IOT BASED REAL-TIME FIRE PROHIBITING SYSTEM USING GOOGLE MAP 'FIREMAP'

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/Internship titled **"IoT Based Real-Time Fire Prohibiting System Using Google Map—Firemap"**, submitted by Nayem Musaddik, Md. Afratul Kaoser Taohid and Md. Imran Khan to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 5 May, 2018.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Rayhan Amin, Lecturer**, Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

The purpose of the system is to build an improved fire alarm mechanism that will alert the Firefighter authority automatically with the real time location of the incident and show them the shortest path on the map to reach there. There will also be a home user's end to confirm the fatality of the risks via a smartphone application. The main feature of the project is to automatically alert and guide the firefighter to the fire incident location as it detects fire. Mainly two categories of users will be notified if any occurrence happens, one is the firefighter authority and another is the home users. With the help of **Smoke Sensor, Flame sensor** and **Temperature Sensor** smoke, fire and temperature data will be collected and using **Arduino Uno R3** and **ESP-8266** Wi-Fi Module the collected data will be sent to a smart phone application via real time firebase database. Thus the both of the users will be alerted. To avoid any false alarm there will also be options for Fire Service authority to contact the users of the incident's location to know the intensity of the fire and the damage percentage. Home users can also take photo of the incident and manually notify the firefighter authority via the smart phone application. The advantage of the system is that it will help the firefighter authority to locate and act quickly for any fire occurrence by knowing the real-time location and shortest path of the place and by the final confirmation from the home users they can avoid false alerts.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Fire is a revolutionary invention of mankind. It is one of the core elements of our survival and without it our survival will be unimaginable. Many times fire breaks out accidently and spreads over a large area and destroys everything in its way. It can break out anywhere anytime in houses, factories, malls etc. it can be very dangerous and can cause a great damage to human life and property. Fire is one of the major causes of accidental death in the world. If proper action is not taken at a proper time, casualties can be unbearable and unrecoverable. As technology advances, various types of alarm system have been developed by using smoke detectors, temperature sensors, GPS modules and cameras etc. Many automatic alarm systems are now available due availabilities of microcontroller and these instruments. The advancement of internet based technologies are increasing the efficiency of these systems. Wireless technologies and higher data transmission rate has created a concept called IoT (Internet of Things). This project may take us one step closer to reach completely Iot based world where everything is connected to internet and automated. Development boards like **Arduino** and **ESP-8266** are helping these automated systems to come to life. These devices are cheap, low power consuming and very small in size. The project proposed in this paper combines these devices with smart phone application and creates an IoT based automated fire alarm system that ensures efficiency and reliability.

1.2 Motivation

This is the era of modern technology. Nowadays technology is helping us to overcome many obstacles in our lives. Technology has made our life more easy and secure. Day by day our technology is getting smart and proper use of smart technology has brought a lot of blessing to us. From the different incidents of the past it has been observed that fire has taken many lives and caused a heavy damage to our valuable properties due to poor response time of firefighter authorities. On the other hand firefighter authorities could not reach the place in time or responds late because they don't get the alert at the correct time. The situation gets worse at night because people remain sleeping at households and the industries, company offices remain closed during the night time. So if the fire breaks out it becomes too late. And because of this delay the damage percentages becomes very high and lives are lost. Sometimes firefighter units also faces difficulties to reach the proper location because they could not determine the exact incident's location. The main idea of our project is to alert the firefighter authority in real time if the fire breaks out and help them to reach the exact location as fast as possible by help of technology. The purpose of our research project is to use the technology to reduce the damage caused by the fire and make our lives and properties secure.

1.3 Objectives.

The first section will be a threshold based auto detection system that will be triggered by using the intensity of smoke sensor, flame sensor and temperature sensor. There will be another section which will be based on an android application. The application will be mainly used for final confirmation and guiding the firefighter unit towards the exact location. The android application will be also used to manually notify the firefighter, to determine the damage percentage, to take photos of the casualty and send it to the authority that will help understand the fire intensity. So the main objectives of this project are as follows:

- Auto detect fire by using the sensors and Alarm the fire service and home users.
- Show the shortest way to the incident's place via Android application.

- If needed firefighter can get confirmation of the occurrence by contacting the home users. So that they could avoid the false alarm.
- On the other hand if the auto detection system fails home users can manually notify the firefighter via Android Application.
- Home users can take photograph of the fire incident and send it to firefighter authority. There will also be an option for home users to to set the damage percentage.

1.4 Expected Outcome

The aim is to complete all the task stated above. The completion of this project will help us to reduce the casualties caused by the fire. People will be safe from any kind of fire incidents.

The cooperation of the firefighter is mostly needed for this project. The project will help the firefighter to act as quickly as possible .It will also help them to reach the place of incident. Another great thing is the project will help detect false alarm. Firefighter authority will able make sure that fire has really gone out of control by interacting with home users. The damage percentage reporting system of the project will also help the firefighter to be sure of the severances and these are some important data for future research.

1.5 Report Layout

The project paper is divided into six chapters where the first chapter has segmented with the introduction, objectives, motivation, expected outcome and report layout. In Second Chapter, Background of this project, introduction, related works, comparative studies, scope of the problem and challenges of this project has assembled. Third Chapter focuses on Requirement Specification where Business process modeling, Requirement collection and analysis, use case modeling and description and logical data model and design requirements. In Chapter 4, Design Specification is based on Front-end Design, Back-end Design, Interaction Design and UX and Implementation Requirements. In Chapter 5, we discussed about how we implement this system and it’s testing. Chapter 6 is about conclusion and our future Scope what we will do in next.

CHAPTER 2

BACKGROUND

2.1 Introduction

Since the evolution of microcontrollers and integrated circuits a lot of automatic security and surveillance systems has been built. As we move towards to IoT world more and more AutoDetect and alarm system are being developed. The up gradation and availability of high speed internet helped these inventions to spread through different platforms. To build our proposed system firstly a background study needed to be done on related projects.

2.2 Related Works

Md Saifudaullah Bin Bahrudin and Rosni Abu Kassim [1] proposed a real time fire monitoring system using Raspberry Pi and Arduino Uno. Attaching a camera they capture an image and remotely send an alert only if the smoke is detected. The image will be displayed in a webpage. There is a user confirmation system to avoid the false alarm and report to the firefighter via Short Message Service (SMS).

Sarita Gupta, Ajay Mudgil, Prashant Bhardwaj and Mahendra Gupta [2] built a wireless, real time, automatic fire alert system consist of microcontroller, RF module, GSM and two types of sensors. This system can detect degree of fire or spread of fire and location of accidental site. They used GSM module to transmit the collected data to the firefighter authority. Google Map is also used here to display and point the fire affected location.

Zhang Kun, Hu Shunbin and Li Jinfang[3] developed an automatic warehouse fire alarm system based on MCU. Their system consists of ATmega16, temperature sensors, smoke sensors, and EX-1 auto dialed alarm module.The system collects data by using temperature and smoke sensors and processes the data using MCU. If the fire is detected by the system then the alarm signal is turned on and transmits messages through EX-1.

Suresh S., Yuthika S. and G.Adithya Vardhini[4] built an affordable Home based Fire monitoring and Warning System using Arduino Uno R3. If the system detects a certain level of smoke or flame it alerts the property owner using GSM. They mainly focused on building an economical automatic fire alarm system so that users at any level of income can afford it.

2.3 Comparative Studies

All these projects above are very well developed and effective. But our project is focused on both IoT and smartphone application. None of these projects have any part for smartphone application. We think nowadays smartphone applications have become very important, useful and popular in our everyday life.it can also be useful to avoid any dangerous situations. By the help of the smartphone application we can show the firefighters the shortest path of the incident. In our project there is options for firefighter authority to avoid any false alarm by contacting the home user on other hand there is an option for home users to alert the firefighters manually via the smartphone application. Our system also has options for users to take photo by the smartphone application and submit the damage percentage of the incident. These extra effective features made our system more unique and ensures more safety for any unwanted fire situations.

2.4 Scope of the Problem

To make an effective fire alarm system we needed to ensure that it is automated and there are measures to avoid false alarm. By the help of the microcontrollers and sensors we have made the system automatic and by the help of smartphone application we added the extra features and ensured the reliability. We have also option for home users to submit the damage percentage so that firefighter can determine the risks and the submitted data can be used for future studies.

2.5 Challenges

Finding the threshold value for the sensors was very challenging task. We had to fix a certain amount of smoke and flame intensity to trigger the alarm. This threshold value indicates if the smoke/fire has crossed the danger level or not.

There are different options for firefighter authority and home users. For that we have to build two separate android application for two types users.

Determining the exact location of our home device was very difficult as GPS module Neo-6M does not pick the correct location under the roof. It only works if the device is situated outside. So cope up with this problem we have let the home user to provide the location while signing up and we have used the ESP-8266 module and embedded with Google maps to pick up the location of the device.

CHAPTER 3

REQUIREMENTS SPECIFICATION

3.1 Business Process Modeling

3.1.1 Feasibility Study:

In this phase the feasibility of the system needs to be analyzed and proper business proposal plan needs to be determined and cost estimates also should be considered. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

Economic Feasibility

To determine how the system will impact on the organization economically, this study is conducted. Only limited amount of fund will be invested by the company into the research and development of the system. So the system is made as cheap as possible so that the expenditures is properly justified. Using cheap small and portable devices like ESP-8266 and Arduino UNO R3 rather than using Raspberry pi has made this system less costly and economical.

Technical Feasibility

To make the system more technically efficient this study is carried out. The system must be made as error proof as possible to cope up with this challenging world. Without technical efficiency this system will not be useful at all. This will dissatisfy the system's purpose. The developed system must have a decent requirement, as only exquisite or null changes are needed for implementing this system.

Social Feasibility

The purpose of study is to verify the level of acceptance of the system by the user. This includes the method train and motivate the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as an importance. The level of acceptance by the users mostly depends on the processes that are used to educate the user about the system and to make him recognize it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed.

