Software Requirements Specification

for

VEHICULAR HEATSTROKE ALERTING SYSTEM

Version 1.0 prepared according to IEEE standards

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12-04-2021

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Revision History

Name	Date	Reason For Changes	Version

1. Abstract

Abstract for the document:

The issue of a vehicular heatstroke is very crucial in any automobile organisation. A heat stroke begins when the core body temperature reaches about 104 degrees and a core body temperature of about 107 degrees is lethal. Children especially are more prone to heat strokes as a child's body temperature rises three to five times faster than an adult's. When a child is left unattended in a hot vehicle, the child's temperature can rise quickly and they could die within minutes. The objective of this device is to safeguard children and pets left in the car by monitoring the temperature and toxic gas levels when their presence is detected and alerting the concerned adults and local authorities via text message when the temperature rises beyond a certain limit and/or the air quality deteriorates.

2. Introduction

2.1 Purpose

An annual increase has been observed in the death toll of animals and children worldwide due to vehicular heat strokes. The Vehicular Heatstroke Alerting System aims to reduce the frequency of such unfortunate incidents.

2.2 Document Conventions

The document follows the current IEEE standards with the headings in H1 and the texts which are justified with a face of Arial and a size of 11.All pages are numbered and a header is maintained on every page.

2.3 Intended Audience and Reading Suggestions

The intended audience of this document is anyone with or without prior knowledge of coding or ML modelling. Anyone keen on the idea and having minimal grasp over the technical concepts can read and comprehend the report. Thus intriguing the reader and helping them understanding the importance of implementing this essential safety precaution.

2.4 Product Scope

The scope of this product is global. But practically this product is best used in cars which do not have a blocked rear seat system such as some vans, and trucks. The requirement of sending the details of the vehicle and its geographical coordinates to the cloud and that then being forwarded to the parents/concerned local authorities is not a low bandwidth task and would thus be possible if and only if there is a stable internet system in the given town or city.

2.5 References

Vehicular Heatstroke Alerting System - Arvind P Jayan
(https://github.com/arvindpj007/Vehicular-Heatstroke-Alerting-System/blob/master/IoT%20project%20final%20documentation.pdf)

SOFTWARE ENGINEERING - A practitioner's Approach. - Roger S Pressman

3. Overall Description

3.1 Problem Statement

Heatstroke is exposure to high temperatures for an extended period of time. Vehicular heatstroke involves being trapped in a vehicle under such circumstances. The issue of vehicular heatstroke is very crucial in any automobile organization. Vehicles heat up very quickly, and the heat can be fatal to young children and pets. Children are at a higher risk than adults of dying from a heatstroke in a vehicle because their bodies heat up three to five times faster than that of adults. On an average 38 children under the age of 15 die each year due to being left unattended in cars. Children who are too young to communicate or open car doors are the worst affected. It takes about 10 minutes for the internal temperature of a car to increase 20 degrees. Also, leaving a window open does not help in reducing the internal temperature of a car. Therefore, it is of at most importance that we aid in reducing these unfortunate incidents. We intend on providing a vehicular heatstroke alert system which monitors the temperature and toxic gas levels and alerts the parents/guardians and local authorities based on criticality levels. It uses a webcam to detect the presence of an animal or child and monitors the temperature and toxic gas levels using the respective sensors when the vehicle's engine is turned off. This calls for the need to develop some sort of alert system that could prevent the occurrence of such tragedies.

3.2 Process Model

The waterfall model can be used for the development of this software. The requirements and functions of this project are well defined, well understood and stable. The development can follow a linear fashion, beginning with the specification of requirements, and then progress on to planning, modelling, construction and deployment of the software. The alert system has to detect the presence of children, adults or animals inside a vehicle when the engine is switched off. This is done using a variety of sensors and a webcam. After monitoring the values shown by the sensors for a given amount of time, the parents/guardians will be alerted. If no action is taken beyond a threshold time the local authorities will be alerted.
The model works as shown in Figure 1, when the vehicle's engine is switched off the camera which is built over an ML face detection suite identifies the presence of a child and/or pet which is left unintentionally inside the car. Now the other ADA sensors have the responsibility of monitoring the temperature and CO_2 levels inside the vehicle. The readings are sent to the ADAFRUIT cloud, this

