SOFTWARE REQUIREMENT SPECIFICATION DOCUMENT (SRS)

OVERSEE – An AI based Driver State Monitoring System

GOLF – SECTION A

GROUP MEMBERS:

TASNIA IQBAL: 201814030

TASNEEM MUBASHSHIRA: 201814054

IFATH ARA: 201814060

FARIHA AMIN: 201814061

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1. Introduction

In recent years, driver inattention or distraction is one of the major causes for road accidents. The inattention and anger detection system should be designed in such a way that it triggers the alert system only when the driver is distracted beyond the acceptable limit. Every year, In Bangladesh, many car accidents due to driver fatigue and distraction occur around the world and cause many casualties and injuries. It occurs in Bangladesh primarily owing to the reckless driving of the drivers. **Driver State Monitoring System (DSMS)** is one of the main approaches for driver fatigue or distraction detection and accident prevention. Driver face monitoring systems capture the images from driver face and extract the symptoms of fatigue and distraction from eyes, mouth and head. The system estimates driver alertness based on extracted symptoms and alarms if needed.

1.1 Purpose:

Improvement of public safety and the reduction of accidents is one of the important goals of the intelligent transportation systems (ITS). One of the most important factors in accidents, especially on rural roads, is the driver fatigue and monotony. Fatigue reduces driver perception and decision-making capability to control the car. Research shows that usually after 2-3 hours of continuous driving, driver is fatigued and steering performance deteriorated. In the early afternoon hours, after eating lunch and at midnight, driver drowsiness is much more than other times.

Monotony of a certain task can reduce the concentration of person and may cause distraction. Monotony is caused by three main reasons:

(1) lack of personal interest

(2) doing a repetitive task for long time

(3) external factors (like talking with mobile phone)

Monotony in driving usually is caused by the second and third reasons. Prolonged driving on highways with flowing traffic has a negative effect on driver concentration. In this case, driver is not fatigued, but due to the monotony of driving, his/her concentration will gradually be decreased and the driver will not have a

careful control on the vehicle. Driver distraction can also be caused by talking to people or mobile phone.

Due to the importance of early detection of driver fatigue and drowsiness to avoid accidents, many researches and projects were done on this subject in the past decade. The researches on the methods for driver distraction detection are also being done, but are less developed than the methods of driver fatigue detection. Although, researches are being done, In Bangladesh, this system is not developed at all. Some projects are being done but they don't include all the necessary features.

Our purpose is to implement the ideas and researches being done over years on driver fatigue and distraction in Bangladesh and making a feasible and accurate detection system which will be easily usable and affordable.

1.2 Product Scope:

There is a relation between the fatigue/drowsiness and body temperature, electrical skin resistance, eye movement, breathing rate, heart rate and brain activity. However, the best tool for measuring fatigue and drowsiness is brain activity monitoring, but in this approach, brain signals must be received from the electrodes that connected to the driver head which make it as an intrusive approach.

Another approach is based on steering motion. But the detection speed in this approach is slow. Distraction and fatigue are something that should be detected as fast as possible. So, this approach is also improper.

After monitoring of brain activity, the most significant symptom of fatigue is appeared in eye. According to the researches, the latency between the visual stimulus and its response is one of the main measures to determine the consciousness. This latency is known by a parameter called **Psychomotor Vigilance Task (PVT)** that shows the response speed of a person to his/her visual stimulation. Researches show that there is a very close relation between PVT and the percentage of closed eyelids in a period of time. **The percentage of eyelid closure over time called PERCLOS**. Therefore, there is a close relation between fatigue and percentage of eye closure. Driver face monitoring systems use this relation to estimate driver fatigue or drowsiness.

Driver distraction can be estimated by **head and gaze direction determination.** Distraction detection is more difficult than fatigue detection, but the approaches based on driver face monitoring can estimate the lack of the driver concentration in limited circumstances. Comparison between the main approaches is briefly listed in Table given below.

	Approaches based on bioelectric signals	Approaches based on Steering motion	Approaches based on Driver Face Detection
Fatigue detection	Yes	Yes	Yes
Distraction Detection	No	Yes	Yes
Accuracy	Very Good	Good	Moderate
Simplicity	Difficult	Relatively Simple	Simple
Detection Speed	Fast	Slow	Fast

1.3 Definitions, Acronym and Abbreviation

1.3.1 Driver State Monitoring System (DSMS):

A Driver State Monitoring System prevents any casualty on the road because of drowsiness and distraction while driving. It is an in-vehicle, vision-based electronic system for automobiles. It utilizes a camera installed on the vehicle facing towards the driver. It captures the edge-based face features of the driver.

1.3.2 Intelligent transportation system (ITS):

An intelligent transportation system is an advanced application which aims to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

1.3.3 Psychomotor Vigilance Task (PVT):

The psychomotor vigilance task (PVT) is a sustained-attention, reaction-timed task that measures the speed with which subjects respond to a visual stimulus. Research

indicates increased sleep debt or sleep deficit correlates with deteriorated alertness, slower problem-solving, declined psycho-motor skills, and increased rate of false responding.

1.3.4 The percentage of eyelid closure over time (PERCLOS):

PERCLOS is the percentage of eyelid closure over the pupil over time and reflects slow eyelid closures (“droops”) rather than blinks. A PERCLOS drowsiness metric was established in a 1994 driving simulator study as the proportion of time in a minute that the eyes are at least 80 percent closed.

1.3.5 Raspberry Pi:

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

1.3.6 OpenCV:

OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

1.3.7 Eye Aspect Ratio (EAR):

The Eye Aspect Ratio is an estimate of the eye-opening state. Based on Figure 2, the eye aspect ratio can be defined by the below equation.A program can determine if a person's eyes are closed if the Eye Aspect Ratio falls below a certain threshold. Clmtrackr is another facial landmark plotter.

1.3.8 GPS:

The Global Positioning System (GPS) has been developed in order to allow accurate determination of geographical locations by military and civil users. It is based on

the use of satellites in Earth orbit that transmit information which allow to measure the distance between the satellites and the user.

1.3.9 Google Map:

Google Maps is a web mapping service developed by Google. It offers satellite imagery, aerial photography, street maps, 360° interactive panoramic views of streets (Street View), real-time traffic conditions, and route planning for traveling by foot, car, bicycle and air (in beta), or public transportation.

