‘DESIGN AND DEVELOPMENT OF AN ACCIDENT DETECTION AND ALERTING SYSTEM’

a mini-project report submitted to Rashtrasant Tukadoji Maharaj Nagpur University in partial fulfilment for the award of degree of

Bachelor of Engineering

In

Computer Science and Engineering

By

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Under the supervision of

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Nagpur-440 013

(An Autonomous Institution of Rashtrasant Tukadoji Maharaj Nagpur University)

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SHRI RAMDEOBABA COLLEGE OF ENGINEERING & MANAGEMENT, NAGPUR

(An Autonomous Institute affiliated to Rashtrasant Tukdoji Maharaj Nagpur University)

Department of Computer Science & Engineering

CERTIFICATE

This is to certify that the Thesis on

"Design and Development of An Accident Detection and Alerting System"

is a bonafide work of

Ashish Prasad

Atharva Kasangottuwar

Sanjana Rathi

Swaroop Prajapati

Vrushali Nikhade

submitted to the Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur in partial fulfillment of the award of a Degree of Bachelor of Engineering, in Computer Science and Engineering. It has been carried out at the Department of Computer Science and Engineering, Shri Ramdeobaba College of Engineering and Management, Nagpur during the academic year 2019-20.

Date : 2 November, 2019
Place: Nagpur

Prof. D.A. Borikar
Project guide
Department of Computer Science and Engineering

Dr. M.B. Chandak
H.O.D
Department of Computer Science and Engineering

Dr. R.S. Pande
Principal

DECLARATION

We, hereby declare that the thesis titled **"Design and Development of An Accident Detection and Alerting System"** submitted herein, has been carried out in the Department of Computer Science and Engineering of Shri Ramdeobaba College of Engineering & Management, Nagpur. The work is original and has notbeen submitted earlier as a whole or part for the award of any degree /diploma at this or any other institution / University.

Date : 2 November, 2019

Place: Nagpur

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This report entitled

"Design and Development of An Accident Detection and Alerting System"

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Vrushali Nikhade

is approved for the degree of Bachelor in Computer Science and Engineering.

Name & signature of Supervisor	Name & signature of External. Examiner
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Name & signature RRC Members	Name & signature of HOD
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Date: 2 November 2019

Place: Nagpur

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By –

ASHISH PRASAD 50

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ABSTRACT

On road accident is a major issue of concern. Even with all modern developments in the field of vehicle design, road lane design and management, accidents do occur. Timely accident detection and taking immediate action with respect to emergency health care of victims by informing an emergency center such as a hospital or a police station about the accident on time plays a vital role inhuman safety and road traffic management.

A large number of deaths are caused by Traffic accidents worldwide. The global crisis of road safety can be seen by observing the significant number of deaths and injuries that are caused by road traffic accidents. In many situations the family members or emergency services are not informed in time. This results in delayed emergency service response time, which can lead to an individual's death or cause severe injury. The purpose of this project is to reduce the response time of emergency services in situations like traffic accidents.

By utilizing onboard sensors of a smart phone to detect vehicular accidents and report it to the nearest emergency responders available and provide real time location tracking for responders and emergency victims, will drastically increase the chances of survival for emergency victims, and also help save emergency services time and resources. The application focuses on alerting the responders in an efficient manner.

LIST OF FIGURES

INDEX

CHAPTER 1
INTRODUCTION

1.1 Background

Now-a-days, due to increased traffic and human recklessness, there has been a huge rise in road accidents. And many-a-times, these accidents either remain unnoticed or get addressed late if it occurs in some isolated place. The local police authority or ambulance is not informed on time, and it results in delayed assistance for the affected person. Often, the accident cases are critical and every second is precious for saving the life of victim, but due to late addressal, the chances of proper treatment reduces. At such times, emergency resolution is necessary but due to lack of proper system the problem remains as it is.

In the set of existing systems, problems arise due to external hardware intervention. The existing systems are costly and require quite maintenance as they are hardware based.

The proposed system focuses on reducing the time of accident detection and increasing the chances of emergency services assistance for the victim. The application mechanism detects accidents and report it to the nearest available emergency responders with the exact location of victims in emergency. On an emergency responder side, the system will inform responders about the incidents that occur near to them and provide them with real time tracking of emergency victims on a Google map. This will help emergency responders keep track of victim's location and rescue them as soon as possible.

1.2 Problem Definition

Accident detection and Emergency alerting system is a real-time based application designed to avoid accident based scenarios, and to make the localities and official authorities such as police and paramedics aware of the situation instantly as soon as a critical accident takes place with the help of an integrated alerting system.

1.3 Need of the system

The most likely reason for an individual's death in an accident is lack of the first aid provision that is because of emergency services not receiving information about accident in time. Emergency response time is extremely vital when it involves incidents involving vehicle accidents. Analysis shows that if we decrease just 1-minute in accident response time that can increase chances of saving an individual's life up to six

percent. In order to reduce response time, implementation of enhanced traffic technologies would be necessary, which will help scale back response time and therefore reduce fatalities.

1.4 Objectives of the system

According to the World Health Organization, 1.35 million deaths were estimated per year .i.e. one death at every 25 seconds. And the major reason behind death isn't the criticality of accident, but the delay in emergency assistance. We see many cases where people die on the road due to unnoticed road accidents. This becomes a usual case at nights. There are some systems that address the accidents as soon as it takes place but the major flaw is that they are expensive, and hard to maintain as they are entirely based on external hardware.

The proposed system focuses on reducing the time of accident detection and increasing the chances of emergency services assistance for the victim. The objectives of the current system are as shown below:

1. To identify the accident and its severity and to make the nearby authorities aware of the case.
2. To alert the localites nearest to the site of accident so that the accident gets noticed as soon as possible.
3. Detection of accident and improvisation of the same for effective addressal of accident, in such a way that alerts are sent only when the accident is occurred.
4. To process the driving habits of the driver and to keep track of it to make the system smart of the person involved in commute activities.
5. To determine accident on the basis of different environmental factors, human errors in order to increase the effectiveness.