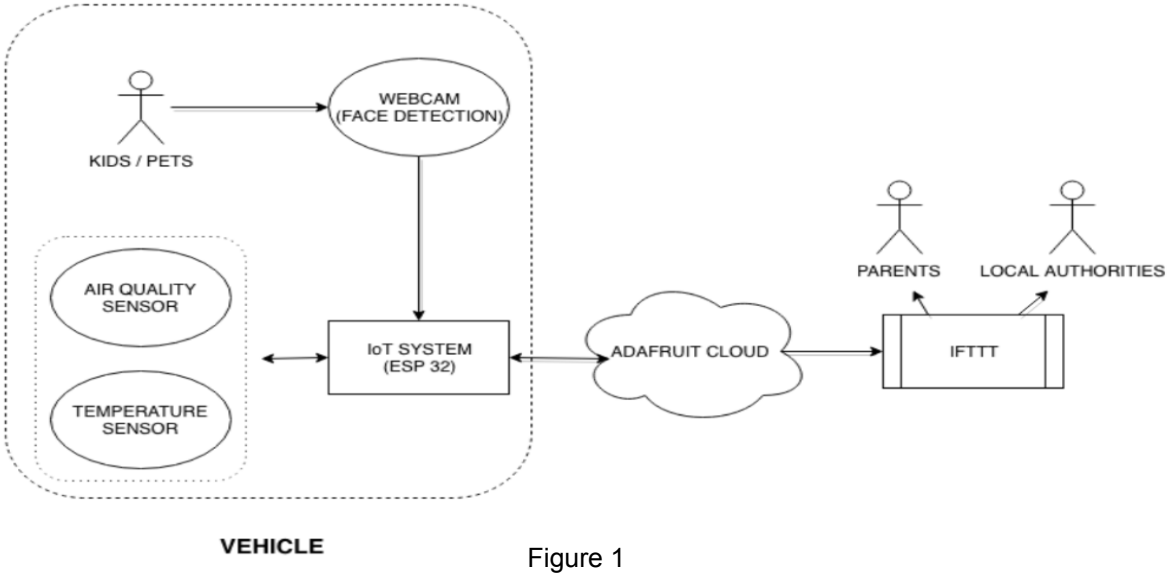

Figure 1

exchange happens over the ADAFRUIT (IoT system). The cloud then sends the readings to the If This Then That (IFTTT) which is programmed to alert the parents and local authorities based on severity of the emergency. If the severity is less critical, then the parents/concerned adults are alerted. If no action is taken beyond the threshold time the local authorities are alerted and if the severity is highly critical the local authorities are alerted along with the parents/concerned adults.

3.3 User Classes and Characteristics

i . Setup Manager

- Setup manager needs to understand the technical aspects of the software in order to install it and to get it to work.
- Setup manager needs security privileges.

ii. Parents/Guardians

- Parents/guardians need not have much technical knowledge about the working of the software. They enter the details of the necessary adults to be contacted in case of an emergency along with the details of the vehicle and respond to alerts.

iii. Local Authorities

- Local authorities need not have any technical knowledge because they only respond to alerts.

3.4 Operating Environment

The ML model is written in python and the IoT components are programmed in C to communicate with the ADAFRUIT server so all of this runs on an Embedded System Component as shown in Figure 2.