1.4 References:

[1] P.Tarnowski, M.Kołodziej, A.Majkowski and J. Rak, "Emotion Recognition Using Facial Expression" *International Conference on Computational Science, ICCS 2017, 12-14 June 2017,Zurich, Switzerland*

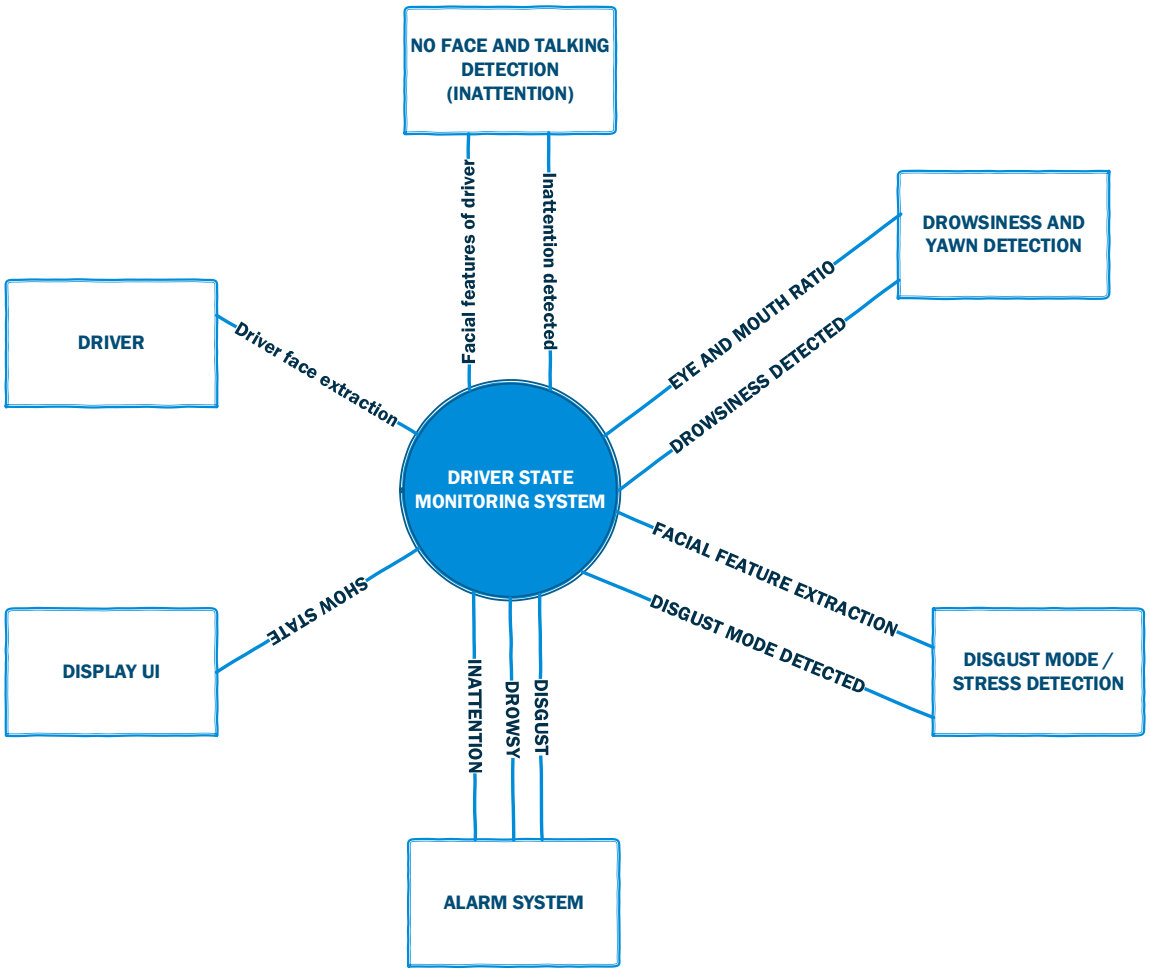
[2] Fatigue, SafetyNet 2009, European Commission Road Safety, *http://ec.europa.eu/transport/road_safety/specialist/knowledge/pdf/fatigue.pdf, (2009).*

2. Overall Description

This section deals in details with the system environment and the functional requirements of the system. The relationship between the stakeholders and the entire system is also briefly mentioned and some non-functional requirements are highlighted at the end.