3.1.2 Data Flow Diagram

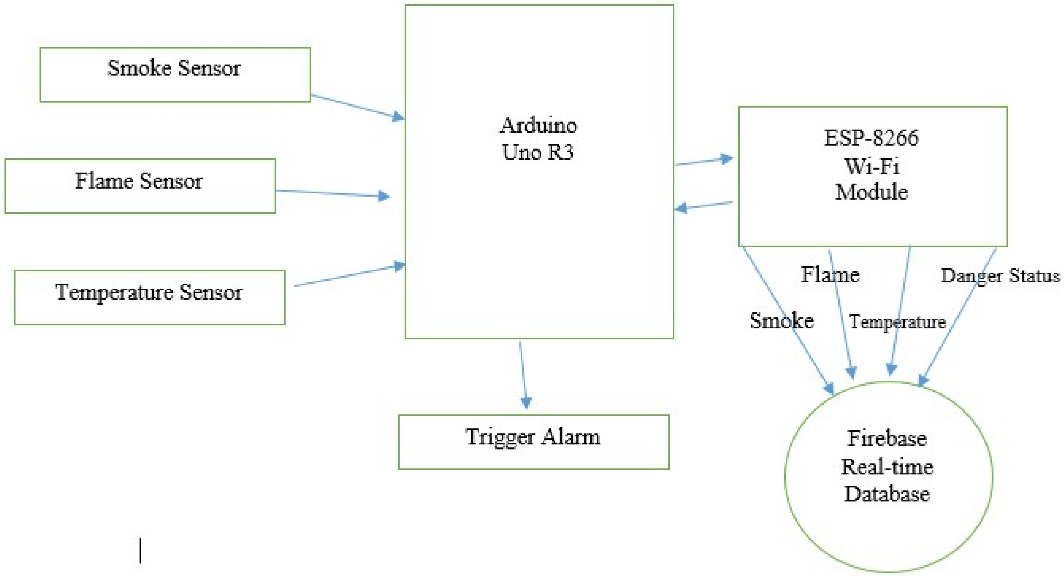


Figure: 3.1.1 DFD Device Module

Figure: 3.1.1 shows the data flow diagram of the device. Here all the components are connected with each other via Arduino Uno. Data is collected and sent to the server.

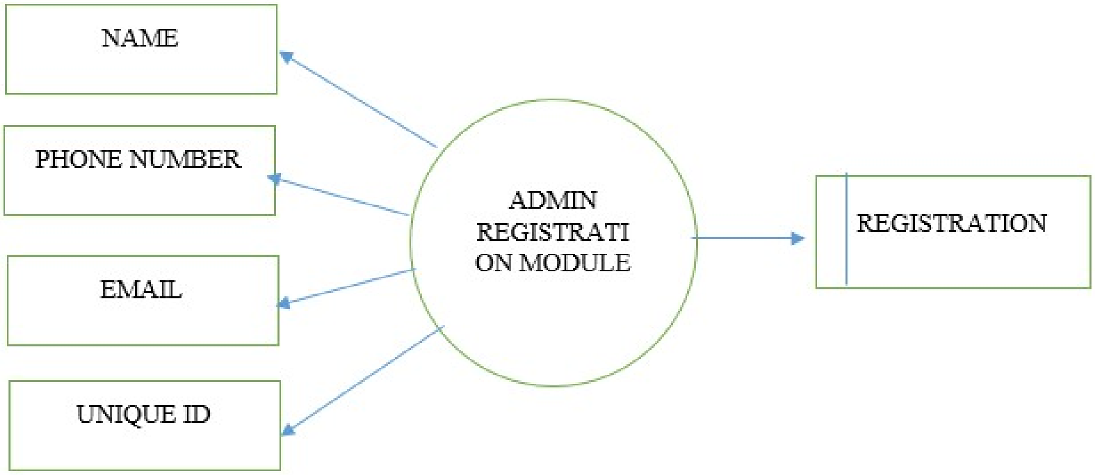


Figure: 3.1.2 DFD Firefighter Registration Module

Figure: 3.1.2 is the data flow diagram of the Firefighter Registration process. All the data is required for registration.

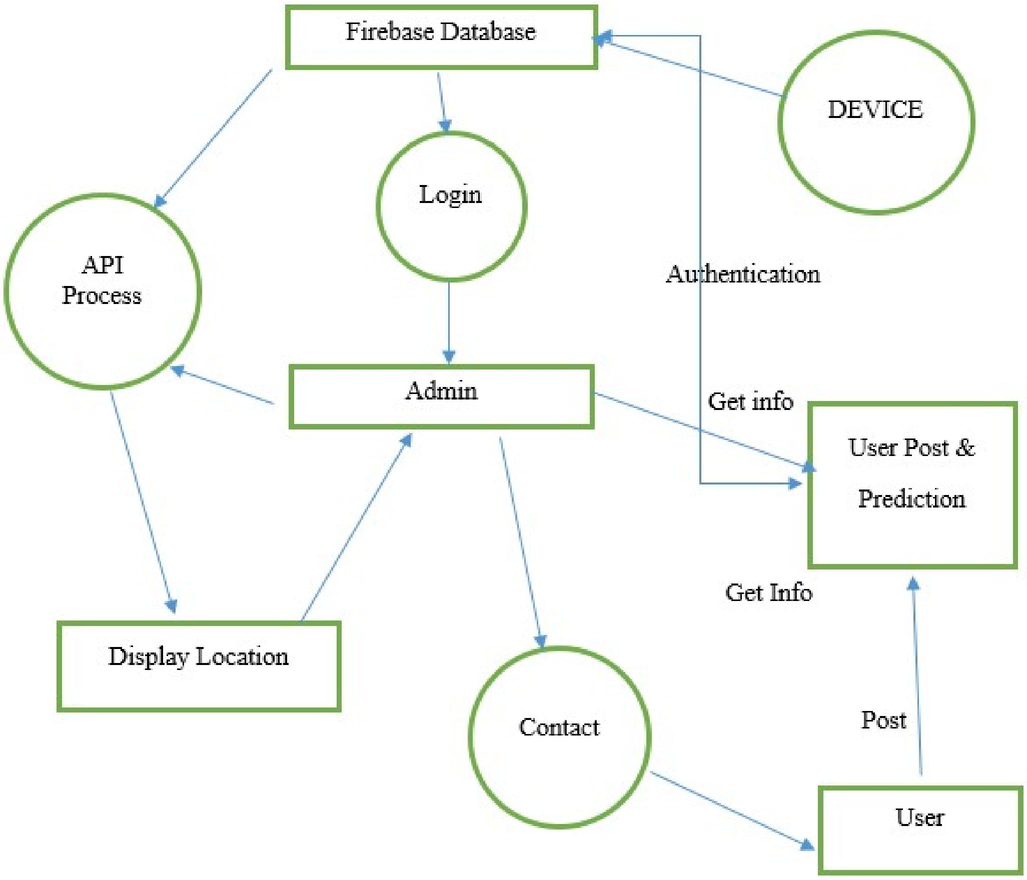


Figure: 3.1.3 DFD Firefighter Module

Figure: 3.1.3 is the diagram of takas of fire fighter app. To access these option firefighter must login first

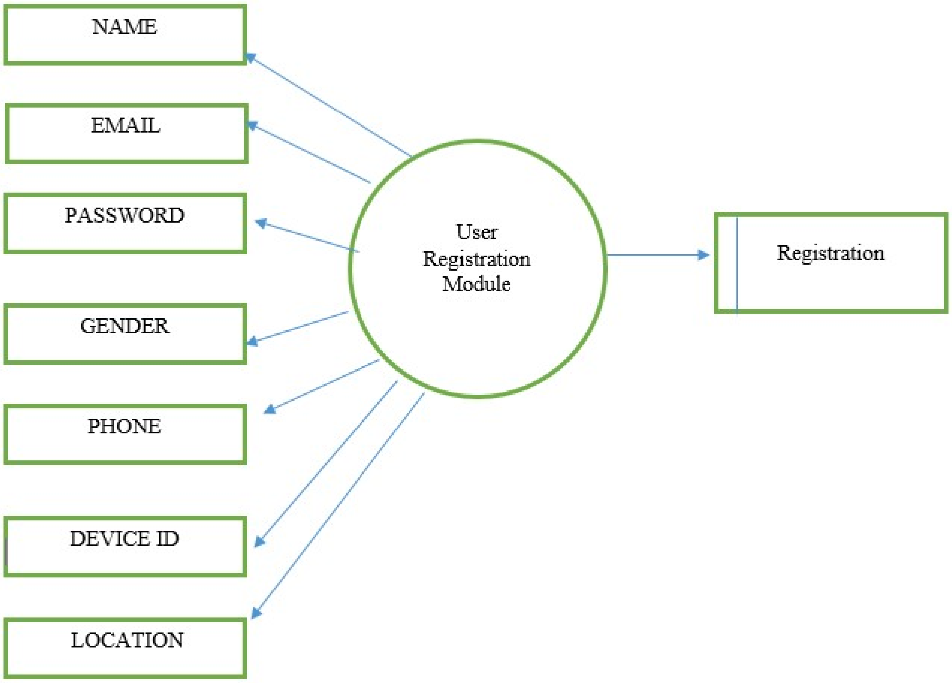


Figure 3.1.4 DFD User Registration Module

Figure: 3.1.4 is the data flow diagram of the Home User Registration process. Home user bust own the device before registering.

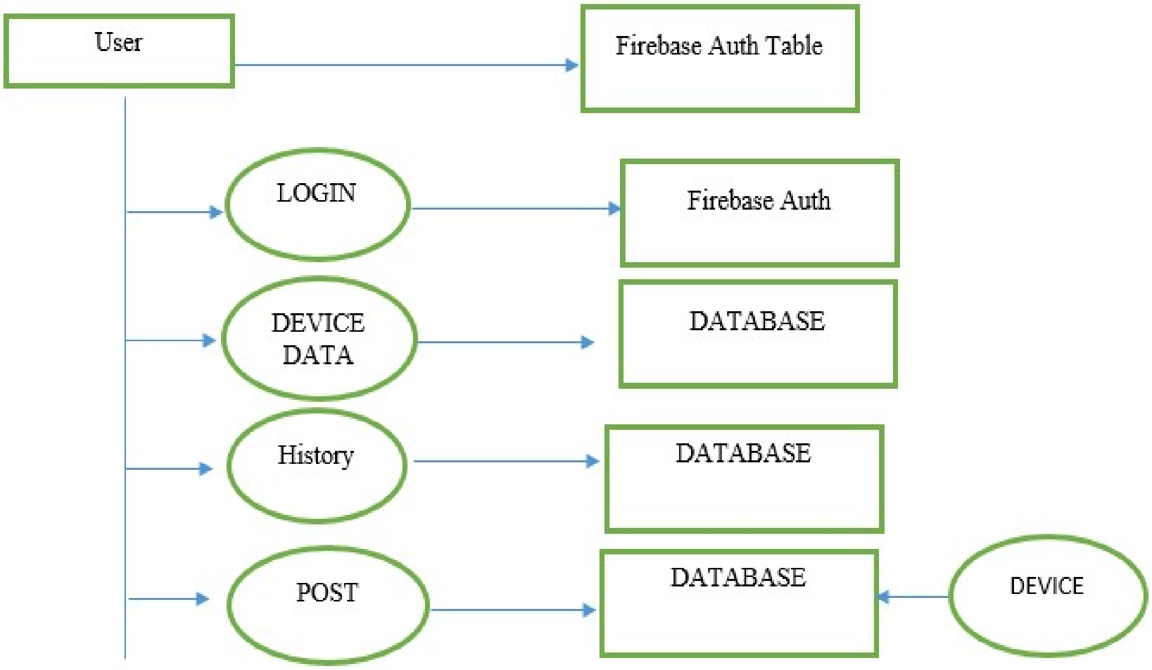


Figure 3.1.5 DFD User Module

Figure 3.1.5 is the data flow diagram for the tasks of Home User app. All the data is maintained by a firebase database.