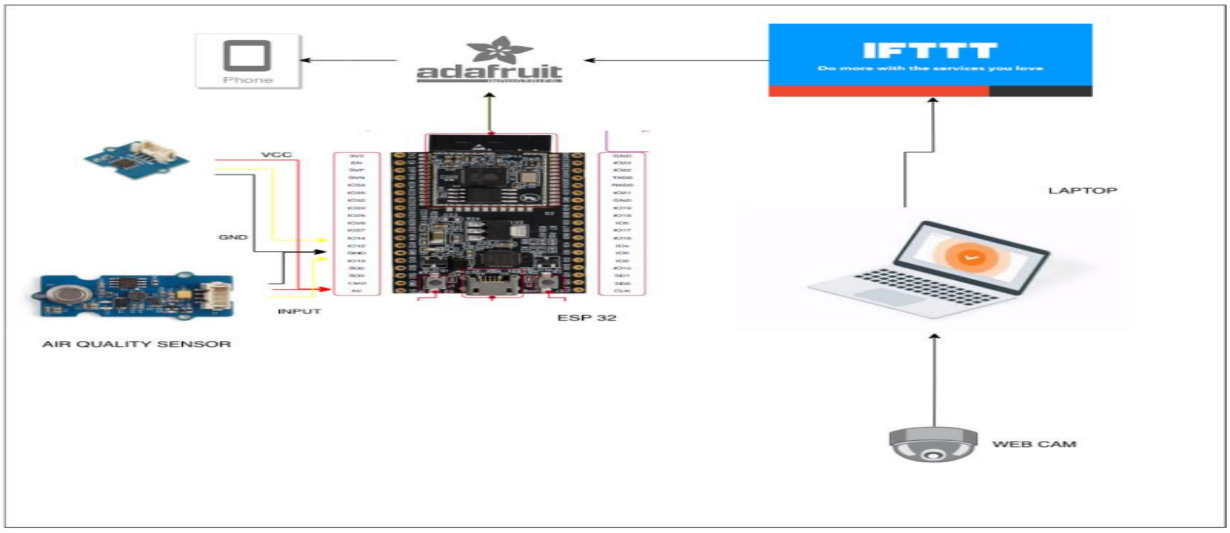

Figure 2

4. Interface Requirements

4.1 Functional Requirements

Functional requirements are the product features or functions designed directly for the users and their convenience. They define the functionality of the software, which the software engineers have to develop so that the user could easily perform their tasks up to the business requirement. The errors caught in the functional requirement gathering stage are the cheapest to fix.

Table 1 describes the functional requirements that were identified for the development of this software.

Identified Requirements	Tag	Cross References
The details of those who need to be alerted in case of emergency need to be fed into the system.	FR1	------
The webcam has to look for faces once the vehicle's engine is turned off.	FR2	------
If there are no faces detected then there is no one in the car and the air quality sensor and temperature sensor need not work. The webcam will continue to work in order to detect faces.	FR3	FR2
The sensors monitor values only if there is a face detected in the vehicle.	FR4	FR2
If a face/faces are detected, the air quality sensor and temperature sensor have to monitor the values of toxic gases and the temperature inside the vehicle.	FR5	FR4
If the intensity of gases and temperature are moderate, the parents/guardians need to be alerted. If no action is taken beyond the threshold time period the local authorities must be alerted.	FR6	--------
If the intensity of toxic gases or the temperature reaches a high level then the local authorities and the parents/guardians are to be alerted.	FR7	--------

Table 1

4.2 Non-Functional Requirements

Non-functional requirements specify criteria that can be used to judge the operation of a system. They establish constraints or restrictions on the design of the system and its functionality. They serve as a system's quality attributes.

Table 2 describes the non-functional requirements that were identified for the development of this software.

Requirement	Tag
The system should have a quick response	NFR1
System should be reliable	NFR2
System should be safe	NFR3
System should give hard real-time performance	NFR4
Sensors should provide accurate measurements	NFR5
System should be easy to use and user friendly	NFR6
System should be cost effective and affordable	NFR7

Table 2

5. Requirement Analysis

5.1 Scenario-Based Elements

i. List of actors:

- Setup Manager
- Parents/guardians
- Alerting System(IFTT)
- Local Authorities
- Camera
- Sensors

ii. List of use cases:

1. The details of the parents/guardians and local authorities who are to be alerted in case a child/pet is trapped in the vehicle are entered into the device.

2. Details of the vehicle are to be entered so that the local authorities can be given the required information.

3. The system is installed in the vehicle in such a way that the camera covers the entire vehicle and the camera is triggered once the engine is turned off.

4. The detection of a face by the camera triggers the air quality sensor and temperature sensor. The sensors start monitoring the values of toxic gas levels and temperature levels.

5. The camera does not detect a face and it continues to scan the vehicle for children/pets. No sensors are triggered.

6. When the intensity of the temperature and toxic gases are less critical the parents/ guardians must be alerted. If no action is taken beyond the threshold time period the local authorities must be alerted.

7. When the intensity of the temperature and toxic gases are critical the local authorities along with the parents/guardians must be alerted.

iii. All use case descriptions:

1. Use case: Details of parents/guardians and local authorities are entered.

Primary actor: Parent/Guardian

Goal in context: To enter the details of the adults to be alerted in case of an emergency.

