				Task1: Completed
4/11/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Optimizing the code Task 2: Fixing the input/output lag	Task 1: Faiyadh,Atoshe Task 2: Faiyadh	No meeting with ATC Task1: Completed
22/011/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Progress Presentation given to in front of all ATC members	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC Task1: Completed
25/11/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Consultation with Antara madam to discuss screen tearing issues	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Suggestions given by Antara madam Task 1: Completed
26/11/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Primary survey on drivers for ethical consideration.	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC Task 1: Completed
01/12/2022	1.Faiyadh	Task 1: Fixing screen tearing issue	1.Faiyadh	No meeting with ATC Task1: Partial
03/12/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Second day of primary survey on drivers for ethical consideration.	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC Task1: Completed
04/12/2022	1.Faiyadh 2.Srejoni	Task 1: Hardware improvement, applying thermal paste, different heat sinks	1. Faiyadh 2.Srejoni	No meeting with ATC Task1: Completed
05/12/2022	1.Faiyadh 2.Atoshe	Task 1: Further surveying and ethical considerations with different vehicle drivers	1. Faiyadh 2.Atoshe	No meeting with ATC Task1: Completed
08/12/2022	1. Srejoni 2. Faiyadh	Task 1: Validating the outputs and checking with different parameters and conditions such as facial detection in the dark, facial detection using spectacles, facing detection at different angles and distances Task 2: Providing final updates to Dr. Nazmul Sir	Task 1: Srejoni, Faiyadh Task 2: Faiyadh, Atoshe, Srejoni Faiza	Updates accepted by Dr. Nazmul Sir Task1: Completed Task 2: Completed
09/12/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Finalizing hardware setup and codes for the system	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC Task1: Completed
11/12/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Slide Preparation and Report Writing	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC Task1: Completed

15/12/2022	1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	Task 1: Final Presentation given in front of all ATC members. Task 2: Draft Report Submission	Task 1&Task 2 1.Faiyadh 2.Atoshe 3.Srejoni 4.Faiza	No meeting with ATC but noted any suggestions given by ATC Panel Task1: Completed
19/12/2022	1.Faiyadh 2.Faiza 3.Srejoni 4.Atoshe	Task 1: Report writing completion and submission	1.Faiyadh 2.Faiza 3.Srejoni 4.Atoshe	No meeting with ATC Task1: Completed