1.5 End User Scope

The end user goes through the application which allows him/her to register as a responder or a normal user. The commute activity and vehicle of user is tracked alongwith the live location and whenever some accident occurs, live location is sent to the nearest

responder. The integrated application for the end user allows him/her the following services :

1. Application allowing the user to register his/her details.
2. Feature to add emergency contact within the application.
3. Availability to switch the alerting and tracking system.
4. Enabling user to request or cancel emergency services.
5. Availability of post-accident services and track up.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Definition of the system

An accident detection and alerting system tracks the activities of a commuter and senses his/her vehicle's motion and abnormalities. This system revolves around sensing the vehicle and relative factors. An ideal accident detection system should cover maximum parameters and determine accident like situations on basis of them. The more are parameters considered, more is the accuracy and efficiency of results. Alerting system should allow the user to request or cancel the emergency services in situation of false positives.

2.2 Related Works

Using smartphones to identify road traffic accidents is not a new subject. There are completed algorithms for systems which utilizes accelerometer as well as GPS to detect vehicle accidents using smartphones to detect accidents dates back to 2011.

In [1] the authors developed a system which used Android smart-phones and ODB-II connection in a vehicle. When the system detects an accident, will sends an SMS to emergency contacts specified by the user, SMS will contain information about the accident and also a call to the emergency services is made automatically. All modern vehicles have ODB-II connection installed which transmits data about the vehicle in real-time such as acceleration, oil pressure, speed, etc.

In [2], the authors at the University of Baghdad Iraq developed a system which made use of the accelerometer, GPS and microphone to detect accidents. Upon detection of an accident sends an emergency notification to the web server and also sends an SMS to the emergency contacts, emergency responders have to access the web server to find out about an accident. Their system made use of the same sensors and hardware that the algorithm presented in this project work makes use of, except for a few features.

In [3], the authors developed a system called WreckWatch which involves reading data from the accelerometer and acoustic data from the microphone to detect accidents. If an incident has occurred, the application contacts nearby emergency services and provides GPS-coordinates of accident location.

In [4], the authors have developed an android application that uses accelerometer sensor to detect accidents. After sensing the accident, application automatically sends a voice message to 108 ambulance emergency response service that is running in India.

2.3 Features of the System

The system detects accidents and report it to the nearest available emergency responders with the exact location of victims in emergency. It can result in reduction of accidental deaths and increase in improved emergency services. The application or system performs the following tasks or allows the following services:

1. **Localization:** Accident alerts are given to the nearest control station such as police station on the very first moment of collision. This results in reduction of late emergency services.Use of GPS helps in giving the precise location results so that the rescue team can be reached to the site of accident easily.

2. Rescue notifications: Alerting system notifies the contacts and also the nearest population to the victim so that supervision or aid can be received immediately.

3. Consideration of multiple factors : To achieve accuracy for accident detection and to reduce the false positive scenarios, the system takes various environmental cases and parameters as input. These environmental factors are calculated with the help of android device based sensors.

2.4 Limitations of existing system

1. For the system [1] to work a vehicle must support OBD-II standard. Other than that, upgrading and maintenance of this system is very expensive process.
2. The main issue with system [2] is that the notifications are sent to a web server and responders needs to check the web server for accident notification, there is no system for individual responder that responds to the emergency to track victim's location and also the system lacks the functionality to send emergency notification to the nearest emergency center in case there is more than one emergency center in the area.
3. The system [4] is prone to increased false positives because there is no filter in place to verify if an accident detected by the smartphone is a real accident or just false alarm due to dropping smartphone.

4. Most of the systems are built with hardware dependency. This results in increased risk or wear and tear and environmental interference. Also, the maintenance is costly and hence not feasible.

2.5 Advantages of current system

The system accounts for improvisation of the accident alerting and benefits the user in many different ways. Moreover, the current system overpowers the existing system on following crucial parameters :

1. **Hardware independent :** The current system is based on mobile based sensors and requires less or no dependency on external hardware, thus free from wear and tear.
2. **Cost effective :** The existing systems are costly and require quite maintenance as they are hardware based. Due to no such dependency in this system, accessibility to the application is quite cheap and easier.
3. **Localized real time notifications: :** Accident alerts are given to the nearest control station such as police station on the very first moment of collision. This results in reduction of late emergency services. Cellular network usage is the key to notification and thus, is faster unlike system. [2]
4. **Multiple factor consideration :** The system takes various environmental cases and parameters as input. These environmental factors are calculated with the help of android device based sensors instead of IoT based sensors. These parameters altogether make the detection and alerting mechanism effective which results in lesser false positives.

CHAPTER 3

ANALYSIS AND DESIGN

In this chapter, the procedure for implementation of the project and a brief explanation of why it will be useful for implementing the proposed system is included, and a brief description of the current system development approach is counted.

3.1 Methodology

The project development methodology is as follows :

1.Software Requirement Analysis :

This phase comprised of case study and literature survey of accidents, its types and statistics to determine the factors causing it. Case study of systems available for accident detection and it's accuracy. The case study needed to be thorough to get a clear idea of how the alerting system should be made.

2.System Design :

This involved analysis of the independent modules required to carry out project development and study of processes involved for the application. Wire framing the modules, creation of flow structures, mapping of processes, API's and refining it until an effective integrated design is made was being the major concern.

3.Coding :

It comprised of implementation of the preplanned user interfaces and involvement of components for better user experience. Programmatically implementing the sensors, gathering its data and using it within the half-baked application was the major goal. Also, programming of the location based services and it's related modules was another concern. Firebase services integration was also the major task in this phase.