Preconditions: System has been programmed to accept emergency contact details.

Trigger: Parents/guardians decide to enter emergency contact details.

Scenario:

1. Parents/Guardians: Enter and store their details.

2. Parents/Guardians: Enter and store the details of the local authorities to be alerted.

Alternate Scenario:

1. Guardians: Enter and store their details.

2. Guardians: Enter and store the details of the local authorities to be alerted.

Exceptions:

1. Entered details are incorrect (System beeps once): Parents/guardians re-enters correct details.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Once, initially when entered.

Channel to actor: Via control panel interface.

Cross references: FR1 - The details of those who are to be alerted is fed into the system.

Open issues:

1. Should the control panel display additional text messages?

2. Use case: Details of the vehicle are entered.

Primary actor: Parent/Guardian

Goal in context: To store details of the vehicle so local authorities can be alerted in case of an emergency.

Preconditions: System has been programmed to accept vehicle details.

Trigger: Parents/Guardians decide to enter the vehicle details.

Scenario:

1. Parents/Guardians: Enter and store the details of the vehicle

2. Setup manager: Provides verification number.

Alternate scenario:

1. Guardians: Enter and store the details of the vehicle

2. Setup manager: Provides verification number.

Exceptions:

1. Entered details are incorrect (System beeps once): Parents/Guardians re-enters correct details.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Once, initially when entered.

Channel to actor: Via control panel interface.

Secondary actor: Setup manager

Channel to secondary actor:

1. Setup manager: Phone line

Cross references: None

Open issues:

1. Should the control panel display additional text messages?

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3. Use case: System is installed in the vehicle.

Primary actor: Setup manager

Goal in context: To install the heatstroke alerting software in the vehicle along with a webcam that is triggered when the vehicle's engine has been switched off.

Preconditions: Emergency contact details and vehicle details are entered correctly.

Trigger: Setup manager decides to "set" the system, that is, to check the webcam coverage and activation of sensors when a face is detected.

Scenario:

1. Setup manager: Fixes the sensors in the required location.

2. Setup manager: Checks if the camera covers the entire vehicle.

3. Setup manager: Checks if the sensors are providing accurate and non faulty values.

4. Setup manager: Does initial setup tasks to set the device in working state.

5. Setup manager: Checks if alerting system is functioning.

Exceptions:

1. Camera doesn't cover the whole vehicle: Setup manager repositions the camera to cover the whole vehicle.

2. Sensors fail to activate when the face is detected: Setup manager replaces the faulty sensors with functional ones.

3. Sensors provide faulty values: Setup manager replaces the faulty sensors with functional ones.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Once, initially when installed.

Channel to actor: Via system interface.

Secondary actors: Camera, sensors, alerting system

Channel to secondary actors:

1. Camera: Remote IP address mapped interface

2. Sensors: IoT system

3. Alerting system: ADAFRUIT cloud and IFTTT application

Cross references: FR2, FR4 - The working of webcam and sensors is ensured.

Open issues:

1. Is there a way to deactivate the sensors after face detection?

2. Can the sensor readings be manipulated?

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4. Use case: A face is detected in the vehicle once its engine is turned off.

Primary actor: Camera

Goal in context: To activate temperature sensor and air quality sensor.

Preconditions: System has been programmed to monitor temperature and CO/CO_2 levels when a face is detected.

Trigger: A face is detected by the camera after the vehicle's engine is turned off.

Scenario:

1. Camera: Detects a face.

2. Sensors: Start monitoring the values of CO/CO_2 and temperatures inside the vehicle once a face is detected.

Exception:

1. Camera is not activated when the vehicle's engine is switched off: Parents and setup manager receive an error message.

2. Camera's view is obstructed: Parent/guardian receive an error message and they reposition the camera to ensure full coverage of vehicle.

3. Sensors fail to activate on face detection: Parents and setup manager receive an error message.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Whenever the vehicle's engine is turned off.

Channel to actor: Via system interface

Secondary actor: Sensors

Channel to secondary actors:

Sensors: IoT system

Cross references: FR2 - The webcam looks for faces only when the engine is turned off.