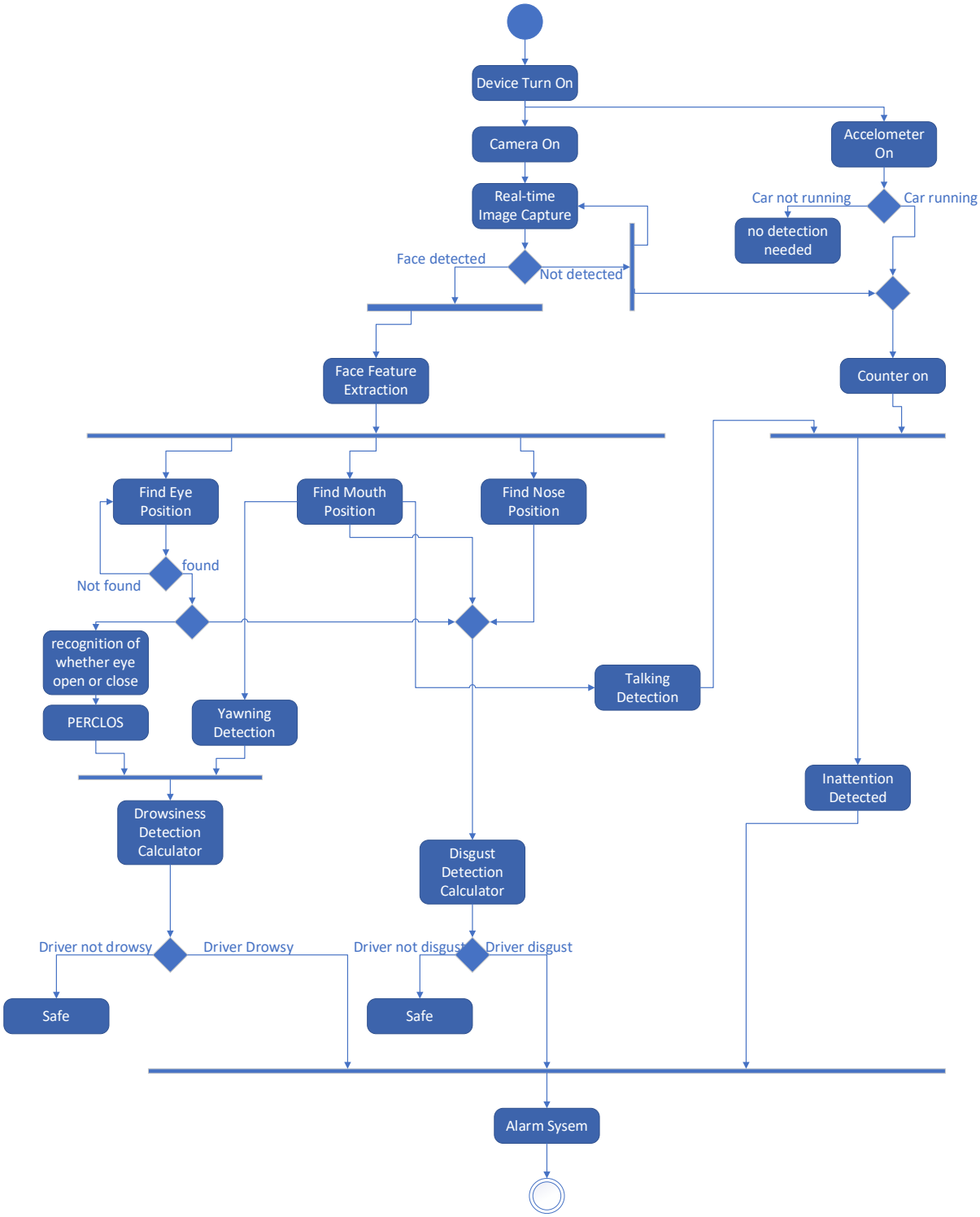
3.2 System Environment

3.2.1 Context Diagram:

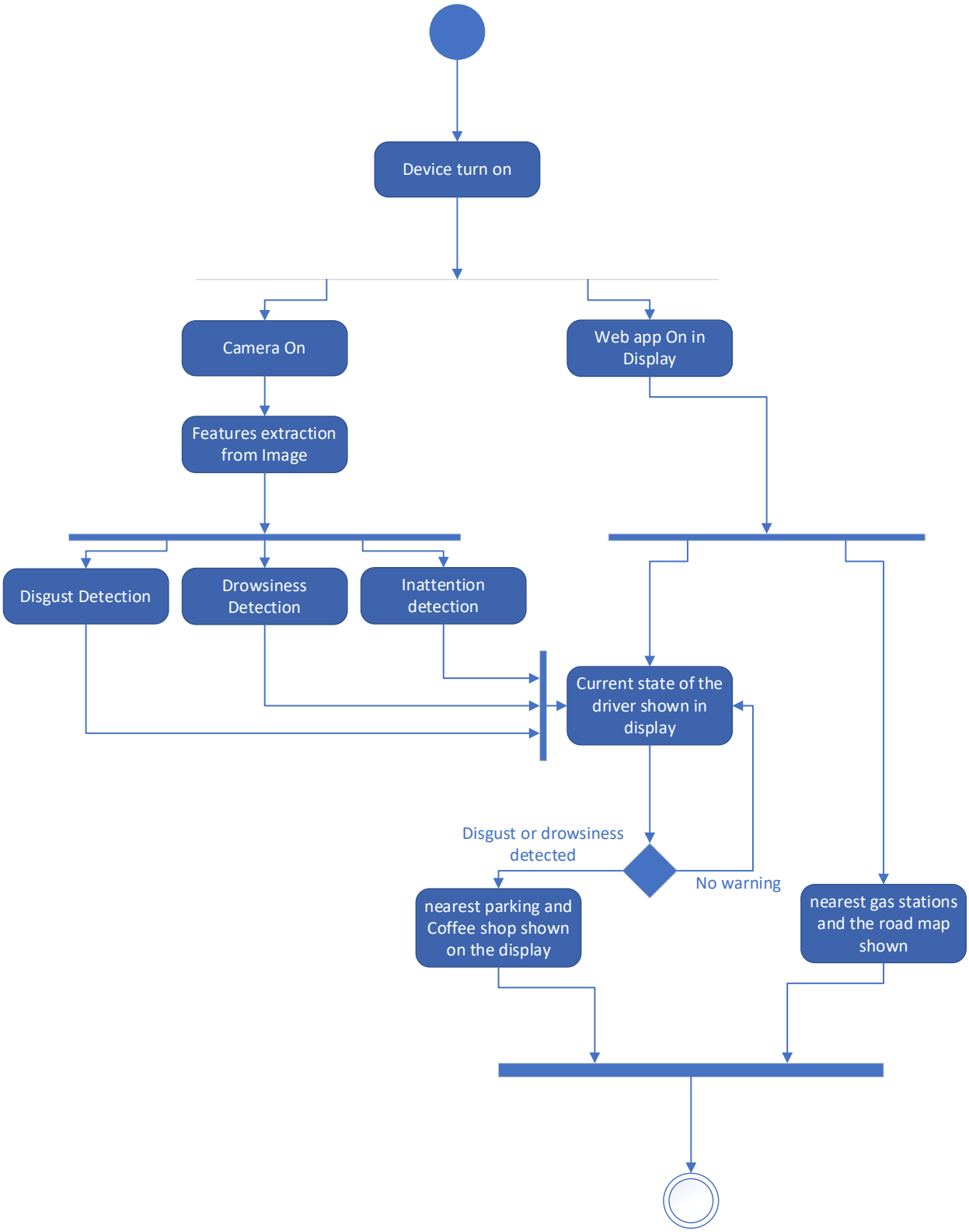


3.2.2 Activity Diagram:

Activity Diagram for Drowsiness, Anger Detection:



Activity Diagram for Web-App



3.3 Functional Requirements Specifications:

3.3.1 Functional and Non-functional requirements

Serial No.	System Requirements	Types of requirements	
		Functional	Non-functional
1	User friendly interface	×	✓
2	Facial Emotion Recognition	✓	×
3	Drowsiness detection	✓	×
4	Mobile phone detection	✓	×
6	A user-friendly display	✓	×
7	Alarm system	✓	×
8	Inattention detection (Timing constraint applied)	✓	×
9	Web app	✓	×

Feature List

- Detect inattention
- Detect disgust
- Drowsiness detection
- A user-friendly display
- Implement an Alarm system
- Show it on a Web app