4.Integration :

This phase revolved around integration of the modules and synchronizing its results. And validation of the actual implementation of application with the preplanned design schema.

5.Testing :

Testing the integrated services of location API's, firebase. Involvement of field testing of application and determination of ways to improvise on accuracy of result was the primary objective.

3.2 Users defined for the system

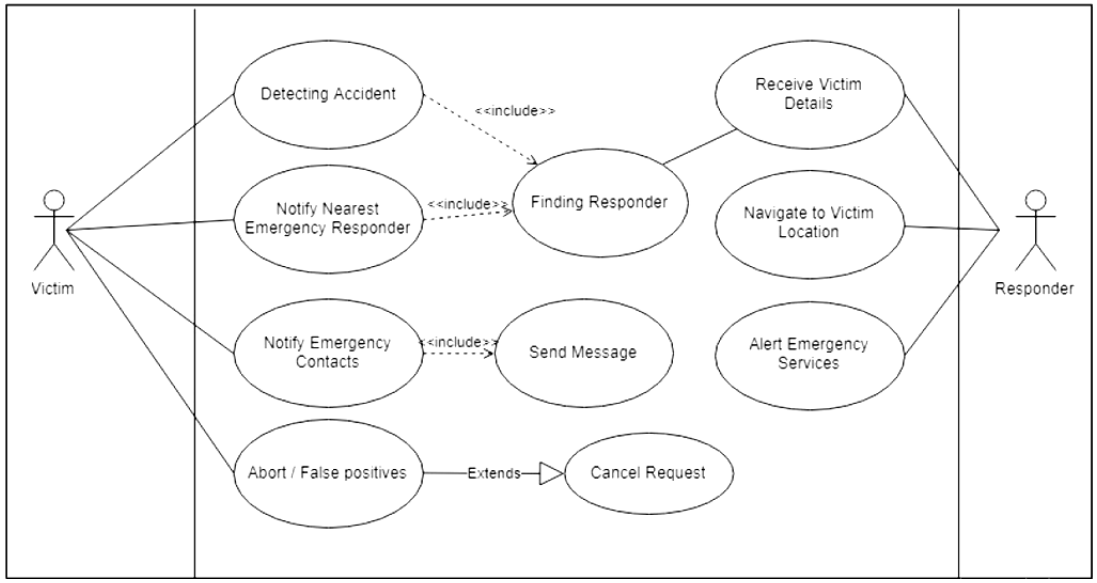

Figure 3.2.1- Use case diagram of System

Above Use Case indicates the user's full interaction with the system. The user first registers himself, user can then log in to the system using firebase email and password authentication. He/she can view/update his profile at any time after authenticated. The user can turn on Monitoring which will register an accelerometer service running in the background, it can now detect commute activities and all kinds of jerks produced by the user on his/her smartphone and correctly differentiate between accidents and normal routine jerks.

User can add emergency contacts too. In case if any accident is encountered, automatic notifications are sent to the responder and also to the emergency contacts. When a trigger is generated mistakenly, a user can cancel the trigger and thus a false positive is avoided.

3.3 Flow of Control

The figure above is an activity flow diagram of given system. The system focuses on three modules as showing in above figure, i.e.

1. Triggering of alert
2. Nearest Responder Search
3. Location Tracking

Apart from these, the first decision block acts like a filter for trigger, if the user clicks on 'Abort' emergency services won't be alerted then. Else the nearest responder is selected for the providing the emergency service. And side by side, the location path is shown to the user and responder, both.