3.1.3 Process Diagram

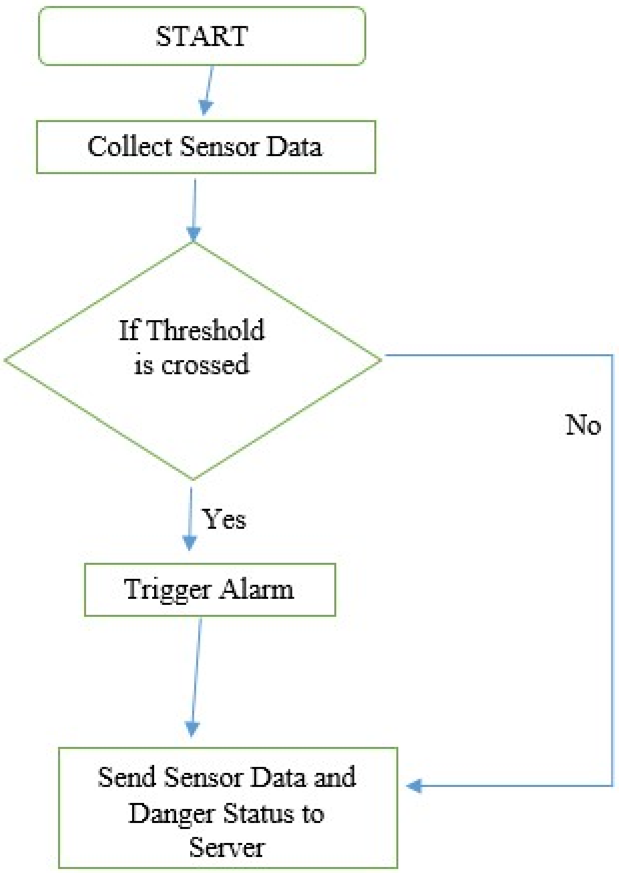


Figure 3.1.6 Process Diagram (Device)

Figure 3.1.6 shows the process diagram of the device. The device collets the data using the sensors and if the values crosses the threshold then its sets alarm and send the danger status to server.

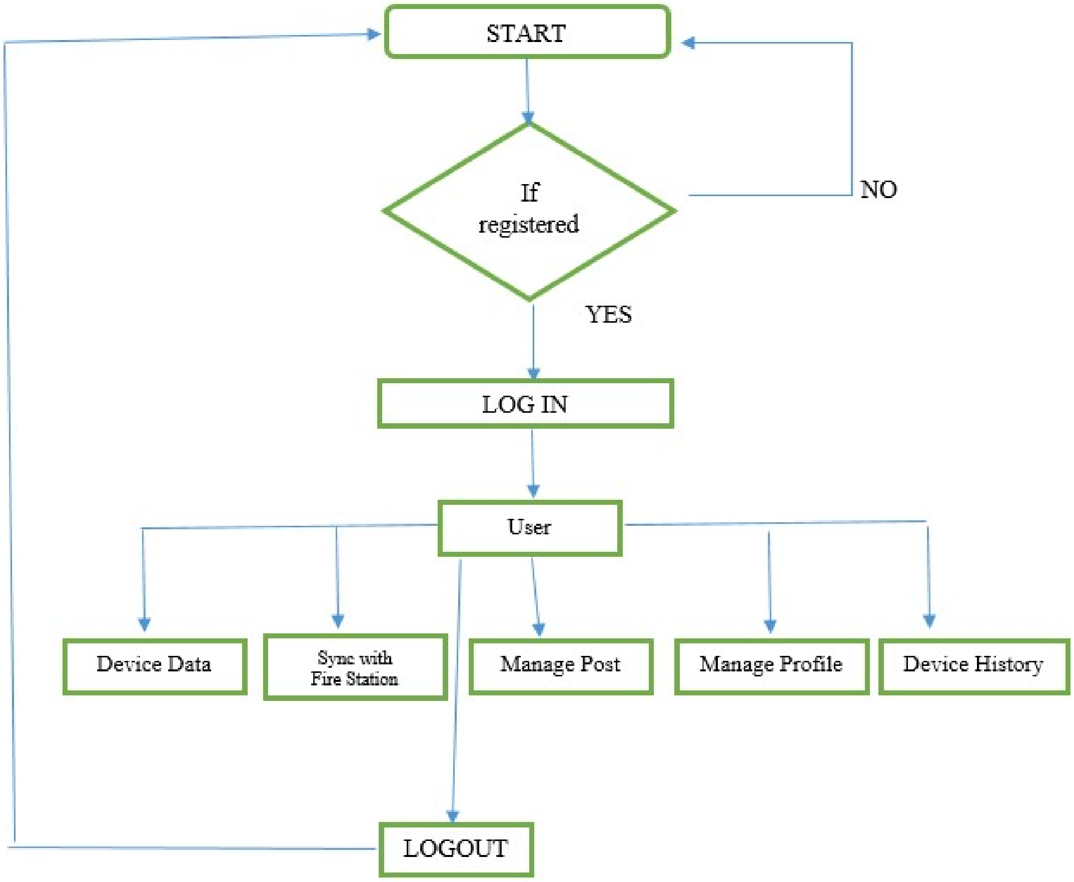


Figure 3.1.7 Process Diagram (User)

Figure 3.1.7 is Process Diagram of the user. User must get registered or log in to access these features like viewing sensor data, manage profile, manage post e.t.c

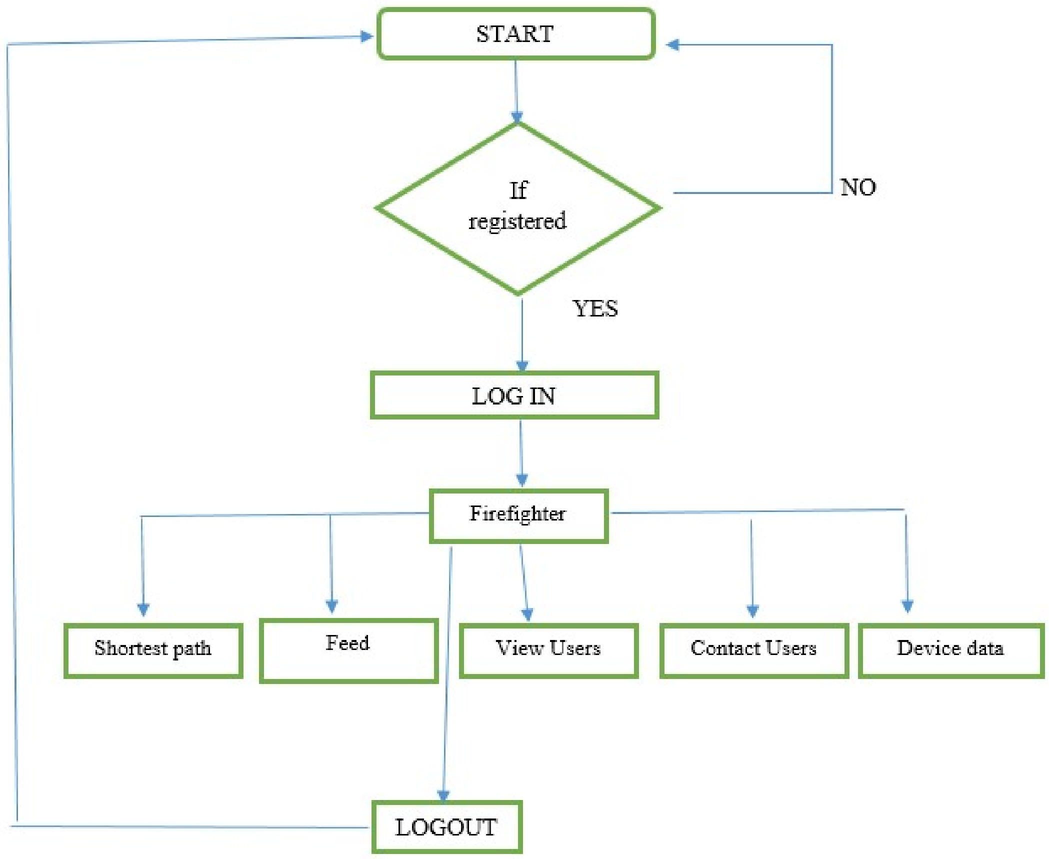


Figure 3.1.8 Process Diagram (Firefighter)

Figure 3.1.8 is the process diagram of the firefighter app. Firefighters can take immediate action using these features.

3.2 Requirement Collection and Analysis

For building this project we have analyzed different hardware components and collected the proper, efficient, portable and cost friendly equipment. Here we have described the details about our required product and theirs benefits.

3.2.1 Arduino Uno R3

We have used **Arduino Uno R3** Development board for this project.

Figure: 3.2.1 Arduino Uno R3

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Table: 3.1 Specifications

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13

3.2.2 ESP8266

For connecting our system to the internet we have user ESP-8266**.**

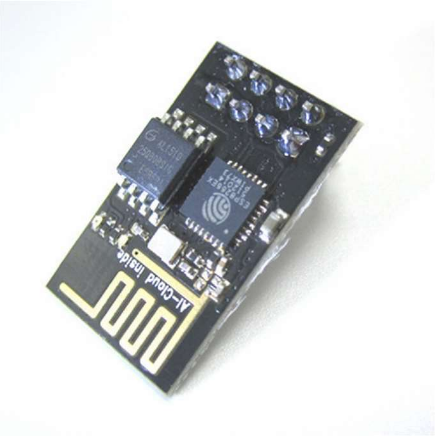


Figure: 3.2.2 ESP8266 Al Cloud Inside

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

Features

- 802.11 b/g/n
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode

- Power down leakage current of <10uA
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

3.2.3 Smoke Sensor

For this project we have used **MQ-2 Smoke/LPG/CO Gas Sensor** to detect smoke.

Figure: 3.2.3 MQ-2 Smoke/LPG/CO Gas Sensor

The Analog Smoke/LPG/CO Gas Sensor (MQ2) module utilizes an MQ-2 as the sensitive component and has a protection resistor and an adjustable resistor on board.

Features

- Power supply needs 5V
- Fast response and High sensitivity
- Wide detecting scope
- Simple drive circuit
- Stable and long life

3.2.4 Flame Sensor.

This module is sensitive to the flame or fire and radiation. It also can detect IR light source in the range of a wavelength 760nm-1100 nm that emitted from fire.

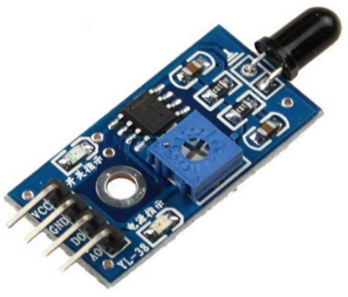


Figure: 3.2.4 Flame Sensor Module

Features

- Detects a flame or IR light source of a wavelength in the range of 760nm to 1100nm.
- Detection range up to 100cm.
- Detection range can be adjustable.
- The angle of detection about 60 degrees and we know that it is sensitive to flame objects
- LM393, the comparator chip allows to make module readings stable.
- Operating voltage 3.3V to 5V.
- Give Digital and Analog Output.
- There are two indicator included like Power indicator and Digital switch output indicator.