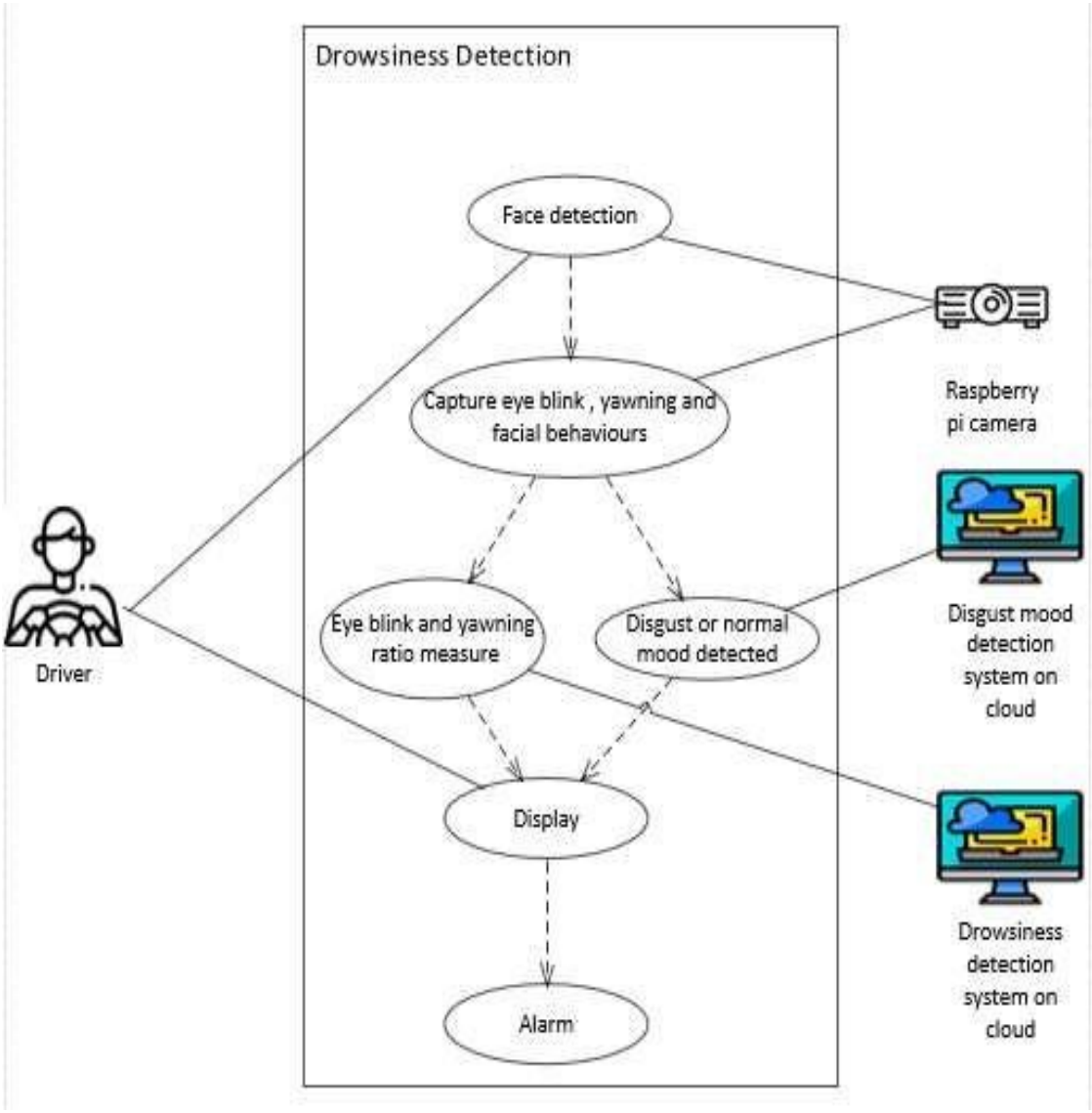
2.2.2. Use case diagram and Tabular Description

2.2.2.1 Use Case Diagram for Drowsiness and anger detection

Scenario 1:

Mr. Kabir a truck driver, had all night duty yesterday. He had to deliver raw material to a factory. Due to this covid-19 situation, the schedules are quite hectic. So, next morning one of his co-workers is sick so he has to do his job as a replacement. His owner has set an AI based driver state monitoring device in the car. After driving for a while, Mr. Kabir was very drowsy due to lack of sleep. His face features are captured through the camera, and so his drowsiness is detected. An alarm went off and he was alerted by this. So, he took parked the truck and took rest for some time. Then he was quite refreshed again, and started his journey

fig: Use case for Drowsiness Detection



Tabular Description:

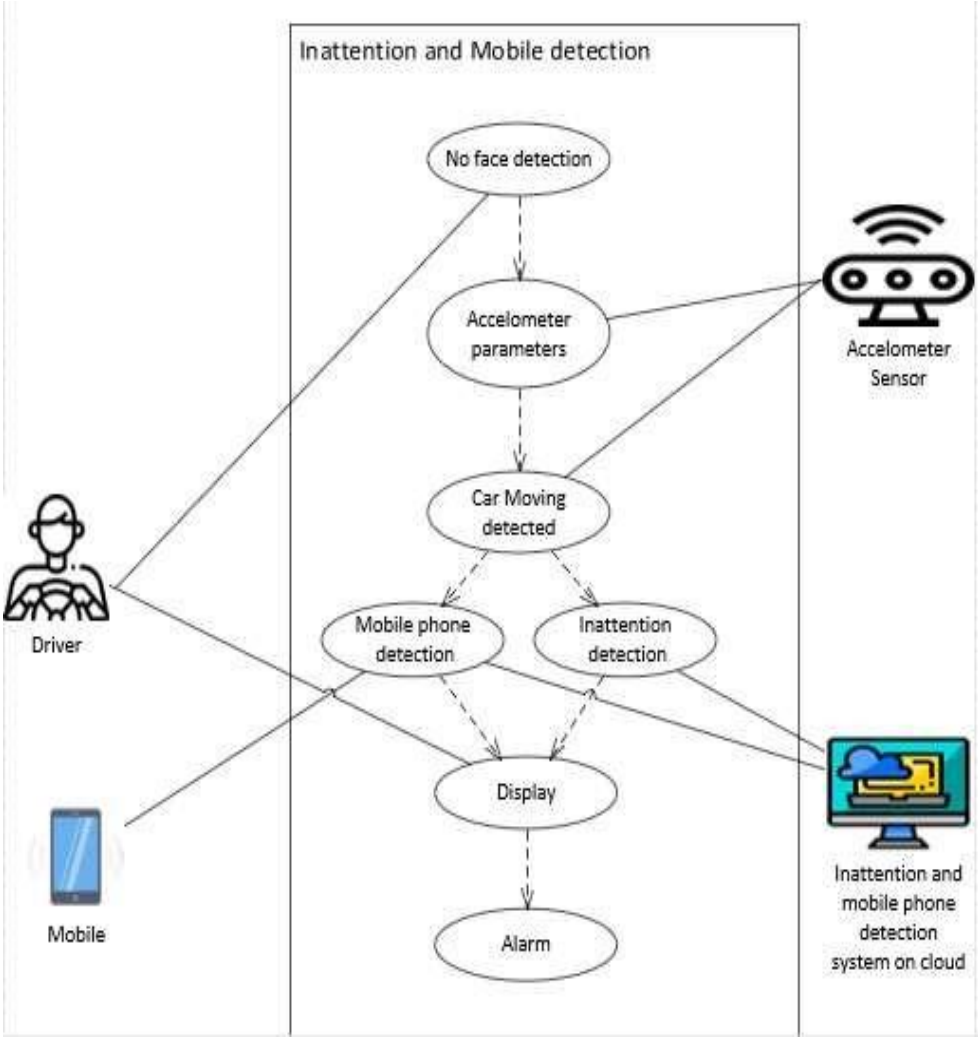
Drowsiness detection	
Actors	**Driver, raspberry pi camera, disgust mode detection system cloud, Drowsiness detection system cloud**
Description	**1. As soon as the driver appears before camera, the pi-cam detects presence of the driver** **2. Eye blink ratio and yawning is captured continuously** **3. The images are sent to the cloud to find the results of the fatigue and emotional condition of driver from his facial expressions and eye blinking and yawning ratio** **4. The results received from the clouds are displayed in the display** **5. If the driver is angry or drowsy for a certain amount of time an alarm is set**
Data	**Face of the driver**
Stimulus	**The driver became angry or drowsy**
Response	**Disgust mood or drowsiness detected of the driver** **successfully and showed in display**
Comments	**The driver must not cover his face (such as mask) for proper functioning of the system, the camera has to be able to detect the face clearly. If the car engine is off or the driver is not in front of the camera the device won't work.**