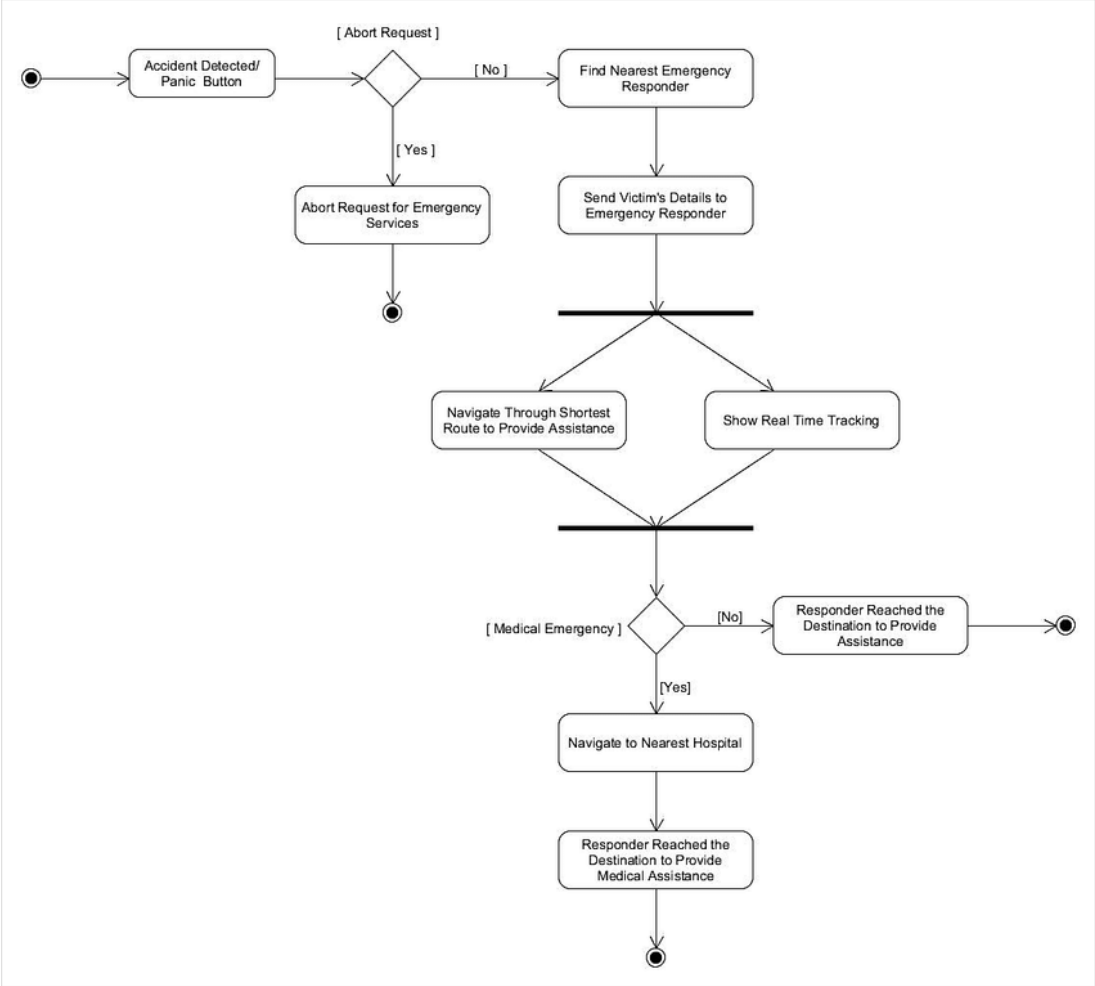

Figure 3.2.2- Activity flow diagram of System

3.4 Process

Accelerometer delivers acceleration values for each of the three axes. Accelerometer values are based on equation below.

$$A_D = -g - \left(\sum \frac{F_s}{m} \right)$$

Equation shows that the acceleration values that an accelerometer sensor generates is force is divided by mass (m) which is affected by gravitational acceleration . Acceleration for each axes (ax, ay, az) is derived based on this equation. The Pythagorean Theorem is used to derive values from accelerometer as shown below.

$$a = \text{root of } ((\text{axis value of } x)^2 + (\text{axis value of } y)^2 + (\text{axis value of } z)^2)$$

By using the value of (a) the value of g-force (gravitational force) is calculated.

$$G = a/g$$

Where, a= acceleration and g= gravitational accelaration

Equation above shows that g-force value is calculated from acceleration (a) divided by gravitational acceleration (G). Accidents can be detected by checking if g-force value exceeds a specified threshold, which in our system will be 4g, which then will generate an emergency alert.

CHAPTER 4
SYSTEM DESCRIPTION

4.1 Software tools

1. Android Studio

The Android Studio IDE is free to download and use. It has a rich UI development environment with templates to give new developers a launching pad into Android development. Developers will find that Studio gives them the tools to build phone and tablet solutions as well as emerging technology solutions for Android TV, Android Wear, Android Auto, Glass and additional contextual models.

Android Studio is intended to be used by development teams as small as one person or as large as global teams. The Android Studio IDE can be linked to larger teams with GIT or similar version control services for larger teams. Mature Android developers will find tools that are necessary for large teams to deliver solutions rapidly to their customers. Android solutions can be developed using either Java or Kotlin in Android Studio.

2. Android SDK

A software development kit that enables developers to create applications for the Android platform. The Android SDK includes sample projects with source code, development tools, an emulator, and required libraries to build Android applications.

3. Geo Fencing

Geo Fencing is the establishing of a virtual fence around a predefined geographic area. When one of our app users enters or exits a geofenced area, a targeted push notification is sent directly to their device. It is a feature in a software program that uses the global positioning system (GPS) or radio frequency identification (RFID) to define geographical boundaries.

Geofence virtual barriers can be active or passive. Active geofences require an end user to opt-in to location services and a mobile app to be open. Passive geofences are always on; they rely on Wi-Fi and cellular data instead of GPS or RFID and work in the background.

4. **Firebase Cloud Store**

Cloud Storage[5] for Firebase is a powerful, simple, and cost-effective object storage service built for Google scale. The Firebase SDKs for Cloud Storage add Google security to file uploads and downloads for your Firebase apps, regardless of network quality. On the server, you can use Google Cloud Storage, to access the same files.

5. **Retrofit**

Retrofit is a type-safe HTTP client for Android and Java, provided by Square. Retrofit makes it easy to communicate with a web server and get back data, as java objects, it automatically supports a large collection of response types, including converting JSON objects into Plain Old Java Objects. Alternative of Retrofit is Googles Volley, which is also a HTTP library, for our system we chose Retrofit because it is light weight and has more documentation.

6. **Google Location API**

The Google Location Services API[6] is part of Google Play Services, provides a more robust, high-level framework that automatically chooses a suitable location provider and power management. Location Services also provides new features like activity detection which is not provided by framework API. Developers should consider using Location services API if they are using framework API and also if they are making their apps location –aware.

7. **Android Google Map API**

The Google Maps Android API[7] is a service which is part of the Google Play services library. Allows access to Google Maps server automatically, displaying map, downloading data, and map gesture response. It also allows to add markers, polygons, and basic map overlays, and to transition the user's context of a specific map area.

8. **Google Places API Web Service**

The Google Places API Web Service[8] is a service which returns information about places like locations, geographic, establishments and prominent points of interest using HTTP requests. The main alternative of Google Places API is Foursquare Venues. In free version Google Places allows 150000 queries per day and Foursquare Venues

allows 120 000 queries per day . These two services are mostly similar, we chose Google Places API because we were more familiar and experienced using it.

9. Google Directions API

The Google Directions API [9] is a service that uses HTTP request to calculate distance between locations. When calculating directions, the API returns the most economic routes. The API decides which route is most efficient on the basis of travel time, number of turns, distance, etc.

10. Firebase Cloud Messaging

Firebase Cloud Messaging is another adaptation of Google Cloud Messaging. It is a cross-platform messaging solution that allows us to reliably deliver and receive messages without any cost. Using FCM, we can send notification messages in order to re-engage users. [10].