3.2.5 Temperature Sensor.

LM35 Precision Celsius Temperature Sensor is used for this project

Figure: 3.2.5 LM35 Precision Temperature Sensor

Features

- Calibrated Directly in Degrees Celsius
- Temperature Range from -40oC to +110oC
- 0.5oC Initial Accuracy
- Less Than 60µA Current Drain
- Low Impedance Output

3.3 Use Case Modeling and Description

3.3.1 Use Case

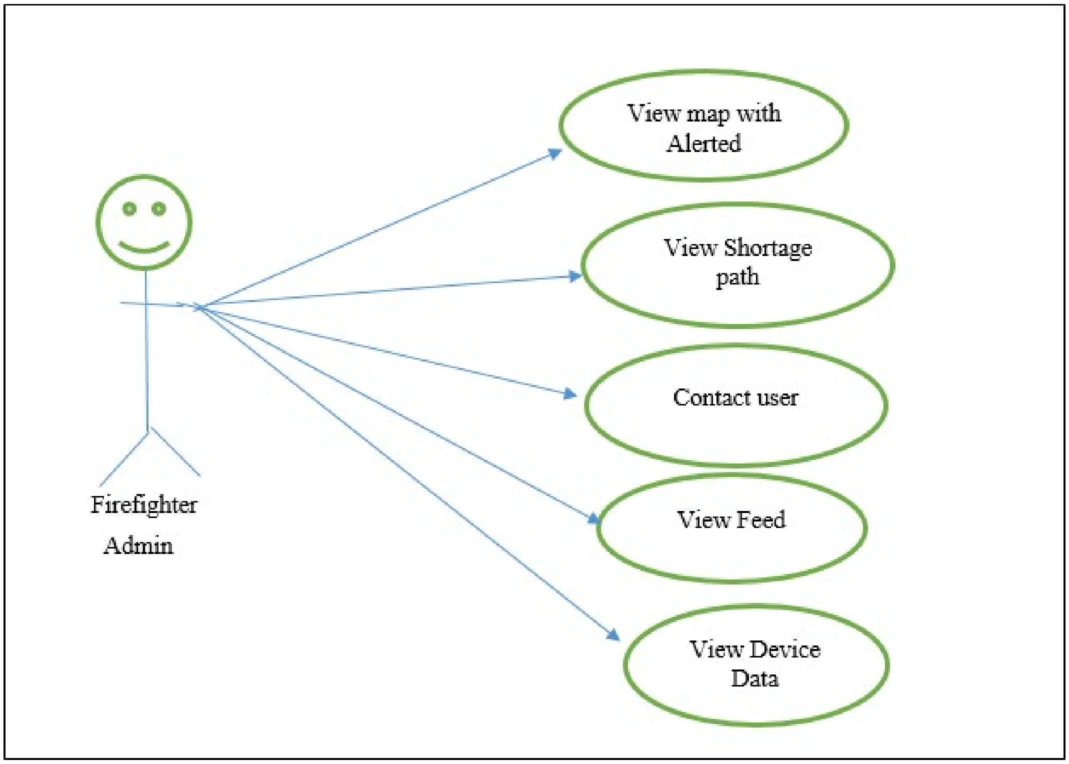


Figure 3.3.1 Use Case (Firefighter)

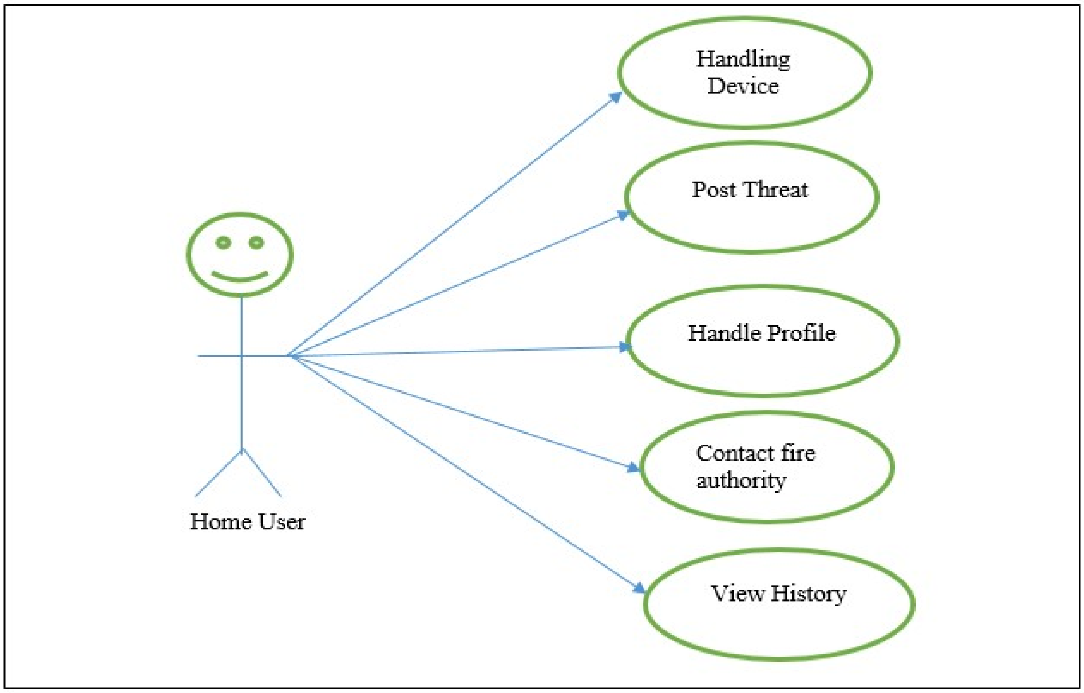


Figure 3.3.2 Use Case (Registered Home User)

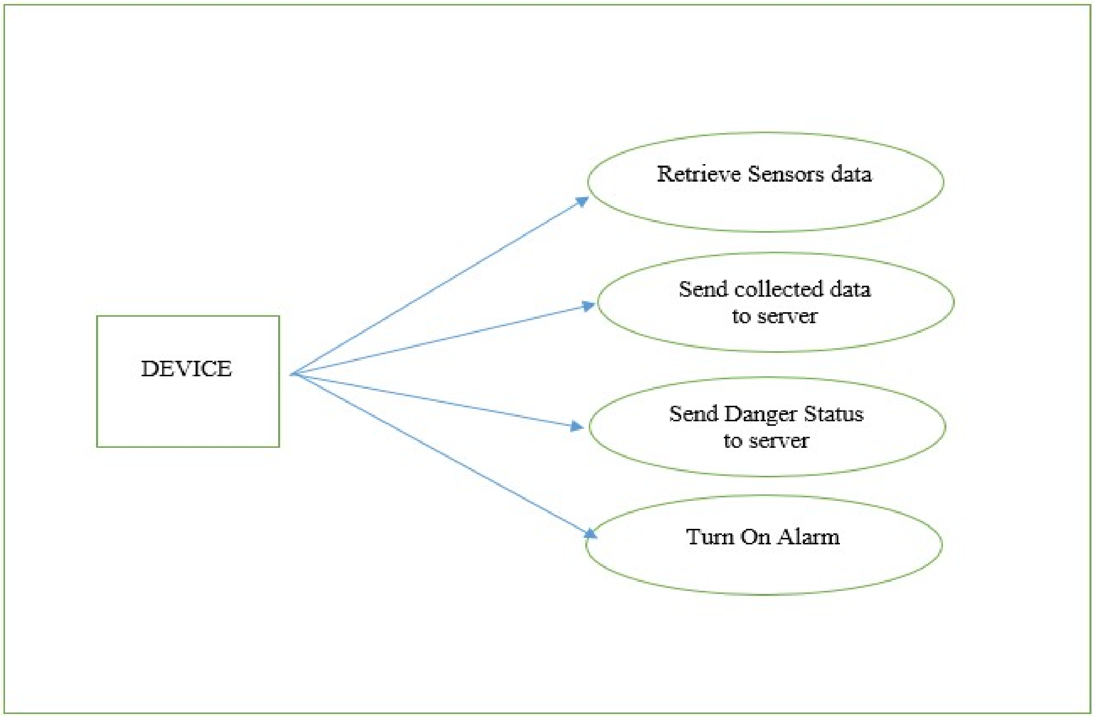


Figure 3.3.3 Device Module

3.3.2 Use Case Narrative

Use Case: Sending Alert

Actor: Device

Pre-condition: Powered on, WIFI connection

Primary Path:

1. Collet the sensor data.
2. Check if sensor value crossed the threshold value.
3. Send Alert to the server
4. Alert both Firefighter and home Users

Exception:

1. No Power
2. No internet Connection
3. Sensor Malfunction

Post-condition:

1. If Firefighter is notified successfully.
2. If Home user is notified successfully.

Use Case: User Registration

Actor: Home User

Pre-condition: Must be the Owner of the Device

Primary Path:

1. Fill device id field
2. Fill name field
3. Fill e-mail field
4. Fill password field
5. Fill contact number field

6. Fill gender field
7. Choose user image
8. Select location
9. Click Register button
10. Open Dashboard page

Exception:

1. Device Id field is empty
2. Name field is empty
3. E-mail field is empty
4. Password field is empty
5. Contact Number field is empty
6. Gender field is empty
7. Image not selected
8. Location is not selected
9. Connection error

Post-condition:

3. If Register is successful
4. If User Dashboard is loaded

Use Case: User Login

Actor: Home User

Pre-condition: Register

Primary Path:

1. Fill E-mail field
2. Fill Password field
3. Click Login button

Exception:

1. Wrong Password
2. Wrong E-mail
3. Connection error

Post-condition:

1. If Log In is successful
2. If Dashboard loaded successfully

Use Case: Post a Threat

Actor: Home User

Pre-condition: Login

Primary Path:

1. Select image
2. Write Heading
3. Write Description
4. Select location
5. Select damage percentage
6. Click Post button

Exception:

1. Image size is too large
2. Location is not specified
3. Heading must be written
4. Description must be written
5. Connection error

Post-condition:

1. If Post is successful
2. If Newsfeed loaded successfully

Use Case: Profile

Actor: Home User

Pre-condition: Login

Primary Path:

1. Change user image
2. Change Location
3. Check own posts
4. View Nearest Fire Station

Exception:

1. Connection error

Post-condition:

1. If picture changed successfully
2. If location changed successfully

Use Case: Call firefighter

Actor: Home User

Pre-condition: Login

Primary Path:

1. Click Call button

Exception:

1. Number busy
2. Connection error

Post-condition:

1. If call is successful

Use Case: Firefighter Registration

Actor: Firefighter

Pre-condition: None

Primary Path:

1. Fill station name field
2. Fill authority contact number field
3. Fill e-mail field
4. Fill the unique-id field
5. Click Register button
6. Open Dashboard page

Exception:

10. Station Name field is empty
11. E-mail field is empty
12. Authority Contact Number field is empty
13. Connection error

Post-condition:

5. If Register is successful
6. If Admin Dashboard is loaded

Use Case: Call Home User

Actor: Firefighter

Pre-condition: Login

Primary Path:

2. Click Call button

Exception:

3. Number busy
4. Connection error

Post-condition:

2. If call is successful

3.4 Logical Data Model

3.4.1 E-R Diagram

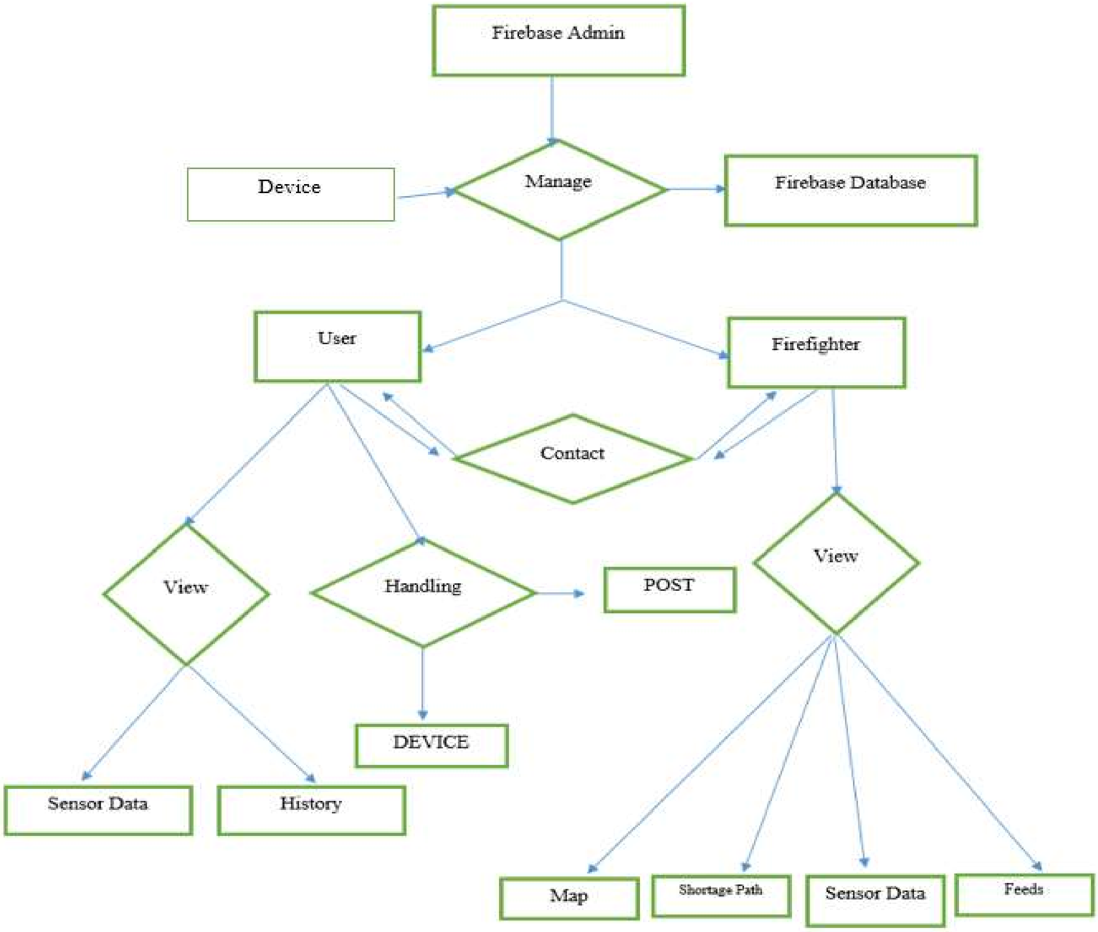


Figure 3.4.1 E-R Diagram

CHAPTER 4

DESIGN SPECIFICATION

4.1 Front-end Design

The front-end design of the system is considered as the implantation of the design of android application for both home users and firefighter authority. For designing the front-end of the Android Application mainly XML a markup language, is used to set up the layout of the apps.

4.1.1 XML

Extensible Markup Language normally known as XML, it is the front end language in Android development to handle the design mechanism in Android application's layouts. It is like a markup language which defines a set of rules for encoding in a format like which likely both readable for developer and system.

Though HTML and XML both is a Markup language but there are some difference between them like XML is designed to carry the data and focus on it rather than just to display it like HTML and tags are not predefined like HTML. XML structure of the data is embedded with data so that it dynamically understand it within the XML and store it, where HTML is only describes the web page contents

Why android is used XML? Earlier we said that it is a human readable format, also easy to parse and initialize in programmatically. It's a tree structure like JSON and most of the IDE tools are already familiar with this. It generate automatically a R file to indexing the resource contents which is provide great deal of benefit to autocomplete. If we make a mistake like define a resource we don't added and want to access it, then it will stop the developer from doing it and make complain.

4.1.2 Anatomy of Android XML Layouts

In order to make an Android application we use layouts as a front end to execute design mechanism. Every layout file have to have a container which is also known as a root element or object of a layout that holds View and View Group. There are some few View Group like Linear Layouts, Relative Layouts, Coordinate Layouts, Constraint Layouts, and Frame Layouts and so on.

.A **View** is simply an object which is building the block of a UI elements in Android. It represents a rectangular box, and is responsible for displaying information or content whatever the user's action.

A **View Group** is the invisible container which is essentially holds multiple Views or View Groups together, and defines their layout properties.

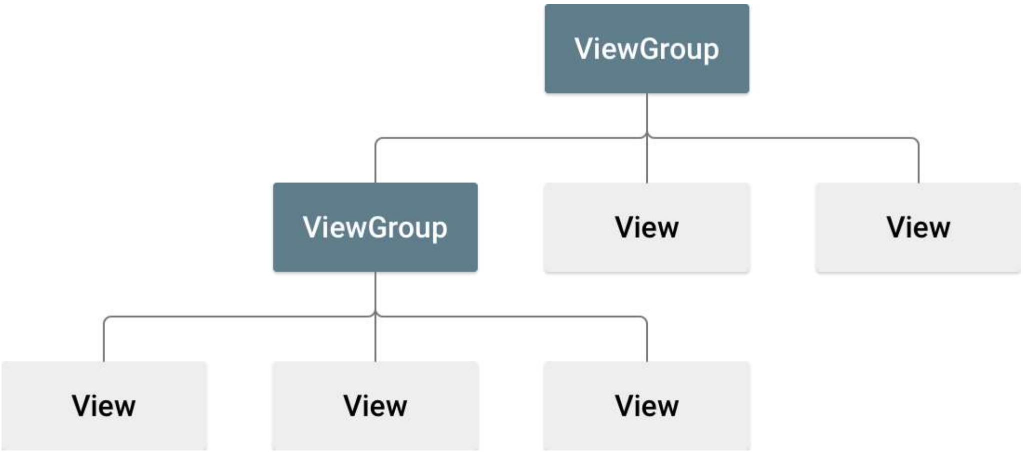


Figure: 4.1.1 Anatomy of Android XML Layouts

Common View Groups

There are three types of layouts that may be the root element in an Android XML Layout:

- A **Linear Layout** aligns its contents into one direction, direction can be vertical or horizontal.
- A **Relative Layout** displays its child components with respect to it's relative to the parent. Like align with parent right or left or top and bottom.
- A **Frame Layout** is like a placeholder on a screen that can display only a single view. Its act like a container which can hold one fragment at a time, usually used for tab layout or the navigation view, According to user action, if user swipe the view, another view is replaced on its place.

Common Views

Other commonly used Views are as follows. These may not be the root element of a layout, but they take place inside a View Group.

- A **List View** displays a list of scrollable items.
- A **Grid View** displays items in a two-dimensional, scrollable grid.
- A **Table Layout** groups views into rows and columns.
- **A Recycler View** can be act as linear list also a grid like gallery

Layout Attributes

Every type of layout has attributes that define the way its elements will be appeared. There are both common attributes that all elements share, and attributes specific to some of the layout types listed above. The following are attributes that apply to all View and View Groups:

- android:id: A unique ID that corresponds to the view.
- android:layout_width: The width of the layout.
- android:layout_height: The height of the layout.

- android:layout_marginTop: Extra space on the top of the layout.
- android:layout_marginBottom: Extra space on the bottom of the layout.
- android:layout_marginLeft: Extra space to the left of the layout.
- android:layout_marginRight: Extra space to the right of the layout.
- android:layout_weight: Specifies how much of the extra space in the layout should be allocated to the view.
- android:paddingLeft: Padding to the left of the view.
- android:paddingRight: Padding to the right of the view.
- android:paddingTop: Padding at the top of the view.
- android:paddingBottom: Padding at the bottom of the view.

Relative Sizing

Height and width properties can be set to specific measurements, but the following are much more common:

- android:layout_width=wrap_content: Sets the width of the view to whatever size is required by its contents. This may also be used with height.
- android:layout_width=match_parent: Sets the width of the view to the width of its parent. This may also be used with height.

Relative and Properties ID

Much like in HTML, id attributes also can be added into XML elements. However, the syntax for assigning an ID is differs from in HTML. Assigning an id attribute looks something like this:

android:id="@+id/search_button"

Here, the @+id/ portion indicates that the name following is a string containing this element's ID, and that it is a new resource that should be created and added to our resources.

For instance, the following XML will create a Button with the id search_button:

```
<Button android:id="@+id/mButton"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/button_text"/>
```

Targeting Views by ID

Similar to the way we used jQuery to target individual HTML elements and alter them in some fashion, we can also target individual XML elements and interact with them. The following code can be used to target the example XML button from above:

Example:

```
Button myButton = (Button) findViewById (R.id.button);
```

FindViewById () method can locate both Views and root views.

4.2 Back-end Design

Our project consists of both hardware and software side. For back-end designing both needs be implemented properly. The microcontrollers needs coding instruction as well as Android Application. There is a Firebase database between hardware and software that acts as a bridge way between them.

4.2.1 Java

Java is normally class based object oriented, high–level programming language which is developed by Sun Microsystem and originally designed for interactive television. It's created by James Gosling who is led a team for Sun Microsystem. It promised to "Write once and Run Anywhere"

Java enables developers to write computer instruction as a code and create Java application on a particular system which is supports Java. We know that Java is platform independent. But why? The designer of the Java language decided to make a platform that independently execute the Java code on a different physical machine since the code eventually has to run on a physical platform. That platform we called Java Virtual Machine in short form JVM. So they put all the Java code in the JVM which platform dependent then JVM executes the Java bytecode which is platform independent. Whenever we writes Java code for a program we do not write it to execute on physical machine, we write the code for to run it on the JVM.

In backend Android is using Java programming language to handle all the system API call. Android is just use Java as a source code but not used the JVM for to execute code. They are only use the syntax of the language. There are some reason to Android choose Java to its source code like

- Android runs on different hardware platform, and we already know that Java is platform independent.
- Java support open source.
- There are huge number of developer know or working with Java so they can easily move to Android platform.
- It is easy to learn and understand though it is object oriented.
- Java community is large so if the developer face any problem on a certain characteristic, developer can get solve for it.