2.2.2.2 Use Case Diagram for Inattention Detection:

Scenario 2:

Mr. Shakib is very careful when it comes to his family's and own safety. He's also very cautious about road safety and traffic rules. That's why he had set oversee- an AI based driver state monitoring device in the car. One morning when he was driving his daughter to school, he had lot of phone calls coming due to some emergency at work. So, he was carried away for a bit and started talking on phone for some time. Oversee has a hand detection feature. He was holding the phone with one hand which is quite risky in roads of Dhaka. So his hand was detected for a certain time and it alarm buzzed and alerted him that he was inattentive. So Mr. Shakib parked the car, finish talking on phone then again started his journey.

fig: Use case for Inattention and talking detection:

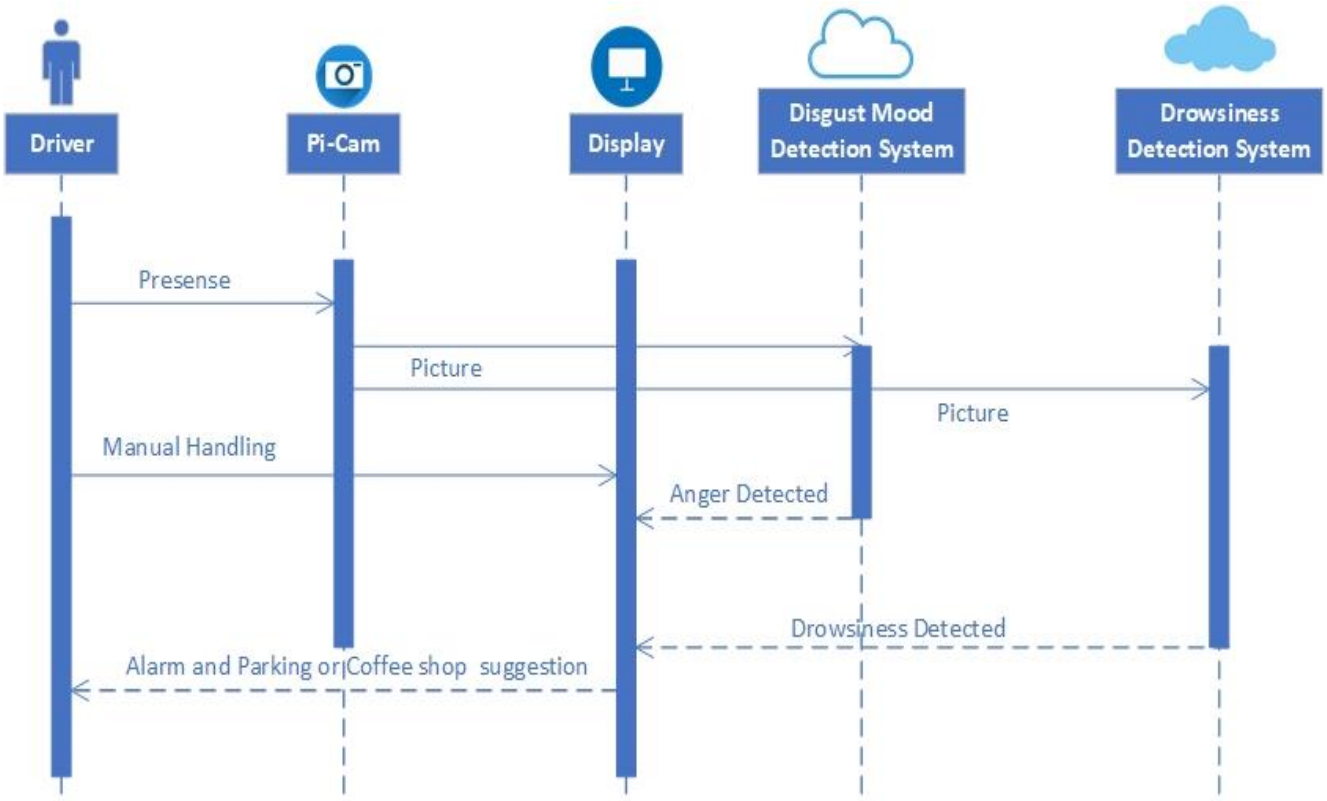


Tabular Description:

Inattention Detection	
Actors	**Driver, Mobile, Raspberry Pi-cam, Accelerometer sensor,** **Inattention and mobile detection system on cloud.**
Description	**1. As soon as the driver appears before camera, the pi-cam detects presence of the driver** **2. If driver face is not detected and mobile is detected then accelerometer sensor data will be collected** **3. If the driver face is not detected for 60s and car is moving or mobile detected and car is moving then the inattention and mobile detection system on cloud sends an alarm to say that the driver is inattentive**
Data	**Face of the driver and mobile phone (if any)**
Stimulus	**Driver being inattentive and if talking on mobile phone**
Response	**Inattention and mobile phone detected (if talking on phone)**
Comments	**If the car engine is off or the driver is not in front of the camera device won't work.**