4.2 Hardware and Sensors

1. Android Smartphone

Smartphones are mobile phones that have considerably a lot of functionality than a regular mobile phone. They're mobile computers. Smartphones are powerful and versatile as a result of built in sensors, powerful processors, multiple network interfaces and a high amount of memory for such small devices.

Smartphone with Android OS (API 21 or above) with cellular network is a prerequisite. The device must also have Internet access available.

2. Accelerometer

An accelerometer works by detecting proper acceleration affecting the accelerometer to determine the G-forces affecting the accelerometer. Proper acceleration means acceleration that is relative to free-fall. An object in free-fall would as such have no acceleration affecting it while an object at rest on the surface of the earth would experience an acceleration of 9,81 m/s2 upwards due to the surface pushing the object upwards to negate gravity.

Accelerometers in smartphones bases their functionality on micro-electromechanical-systems (MEMS), which measure electric currents based on compression of a seismic mass, often silicon, caused by acceleration.

G Force denoted as g_0 is the gravitational force equivalent and is a measurement of the type of force per unit object. The G-Force acting on the user is continuously kept track of. A typical person can handle about 5 g_0 (49 m/s^2) .i.e. some people might pass out when riding a higher-g roller coaster, which in some cases exceeds this point before losing consciousness. The system maintains a threshold of 4 g_0 below which a rider is considered to be safe. When this value crosses the threshold, it indicates that the scenario is more of an implication of accident.

4.3 Storage design

The system uses firebase storage which is entirely based on concept of Documents and Collection. Firestore stores data as collections of documents. Complex, hierarchical data is easier to organize at scale, using subcollections within documents. Requires less denormalization and data flattening.