4.1.1 Combination of C and C++

This is required for giving the instruction to the microcontroller. Arduino is programmed with a C/C++ 'dialect'. Most C/C++ will work but much of the standard libraries will not work. Many of the restrictions is made because of the little available RAM on the Arduino hardware.

C/C++ Advantages

One of the greatest advantage using C/C++ is that you can have a toolkit of libraries to interface with hardware, networking, front-end GUIs, etc.

- With C or C++ you can directly access the registers on the microcontroller and write code that is not in the Arduino code

- Since the Arduino libraries are written in C/C++, you can interface with them directly
- C/C++ let you manage limited resources better

4.2.3 Firebase Database

Firebase is a mobile and web application development platform acquired by Google. It is a backend service which frees the developer to focus dynamic user experiences. It provide server hosting, authentication system, APIs and database, so that developers do not have to worry about such issues. In this system data is stored as JSON and synced in real-time to every connected user.

Realtime Database

Realtime database is one of the feature of Firebase which is provide real-time data transfer protocol between server and client. It works in backend as a service which is creates API that allow data to be synchronized through clients and stored in a cloud with NoSQL. Most database require to make HTTP calls to get and sync data. Client have to ask server to get the updated data but Firebase does not work like that. When we connect Firebase into an application, it connect through a WebSocket not with normal HTTP like other database system. WebSocket are faster than HTTP. So client can make every calls with one socket connection, and that's plenty for to sync data automatically. If any update data is available, Firebase will be notify the client and every time data changes, any connected device get the updates data within milliseconds.

Offline

Data remain in application even if it is not online because once Firebase established connection with client's app it persists data to disk and receive any changes from the database.

Access to Client

Client can directly connect with Firebase from a mobile device or Web browser, no need for an application server. It has some features like user validation, database security rules, expression based rules whether the user can read or write data.

How does it work?

The Firebase Realtime Database let's build rich, collaborative applications by allowing secure access to the database directly from client-side. Data is persisted locally, and even while offline, realtime events continue to fire, giving the end user a responsive experience. When the device regains connection, the Realtime Database synchronizes the local data changes with the remote updates that occurred while the client was offline, merging any conflicts automatically.

The Realtime Database provides a flexible, expression-based rules language, called Firebase Realtime Database Security Rules, to define how data should be structured and when data can be read from or written to. When integrated with Firebase Authentication, developers can define who has access to what data, and how they can access it.

4.3 Interaction Design and UX

4.3.1 System Architecture

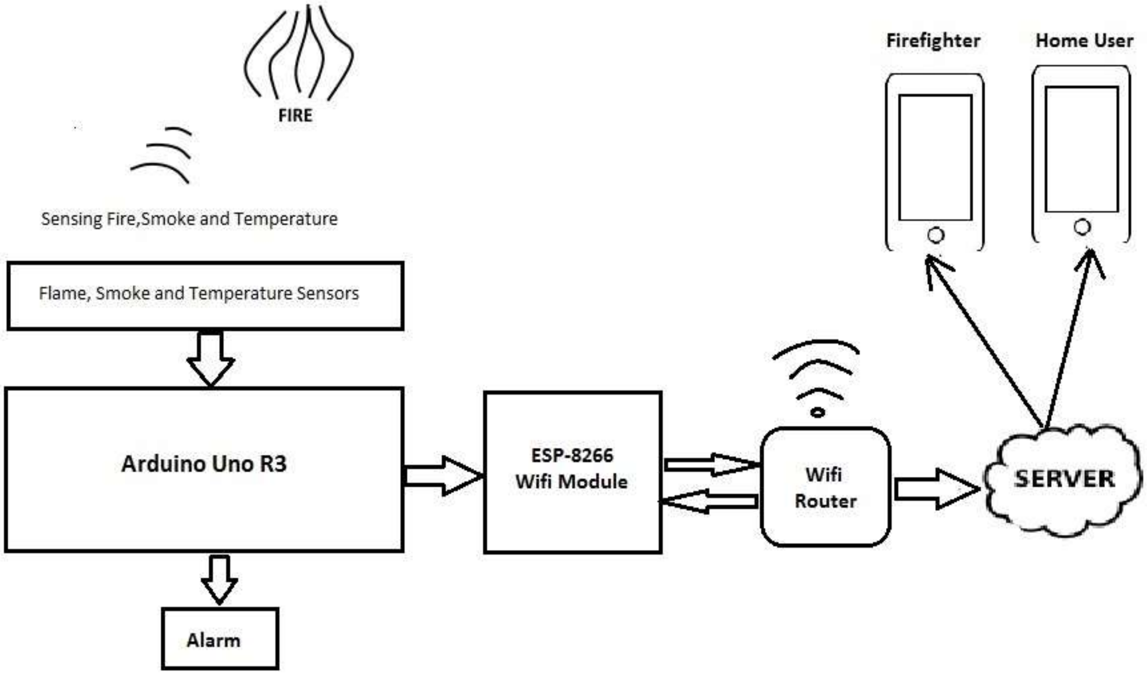


Figure: 4.3.1 System Architecture

Figure 4.3.1 shows the system architecture. The structure of this fire alarm system is consist of six components, which are Arduino Uno R3, ESP-8266, Smoke Sensor, Flame sensor, Temperature sensor and a WIFI router. Arduino was selected due to its good technical specifications, high performance for data processing and is cheaper than other single board computers available in the market. The sensors and ESP-8266 is connected with Arduino. The WIFI router is used to connect the ESP-8266 and send the collected to the server.

4.3.2 Circuit Diagram and Connection:

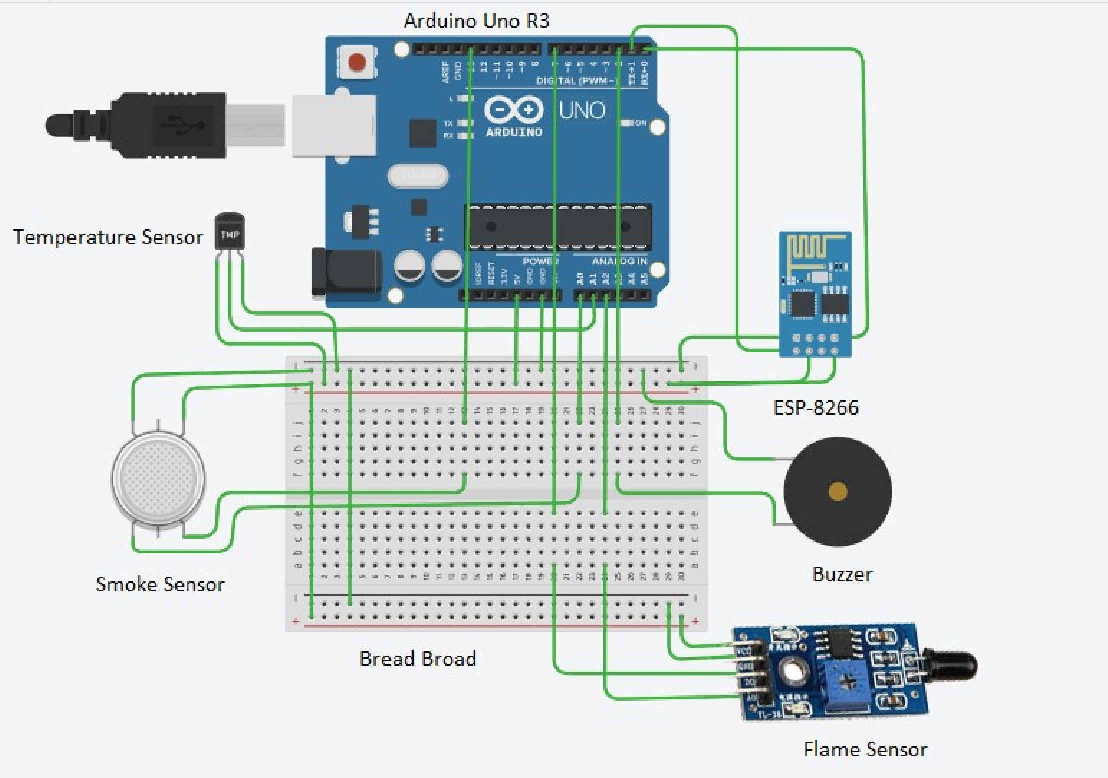


Figure: 4.3.2 Circuit Diagram

Figure: 4.3.2 shows the Circuit Diagram of our system prototype. All the components are conceded using a breadboard and jumper wires.