Open issues:

1. What happens if the cloud server is down or undergoing maintenance?

2. Is there a way to deactivate sensors after face detection?

---

5. Use case: A face is not detected.

Primary actor: Camera

Goal in context: To continue looking for a face in the vehicle.

Preconditions: System has been programmed to detect a face and activate sensors.

Trigger: Vehicle's engine is switched off.

Scenario:

1. Camera: Does not detect a face.

2. Camera: Continues scanning the vehicle to detect a face.

3. Sensors: Not activated as face is not detected.

Exception:

1. Camera falsely detects face and activates sensors: Parents/guardians receive alert from the system. Parents can then contact the setup manager to get the issue fixed.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Whenever the vehicle's engine is turned off.

Channel to actor: Via system interface

Secondary actor: Sensors

Channel to secondary actors:

Sensors: ADAFRUIT

Cross references: FR2 - The sensors won't work until a face is detected.

Open issues:

1. What happens if the cloud server is down or undergoing maintenance?

2. Can the sensors be activated without the presence of a child/pet?

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6. Use case: A face is detected in the vehicle and the intensity of CO/CO_2 and temperature levels are less critical.

Primary actor: Sensors, camera, alerting system

Goals in context: To continue monitoring the temperature and CO/CO_2 levels and alert the parents/guardians.

Preconditions: System has been programmed to monitor temperature and air quality values and alert the emergency contacts.

Trigger: A face is detected in the vehicle and the intensity of toxic gases and temperature levels are less critical.

Scenario:

1. Camera: Detects a face.

2. Sensors: Monitor temperature and CO/CO_2 levels.

3. Sensors: Activate the alert system once the temperature and toxic gas levels have crossed a certain level.

4. Sensors: If a face is still detected continue monitoring CO/CO_2 and temperature levels.

5. Alert system: Alerts the parents/guardians.

6. Parents/Guardians: Receive an alert from the vehicular heatstroke alert system.

7. Local Authorities: Receive an alert from the vehicular heatstroke alert system if parents/ guardians fail to take action beyond threshold time period.

Exceptions:

1. System fails to alert parents: Parents/guardians contact the setup manager to get it fixed.

2. System fails to alert local authorities: Parents/guardians contact the setup manager to get it fixed.

3. Alert system is not activated: Setup manager is notified.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Whenever the levels of CO/CO_2 and temperature are less critical.

Channels to actors:

Sensors: Via ADAFRUIT

Camera: Via Remote IP address mapped interfaces

Alerting system: Via ADAFRUIT cloud

Secondary actor: Parents/Guardians, local authorities

Channel to secondary actors:

Parents/Guardians: Via IFTTT(alert system)

Local authorities: Via IFTTT(alert system)

Cross references: FR6 - The parents have to be alerted as the intensity of toxic gases and temperature levels are less critical. Local authorities have to be alerted beyond threshold time period.

Open issues:

1. Is there a way to prevent parents/guardians or local authorities from receiving the alerts?

2. Can the sensor readings be manipulated?

3. What happens if the cloud server is down or undergoing maintenance?

4. Will the system work in remote areas where the bandwidth is a constraint?

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7. Use case: A face is detected and the intensity of CO/CO_2 and temperature is highly critical.

Primary actor: Sensors, camera, alert system.

Goals in context: To continue monitoring the CO/CO_2 and temperature levels and alert the local authorities along with the parents/guardian.

Preconditions: System has been programmed to monitor temperature and air quality values and alert the emergency contacts.

Trigger: A face is detected in the vehicle and the intensity of toxic gases and temperature levels are highly critical.

Scenario:

1. Camera: Detects a face.

2. Sensors: Monitor temperature and CO/CO_2 levels.

3. Sensors: Activate the alert system once the intensity of the CO/CO_2 and temperature levels are highly critical and continue monitoring the levels as long as a face is detected.

4. Alert System: Alert the local authorities and provide the necessary vehicle details.

5. Alert System: Alert the parents/guardians.

6. Local Authorities: Receive an alert from the vehicular heatstroke system along with necessary details of the vehicle.

7. Parents/Guardians: Receive an alert from the vehicular heatstroke system.

Exceptions:

1. System fails to alert parents: Parents/guardians contact the setup manager to get it fixed.

2. System fails to alert local authorities: Parents/guardians contact the setup manager to get it fixed.

3. Alert system is not activated: Setup manager is notified.

Priority: Essential, must be implemented.