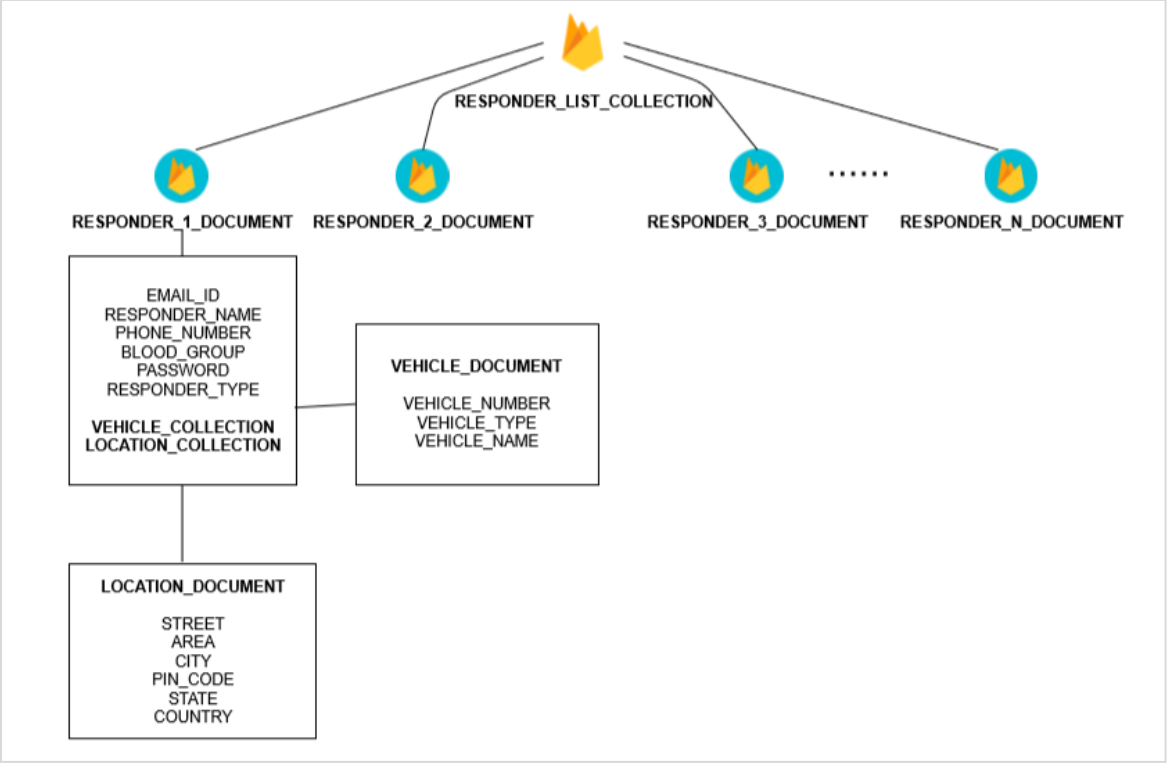

Figure 4.3.1- Database Structure of Responder entity

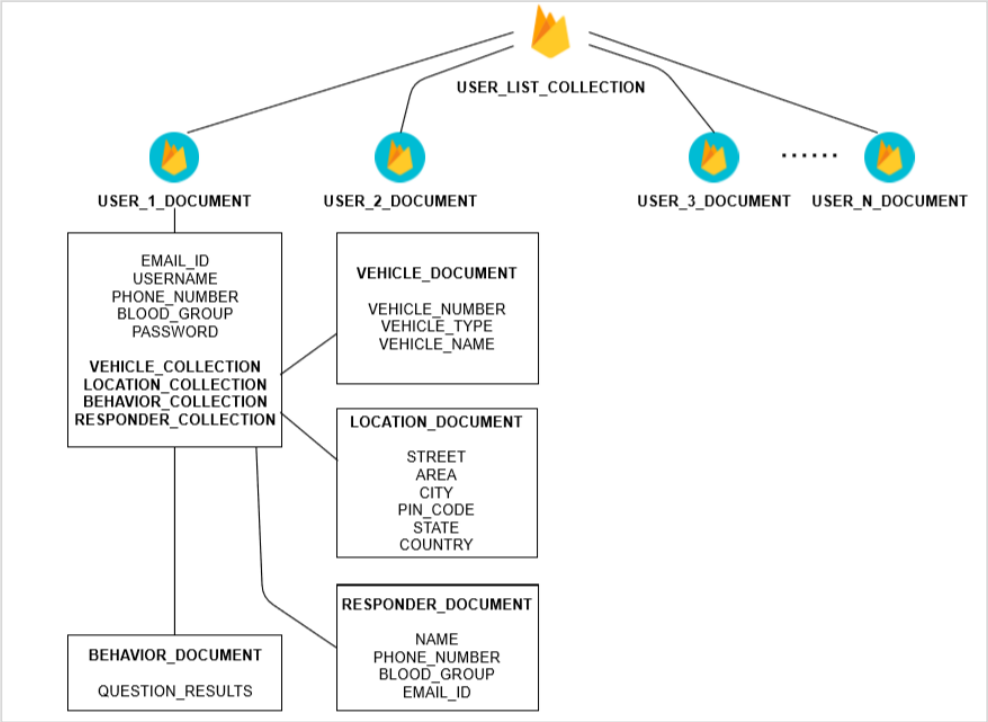

Figure 4.3.2 - Database Structure of User entity

CHAPTER 5

PROJECT IMPLEMENTATION

5.1 Front End Representation

1. User Module

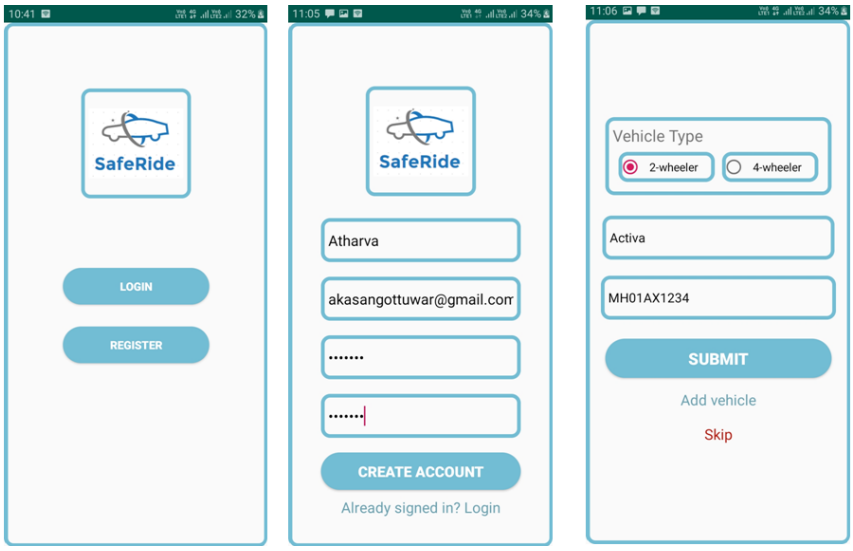

Figure 5.1.1- Registration Options

Figure 5. shows Registration screen wherein users can use email and password to register and then use the same to log in to the system. After users logs in to the system, they will be able to use all system features. All the registration information gets stored into firebase.

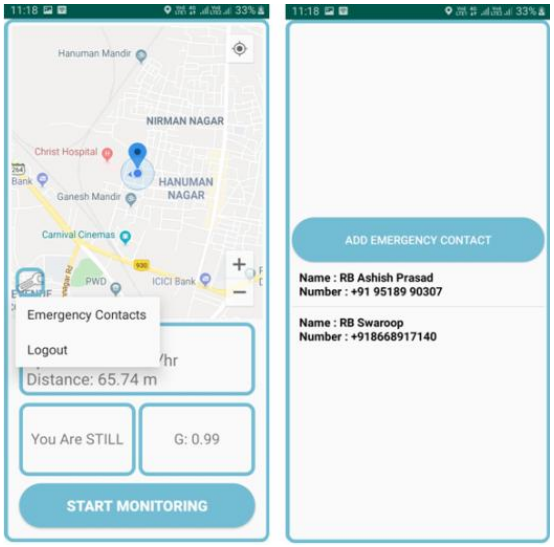

Figure 5.1.2- Add Emergency Contacts

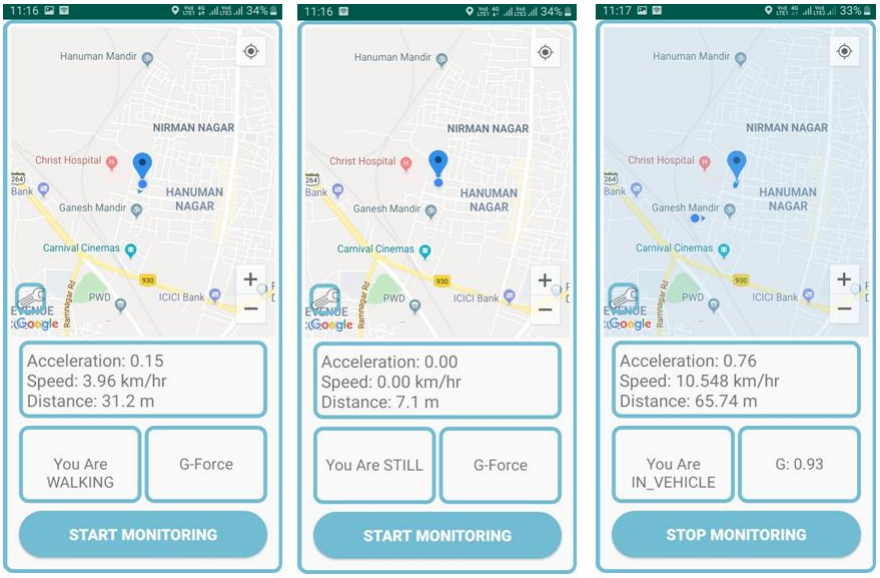

Figure 5.1.3- Activity Monitoring

Figure 6 represents the feature due to which user can add emergency contacts in the system. These contacts will further be used whenever accident occurs. They get alerted using a location based text message.