4.3.3 Activity Cycle

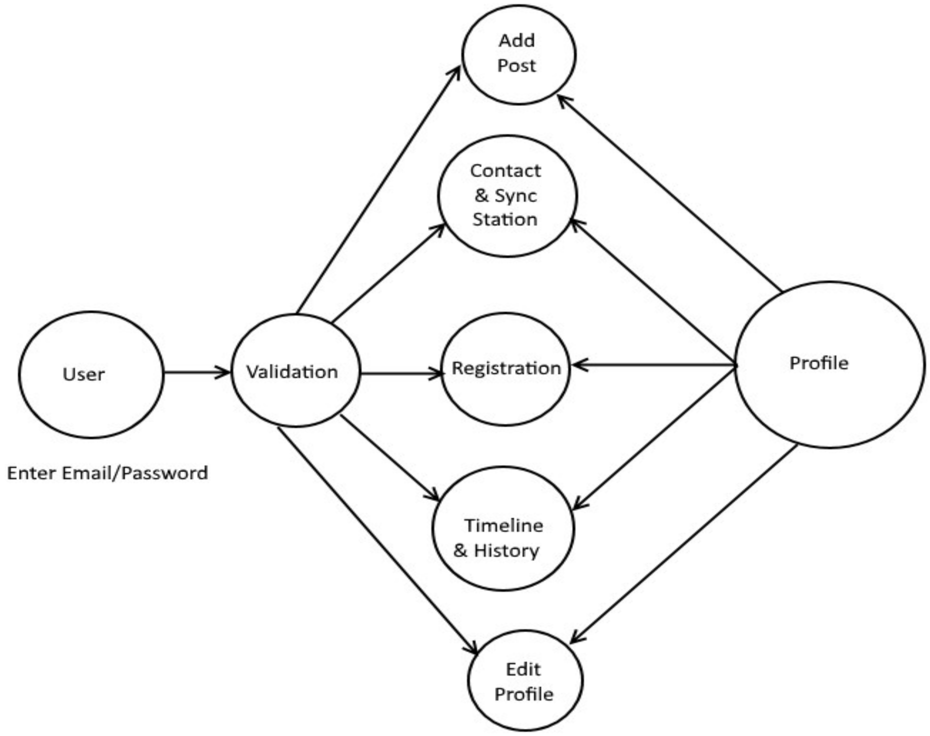


Figure: 4.3.3 User Activity Cycle

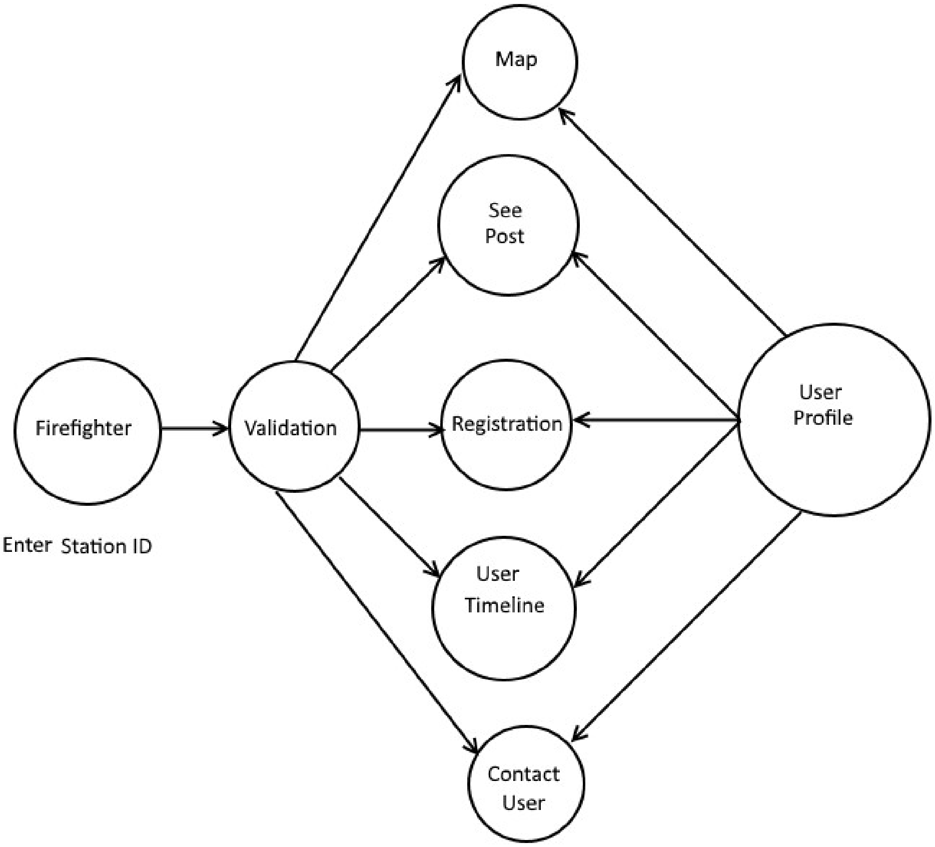


Figure: 4.3.4 Firefighter Activity Cycle

4.4 Implementation Requirements

The hardware devices used for the development of the project is:

Processor	:	Intel Core i3 Processor
RAM	:	8 GB DDR3 RAM
Monitor	:	15” LCD
Hard Disk	:	500 GB
Cache	:	5 MB
Keyboard	:	Standard 102 Keys
Mouse	:	3 Buttons
Router	:	TP-Link

The software used for the development of the project is:

Operating System	:	Windows 10 Professional
Editor	:	Android Studio, Arduino IDE
Language	:	Java, XML, C/C++
Framework	:	JSON
Database	:	Firebase

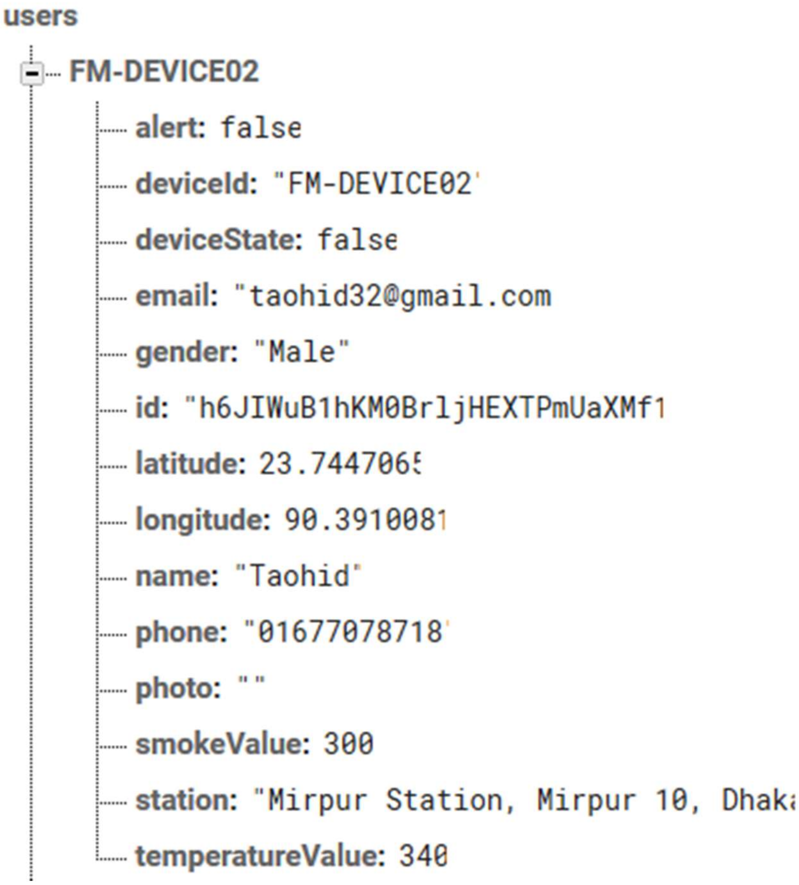
CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 Implementation of Database

In this project we have used a real time firebase database. This is quite different from other databases. So implementation of this database is based on JSON.

5.1.1 User JSON Tree

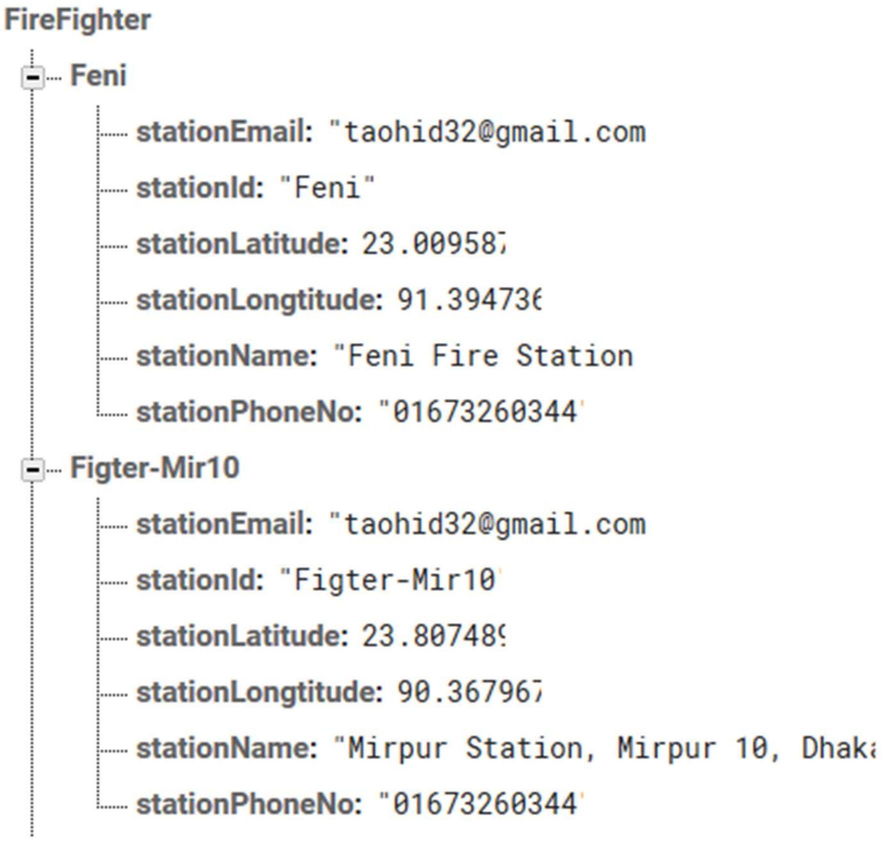


```
users
  FM-DEVICE02
    alert: false
    deviceId: "FM-DEVICE02'
    deviceState: false
    email: "taohid32@gmail.com
    gender: "Male"
    id: "h6JIWuB1hKM0BrljHEXTPmUaXMf1
    latitude: 23.744706
    longitude: 90.3910081
    name: "Taohid"
    phone: "01677078718'
    photo: ""
    smokeValue: 300
    station: "Mirpur Station, Mirpur 10, Dhak
    temperatureValue: 340
```

Figure: 5.1.1 User Node

This is the User JSON tree which is contain each user info under device id node. Under device id it contain user's information like device id, user email, gender, unique id, user location, name, sensor value, device status depends on whether the fire strike or not. Also contain user's profile picture, station name which is user under by. Also have the temperature value from the temperature sensor

5.1.2 Firefighter JSON Tree

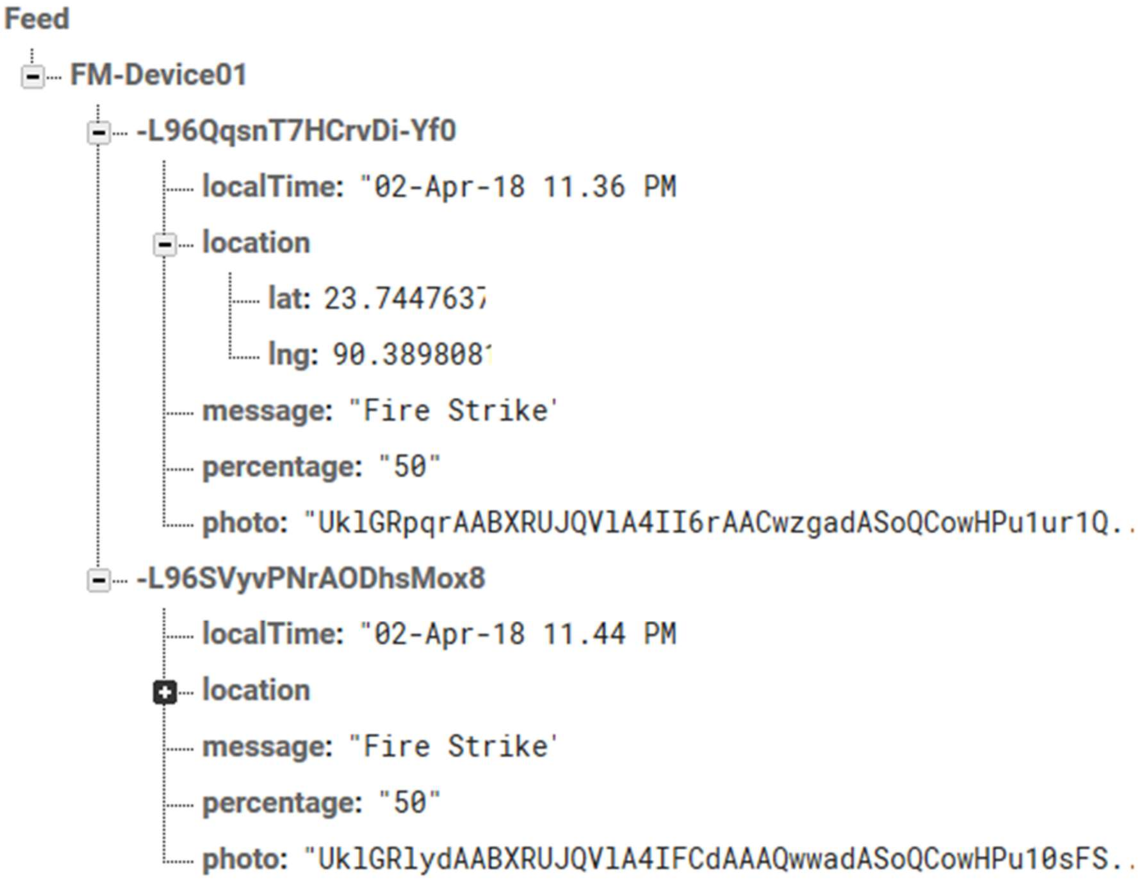


```
FireFighter
 ⊟-- Feni
      |-- stationEmail: "taohid32@gmail.com
      |-- stationId: "Feni"
      |-- stationLatitude: 23.009587
      |-- stationLongtitude: 91.394736
      |-- stationName: "Feni Fire Station
      |-- stationPhoneNo: "01673260344'
 ⊟-- Figter-Mir10
      |-- stationEmail: "taohid32@gmail.com
      |-- stationId: "Figter-Mir10'
      |-- stationLatitude: 23.807489
      |-- stationLongtitude: 90.367967
      |-- stationName: "Mirpur Station, Mirpur 10, Dhaka
      |-- stationPhoneNo: "01673260344'
```