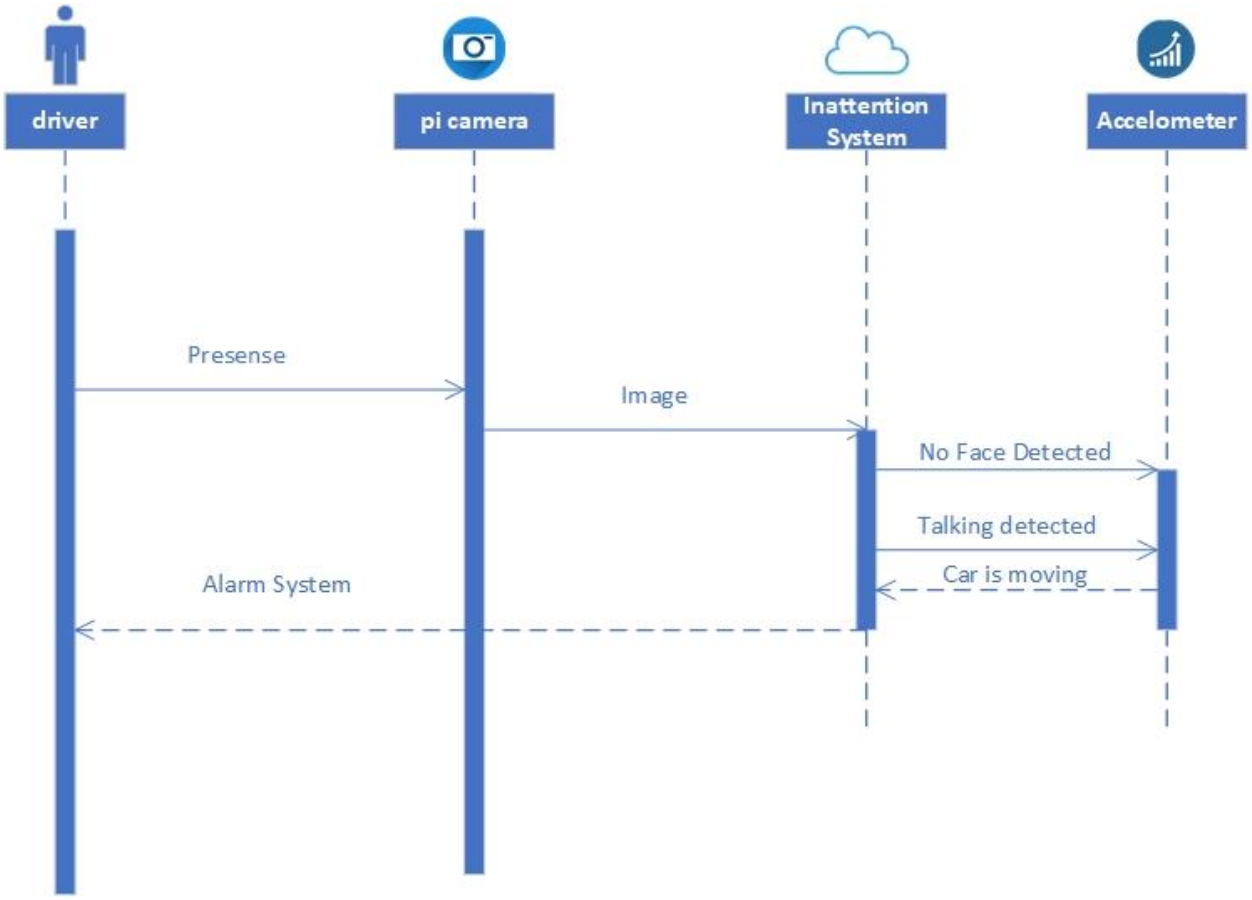
2.2.3 Sequence Diagram

2.2.3.1 Sequence diagram for drowsiness and disgust detection



Sequence Diagram for Drowsiness and Disgust Detection

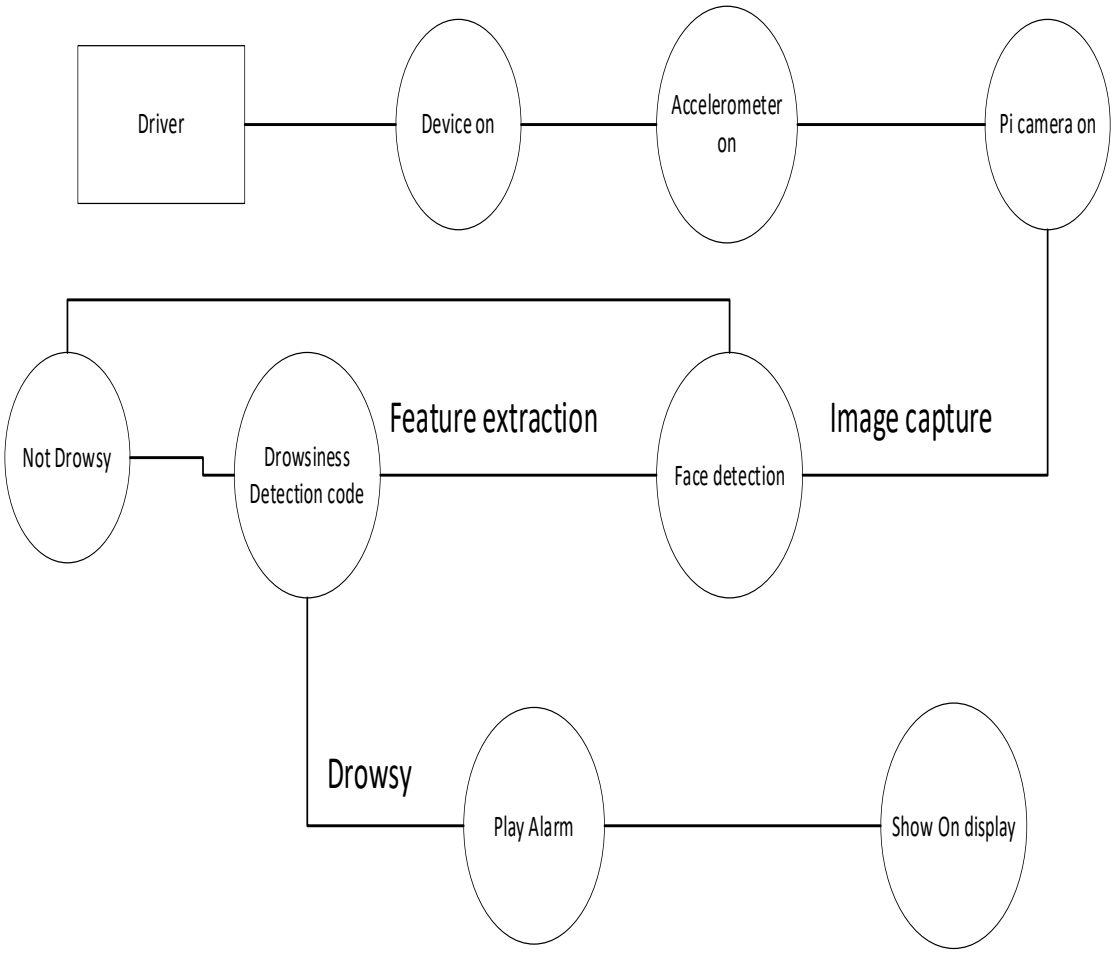
2.2.3.2 Sequence Diagram for Inattention and Talking Detection:



2.2.4 Data Flow Diagram

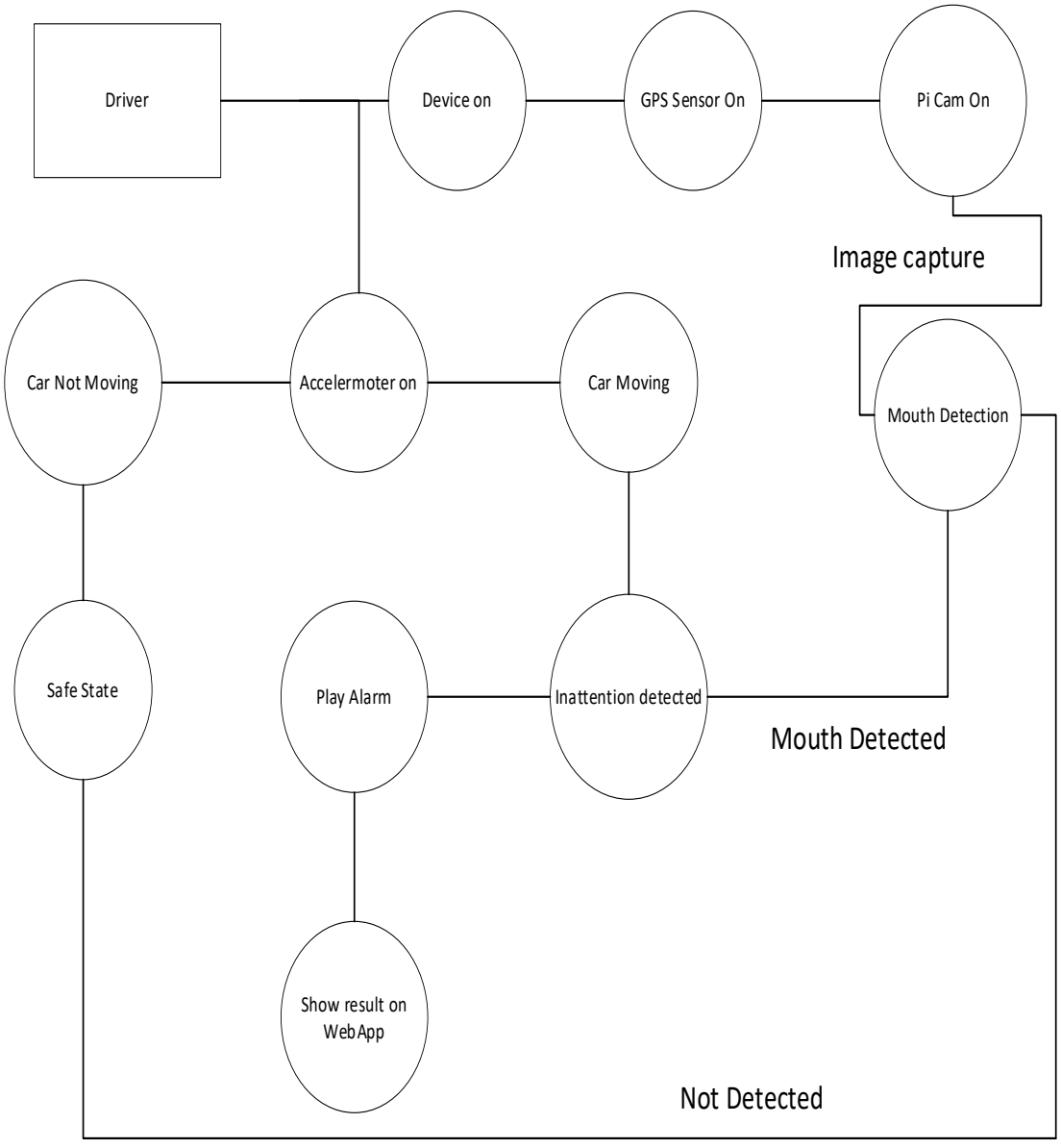
2.2.4.1DFD-1

DFD of scenario 1: Drowsiness Detection



2.2.4.2 DFD-2:

DFD of Scenario 2: Inattention and Talking Detection:



2.3 User Characteristics:

This device is mainly intended for drivers. This device will be attached with the Car and will be placed in front of the driving seat. There are mainly two types of users and stakeholders.

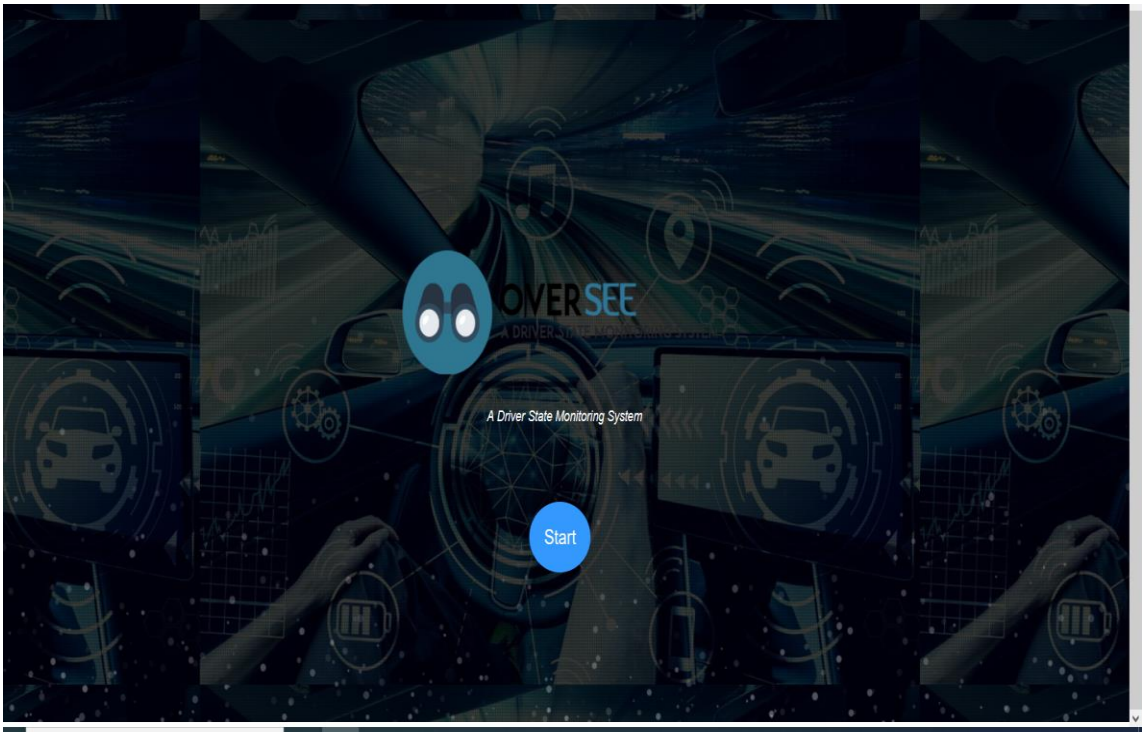
1. **Owner of the Truck, Bus and Rent Car Company**: They can use this device in their vehicles for ensuring safety.
2. **Owner of a private car:** Owner of a private car can use this for himself or his personal driver's safety.