Figure 7 demonstrates the manner in which runtime details are represented to the user. Acceleration, speed and distance be the parameters which are displayed to the user. The activity recognition helps to track whether user is on foot, or vehicle or is still. GForce value is continuously kept track of.

2. Responder Module

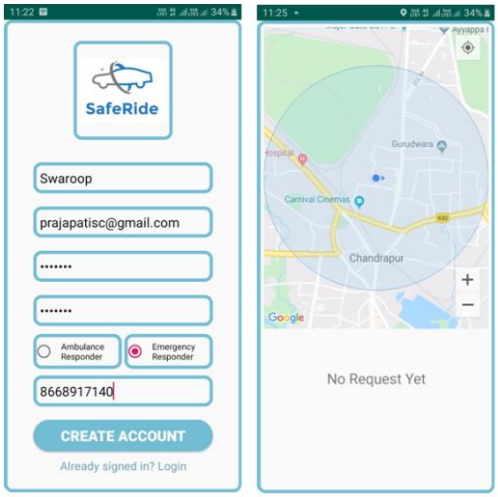

Figure 5.1.4- Responder registration

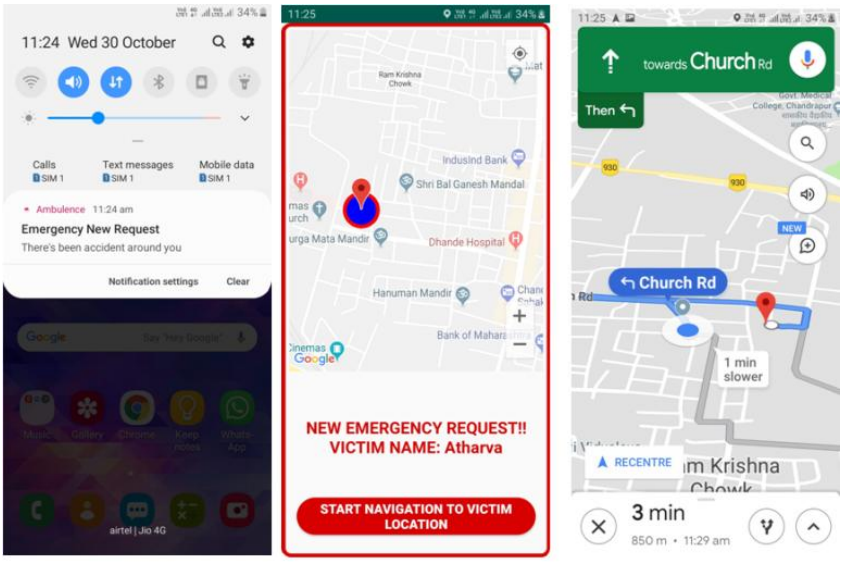

Figure 5.1.5- Alerting when accident occurs

Figure 8. shows Registration screen wherein responder can use email and password to register and then use the same to log in to the system. After responder logs in to the system, they will be able to track any accidents, if nearby.

When an accident occurs in vicinity, a trigger is raised by the user which is sent to the responder in form of notification as shown in figure 9. Responder gets the location of user and can start navigation as soon as an accident is notified.

5.2 Back End Representation

1. User Database

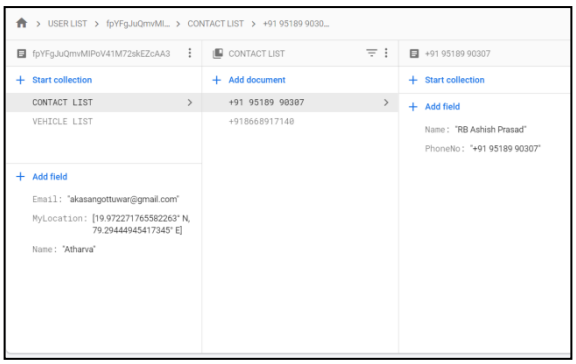

Figure 5.2.1- Emergency contacts

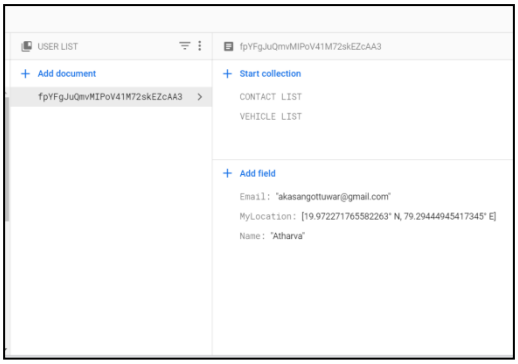

Figure 5.2.2- User Details

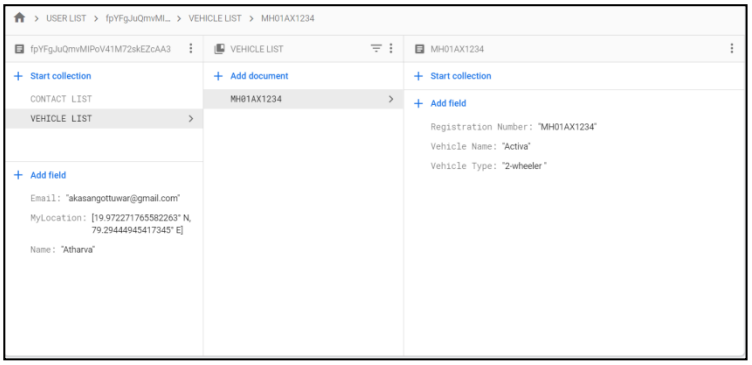

Figure 5.2.3- Vehicle Details

User has to provide email and password to login. Once the user is logged in, it is not necessary to login every time unless user is logged out. The firebase authentication system provides the user id which is synced with a device token that matches the user authenticity. Figures above show registered users, these users are authenticated and can log in to the system to use all system features. All user related details are maintained accordingly.