When available: First increment

Frequency of use: Whenever the levels of CO/CO_2 and temperature are highly critical.

Channels to actors:

Sensors: Via ADAFRUIT

Camera: Via Remote IP address mapped interfaces

Alerting system: Via ADAFRUIT cloud

Secondary actor:Parents/Guardians, local authorities

Channel to secondary actors:

Parents/Guardians: Via IFTTT(alert system)

Local authorities: Via IFTTT(alert system)

Cross references: FR7 - The local authorities and parents have to be alerted as the intensity of toxic gases and temperature levels are highly critical.

Open issues:

1. Is there a way to prevent parents/guardians or local authorities from receiving the alerts?

2. Can the sensor readings be manipulated?

3. What happens if the cloud server is down or undergoing maintenance?

4. Will the system work in remote areas where the bandwidth is a constraint?

Figure 3 shows the use case diagram for vehicular heatstroke alerting system

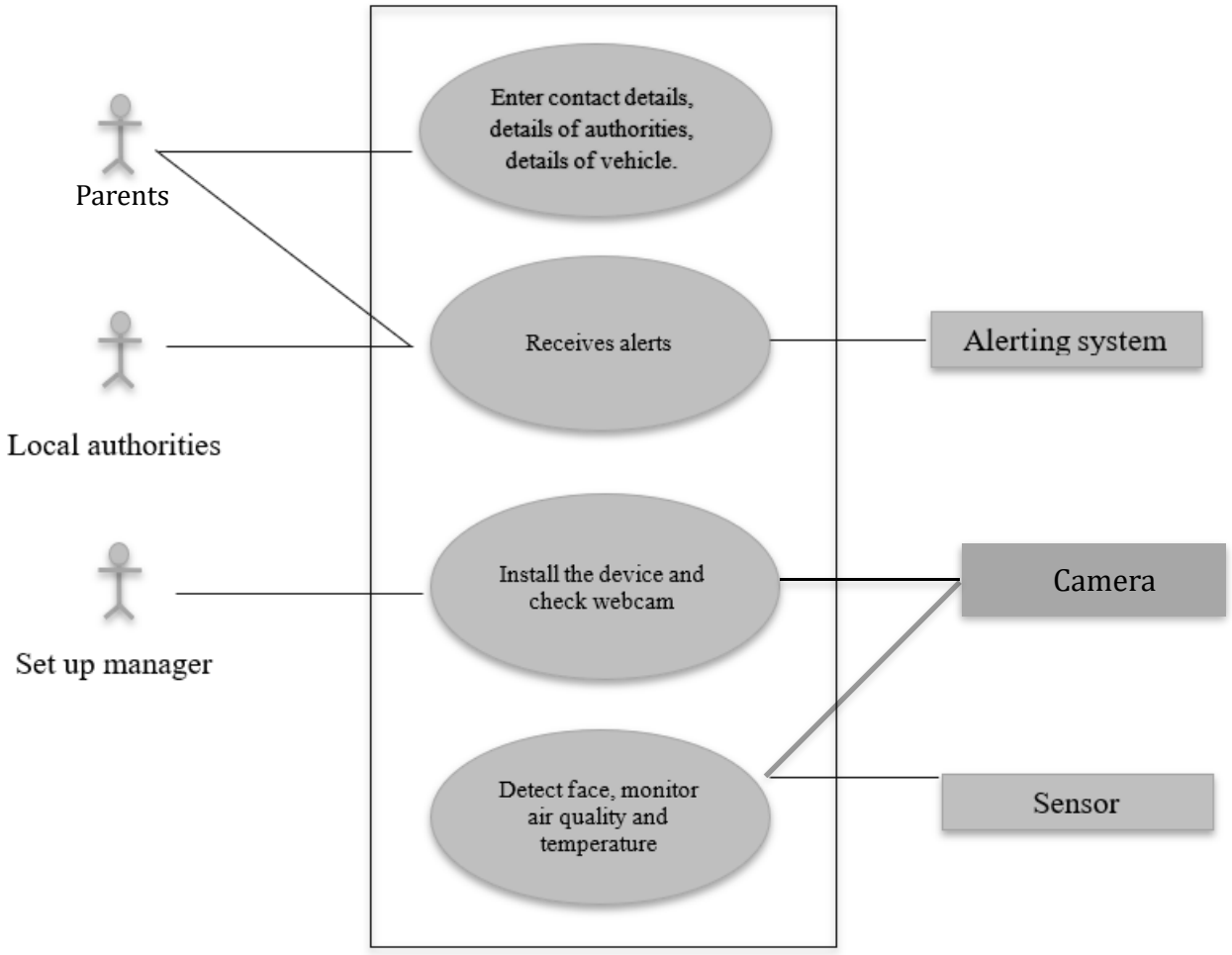

Figure 3

5.2 Behavioural Elements

Figure 4 shows the activity diagram of the software. The parents enter their details along with that of the guardians and local authorities who need to be contacted in case of any emergency. Any errors in the entered details will cause the data to be rejected and the user will be prompted to re-enter the correct details. Once accepted, the system is installed in the vehicle by the setup manager.