3. Specific Requirements

3.1 External Interfaces.

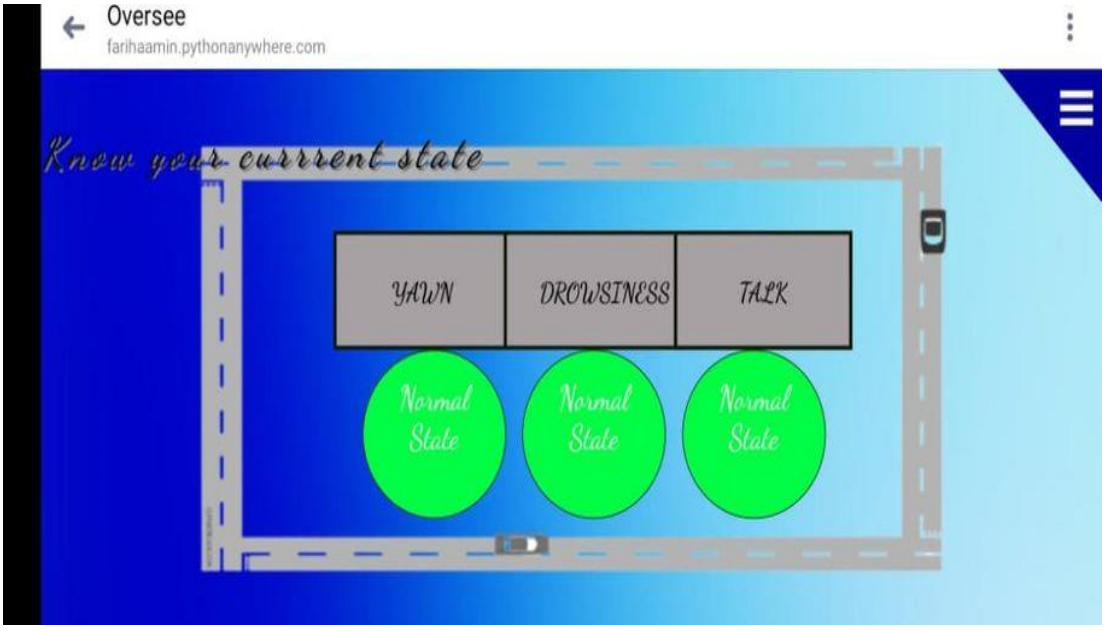
3.1.1. User Interface.

3.1.1.1. Landing Page

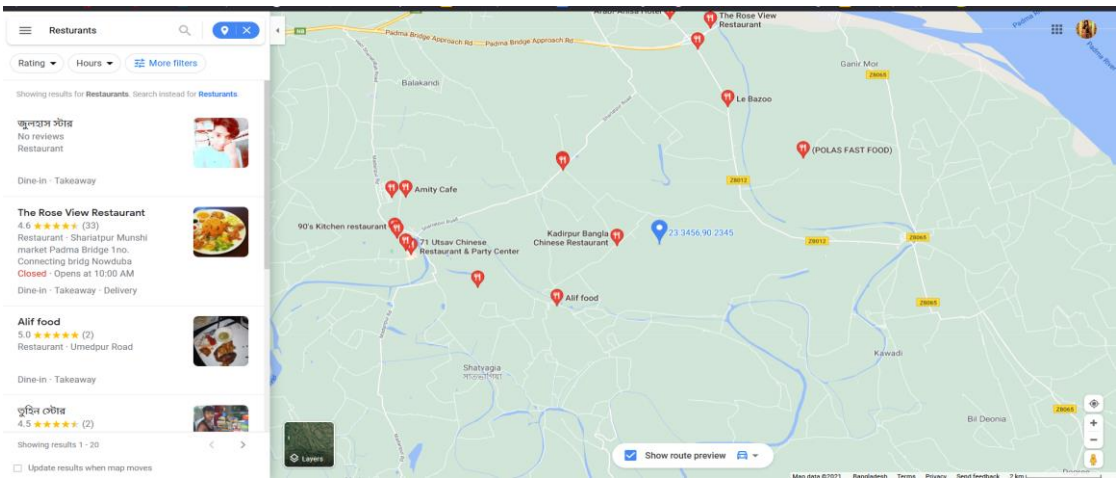


3.1.1.2. Home Page

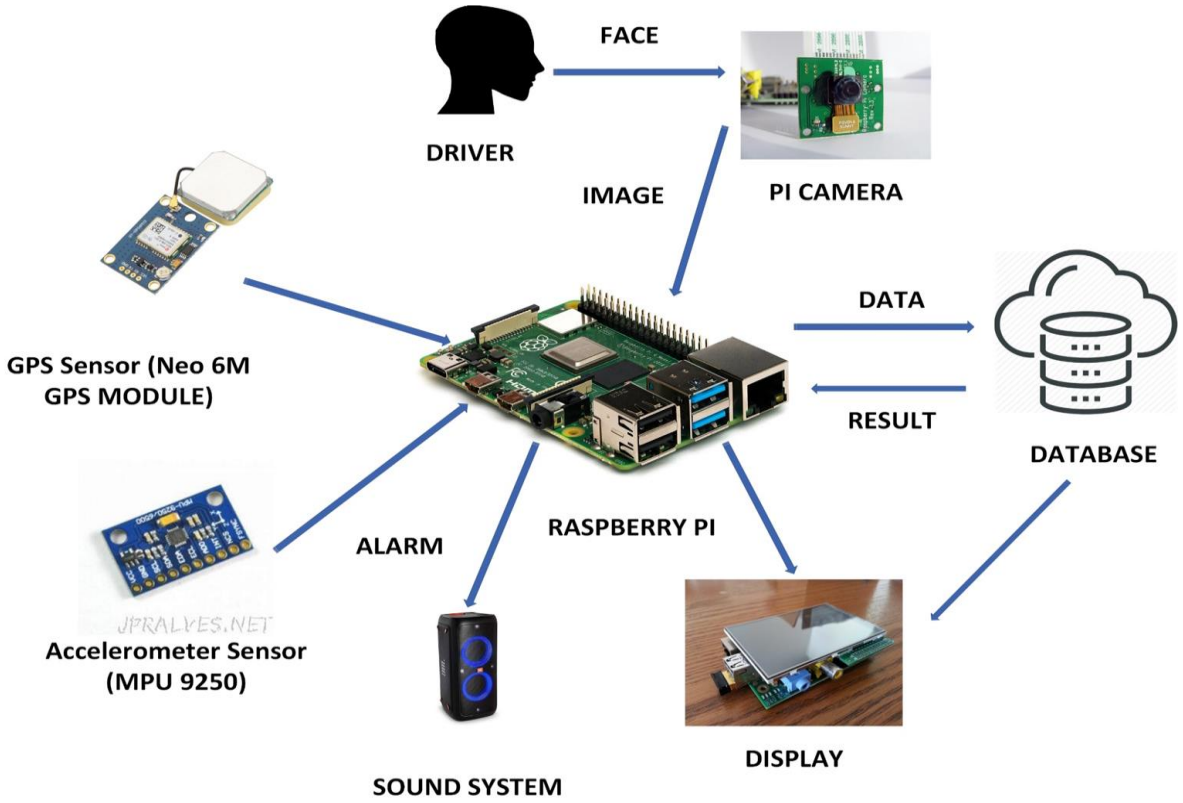
3.1.1.3. Current State



3.1.1.4. Current Location:



3.1.2 Hardware Interface:



Accelerator Sensor Module MPU-9250:

MPU-9250 IMU Breakout features the latest 9-axis MEMS sensor which contains a 3-axis gyroscope as well as a 3-axis accelerometer, and the AK8963, which features a 3-axis magnetometer.

NEO-6MGPSModule:

The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module.

Raspberry Pi Camera Module 5M:

This 5mp camera module is capable of 1080p video and still images and connects directly to your Raspberry Pi.

3.1.3. Software Interface:

The software interface will start with web app, which means the device has started. Data from Pi Cam, accelerometer sensor and GPS sensor will travel to the database. An algorithm will be run which will take the data from those devices and give a feedback report including current state of driver.