2. Responder List

From emergency responder's point of view, the application will show the location of the emergency that occurs near to them, this will help in reducing response time, so that they will be able to track victims in real time and rescue them as soon as possible, resulting in a more efficient usage of emergency services resources. Token is maintained which uniquely identifies the nearest responder.

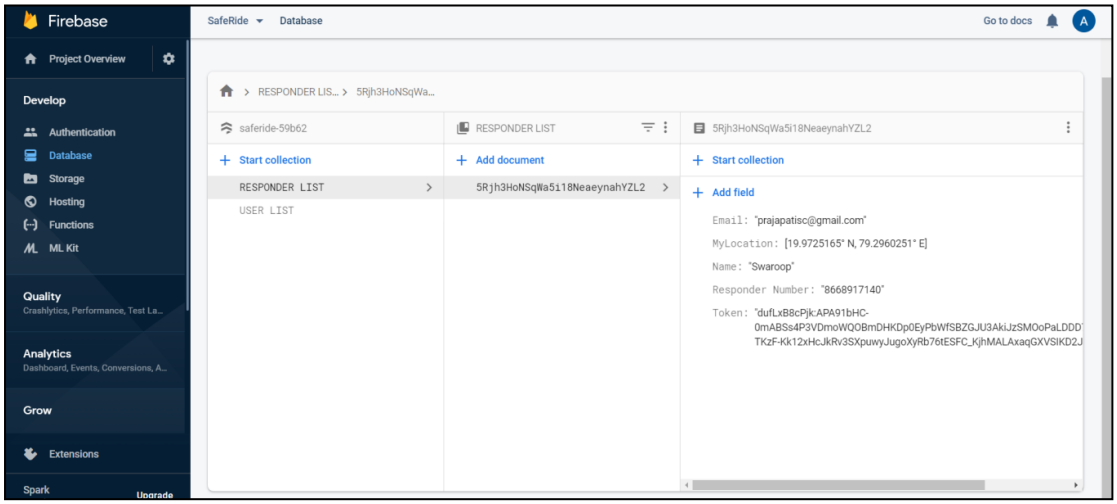

Figure 5.2.4- Responder details

CHAPTER 6
RESULT AND DISCUSSION

From emergency victim's point of view, during fatal accidents, emergency victims usually are not able to call an ambulance by themselves, in these situations the designed system will automatically detect the accident and will send an emergency notification to the nearest emergency responder available, to hopefully save victim's life. Sending an emergency alert is a lot easier and convenient because all essential functionalities reside together. In case of other emergencies, the system also can be further developed to provide functionality to send request to the desired emergency service.

From emergency responder's point of view, the application will show the location of the emergency that occurs near to them, this will help in reducing response time, so that they will be able to track victims in real time and rescue them as soon as possible, resulting in a more efficient usage of emergency services resources.

We conducted some tests by making the smartphone go through an abrupt situation like hard shake, or motion to notice the g-force value changes. We also We conducted some tests by dropping a smartphone from height of 10, 15, 30 and 40cm and recorded the g-force values which can be seen in figure 6.1.

Height	Max	Min	Average
10 cm	2.484621402	1.126285167	1.805453284
15 cm	2.568356721	1.201817380	1.885087050
30 cm	2.981591310	1.766139158	2.373865234
40 cm	3.315491403	2.041593813	2.628542608

Figure 6.1. G-Force findings

The maximum g-force value we got in our testing by dropping smartphone from the height of 40cm was 3. 315491403. Our system will generate alert if the g-force value exceeds 4g.The threshold value at which our system will generate emergency alert is set to 4g, because during fatal traffic accidents the g-force value exceeds 4g. It can detect when an accident occurs but will avoid false positives in case of dropping a smartphone or applying sudden brakes in a vehicle.

CHAPTER 7

FUTURE SCOPE

For future work, more progress is needed in research order to make the accident detection part more reliable and accurate which will help in reducing false positives. Adding additional sensors data in combination with accelerometer for accident detection like gyroscope, microphone, camera (to automatically take pictures of the accident) and a voice recognition module to detect noises during a vehicle crash like noise when air bags are deployed, will drastically increase the reliability and accuracy of the system

Also, the application can be developed to allow the user to report emergency like situations such as fire, panic situations nearby with just a single click.

More robust machine learning based models can be used to work up as classifier on the multiple set of attributes such as tilt movement, acceleration, voice. This will help to improve the accuracy of system.

CHAPTER 8

CONCLUSION

In this project, the system uses on board accelerometer sensor to detect accident and generate emergency alert and send it to the nearest emergency responder and will also send an SMS to emergency contact containing location coordinates of the accident. With real time location tracking for both victim and responder the system will drastically increase the survival rate of an accident victim by providing emergency aid in time. Emergency responder will be able pin point victim's location on a Google map in real time.

The probability of false positives in a smartphone-based accident detection and rescue system is inevitable. We have added some features to reduce these issues. Here are some features we added to reduce false positives.

- **Acceleration filter:** The system will ignore g-force values lower than 4g.
- **Count down timer alert:** On detection of an accident the system will present an alert dialog with 15 sec count down, which the user will be able to cancel in case accident didn't occur.

This application can result in reduction of accidental deaths and increase in improved emergency services. It can be further developed with more characteristics to improve the efficiency of accident detection.

CHAPTER 9

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