When the vehicle's engine is switched off the camera is activated and it begins to looks for a face of a child or a pet that might have been left unintentionally in the vehicle. If a face is detected it triggers the sensors which begin to monitor the temperature and toxic gas levels within the vehicle. If no face is detected the camera continues looking, but no sensors are triggered.

As long as the readings are lower than moderate levels the sensors continue to monitor the temperature and toxic gas levels. As soon as the readings reach moderate levels the alerting system is triggered and the parents/guardians receive an alert. The sensors continue to monitor the temperature and air quality. If no action is taken beyond a threshold time period the local authorities receive an alert along with the required vehicle details. If the values of temperature and toxic gases are very high, the local authorities are alerted along with the parents/guardians.

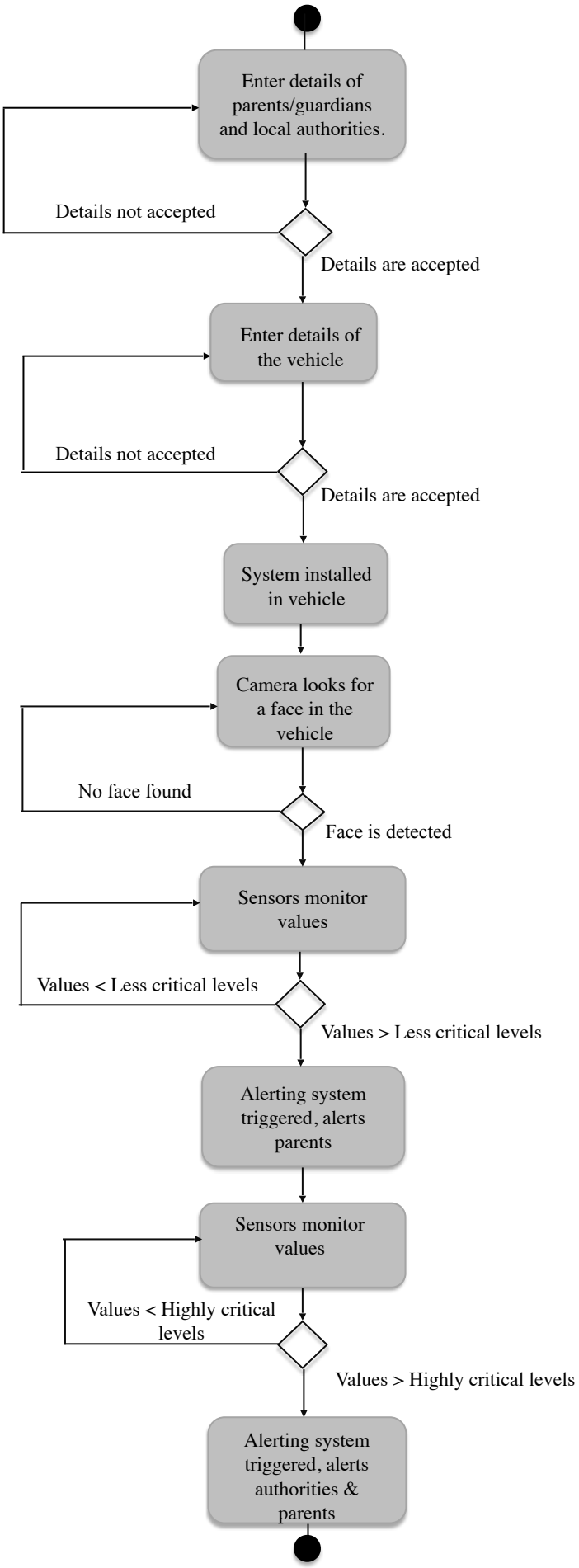
Enter details of parents/guardians and local authorities.
Details not accepted
Details are accepted
Enter details of the vehicle
Details not accepted
Details are accepted
System installed in vehicle
Camera looks for a face in the vehicle
No face found
Face is detected
Sensors monitor values
Values < Less critical levels
Values > Less critical levels
Alerting system triggered, alerts parents
Sensors monitor values
Values < Highly critical levels
Values > Highly critical levels
Alerting system triggered, alerts authorities & parents

Figure 4

5.3 Class Based Elements:

Classes:

1. Class to handle the details of the parents, local authorities and the vehicle.

2. Class to handle face detection.

3. Class to handle functioning of sensors.

4. Class for handling the alerting function.

Interaction between the classes:

- The class handling face detection interacts with the sensor class.
- The class handling the functioning of the sensors interacts with the class handling the alerting function.
- Class handling the alerting function interacts with the class which handles the details of the parents, local authorities and the vehicle.

Description of the classes:

As shown in Figure 5, the ‘Details’ class has functions to accept the names and phone numbers of the people who need to be contacted/alerted in case of an emergency along with the vehicle details.

The ‘Camera’ class contains functions which are activated when the vehicle’s engine has been turned off and detects faces of any animal or child that is left in the vehicle.

The ‘Sensor’ class has functions which are activated when a face is detected and it monitors the toxic gas and temperature levels.

The ‘AlertSystem’ class contains functions which alert the parents/guardians and/or local authorities based on severity of the sensor readings.

Class Diagram:

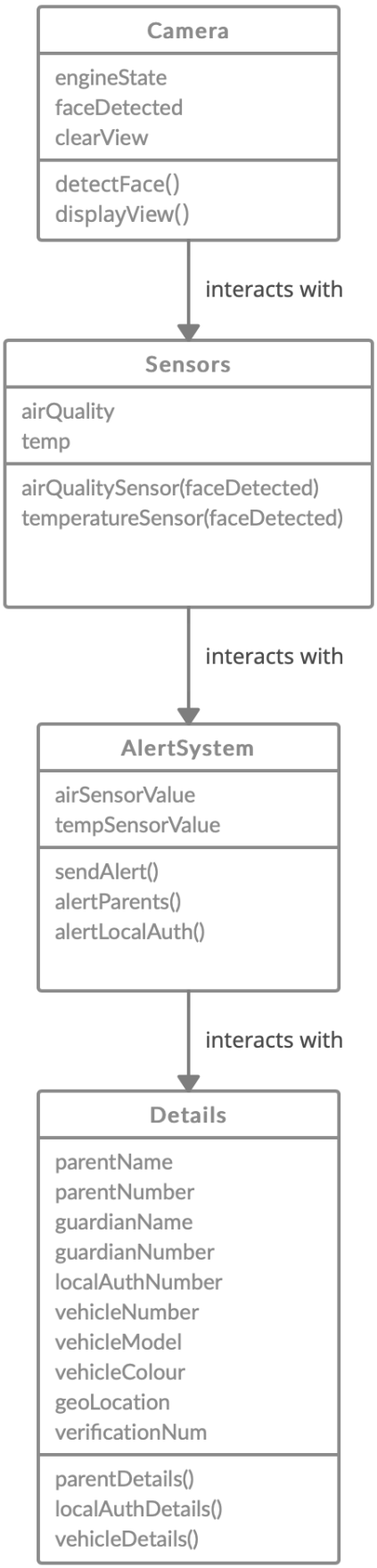

Figure 5

6. Appendix

Appendix A:

To Be Determined List:

Appendix B:

Secondary References and Sources:

- IFTT DOCUMENTATION: https://platform.ifttt.com/docs
- Adafruit IO Basics: Temperature & Humidity :Todd Treece
- Firebase ML Kit : Face Detection by Google