Figure: 5.1.2 Firefighter Node

This is the Firefighter tree which is contain the information of all the Fire station of Bangladesh. All fire station info is contain under unique station id. Following that station email, station id, station location, name and phone number is also included.

5.1.3 Feed JSON Tree

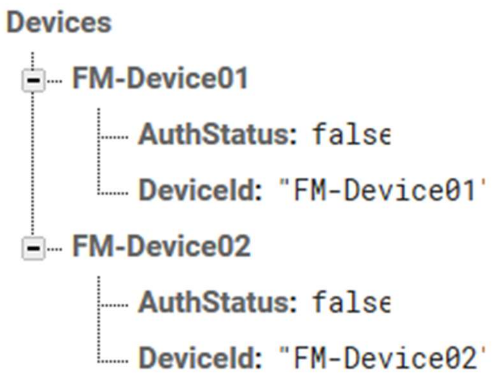


```
Feed
  FM-Device01
    -L96QqsnT7HCrvDi-Yf0
      localTime: "02-Apr-18 11.36 PM
      location
        lat: 23.744763
        lng: 90.389808
      message: "Fire Strike'
      percentage: "50"
      photo: "UklGRpqrAABXRUJQVlA4II6rAACwzgadASoQCowHPu1ur1Q..
    -L96SVyvPNrAODhsMox8
      localTime: "02-Apr-18 11.44 PM
      location
      message: "Fire Strike'
      percentage: "50"
      photo: "UklGRlydAABXRUJQVlA4IFCdAAAQwwadASoQCowHPu10sFS..
```

Figure: 5.1.3 Feed Node

Under the feed node contain the information which is send or submitted by the user. Whenever user sees an incident of fire, he or she can upload a photo of the incident and send it to the database and stored under the node called feed. Photo information, time of capturing the photo, damage percentage, and a personal message of the incident is also included.

5.1.4 Device JSON Tree



```
Devices
├── FM-Device01
│   ├── AuthStatus: false
│   └── DeviceId: "FM-Device01'
└── FM-Device02
    ├── AuthStatus: false
    └── DeviceId: "FM-Device02'
```

Figure 5.1.4 Device Node

This device tree is included information of user’s device ID and AuthStatus. Here AuthStatus means whether use actually setup the device in his or her home or not. This info is needed to check on registration section. If the value is false that means device is not setup and user can not complete the registration process.

5.2 Implementation of Front-end Design

We have divided two apps for Home Users and Firefighter in this project. So front end for both apps had to be implemented. But different user will see the different look of every page.

5.2.1 Home Users

User Sign In and Registration

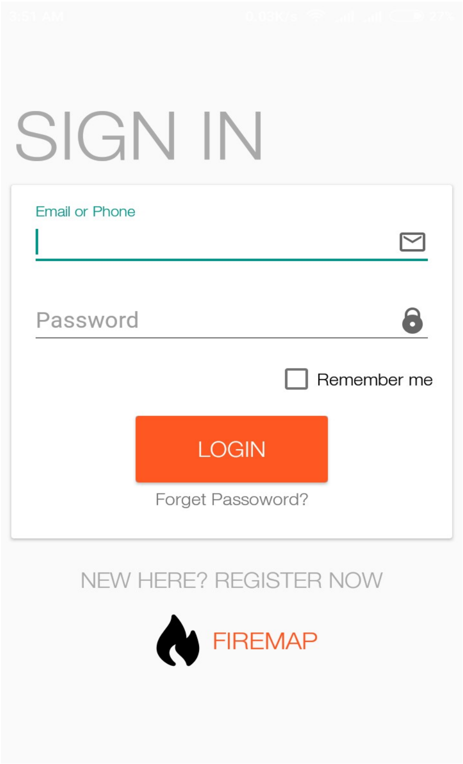


Figure: 5.2.1 User Login

In Figure: 5.2.1(a) we can see the sign in activity of our user app. If user is already registered they can login by providing their email and password. If the user is not registered the click the register now button.

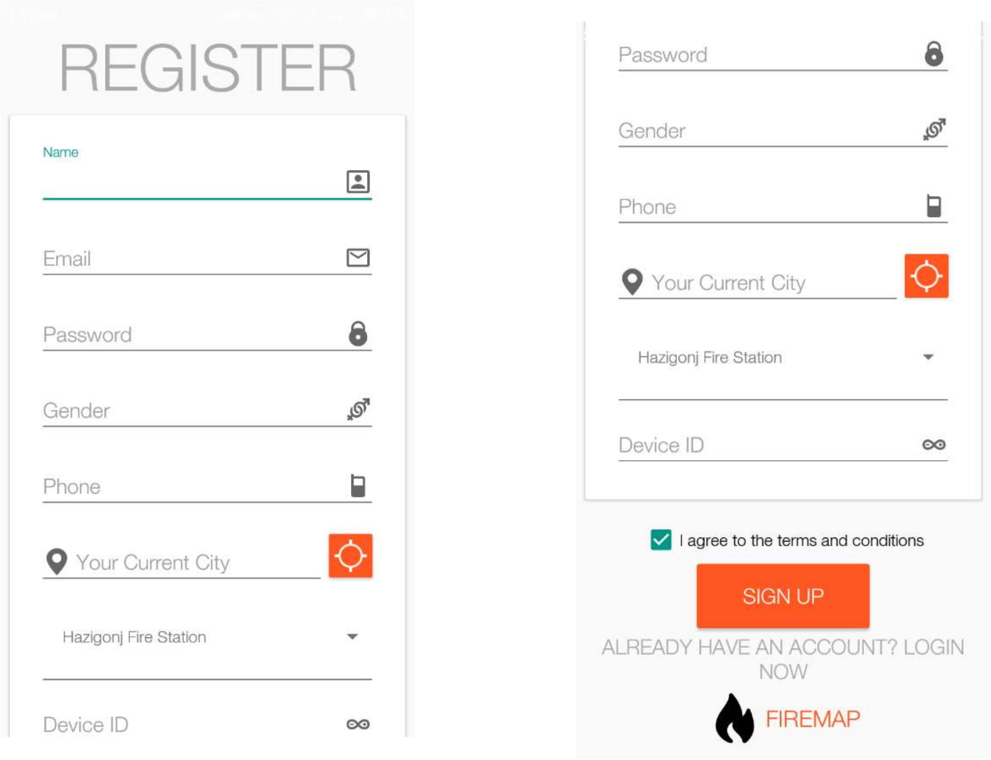


Figure: 5.2.2 User Register

In Figure: 5.2.1(b) we can see the register activity of our user app. The new users must get registered before signing in. for registration a user must provide his name, email, password, gender, phone no, current city by pressing location button, nearest fire station, and device id which will be provided when user will buy our device.

User Dashboard and Menu

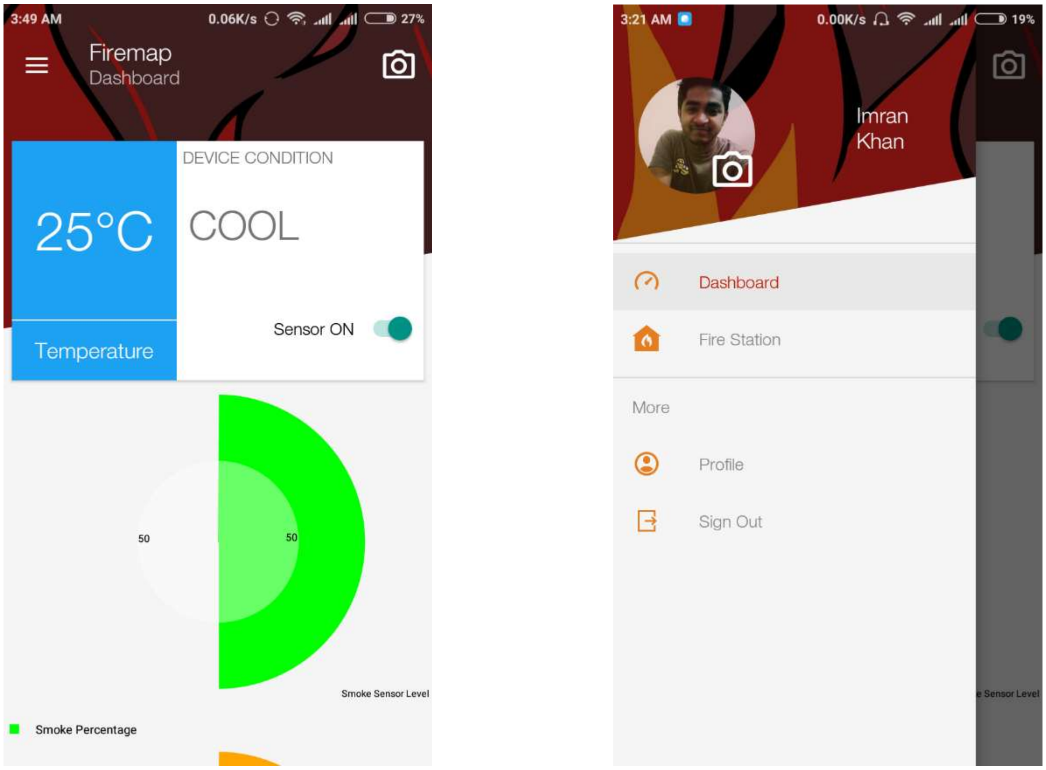
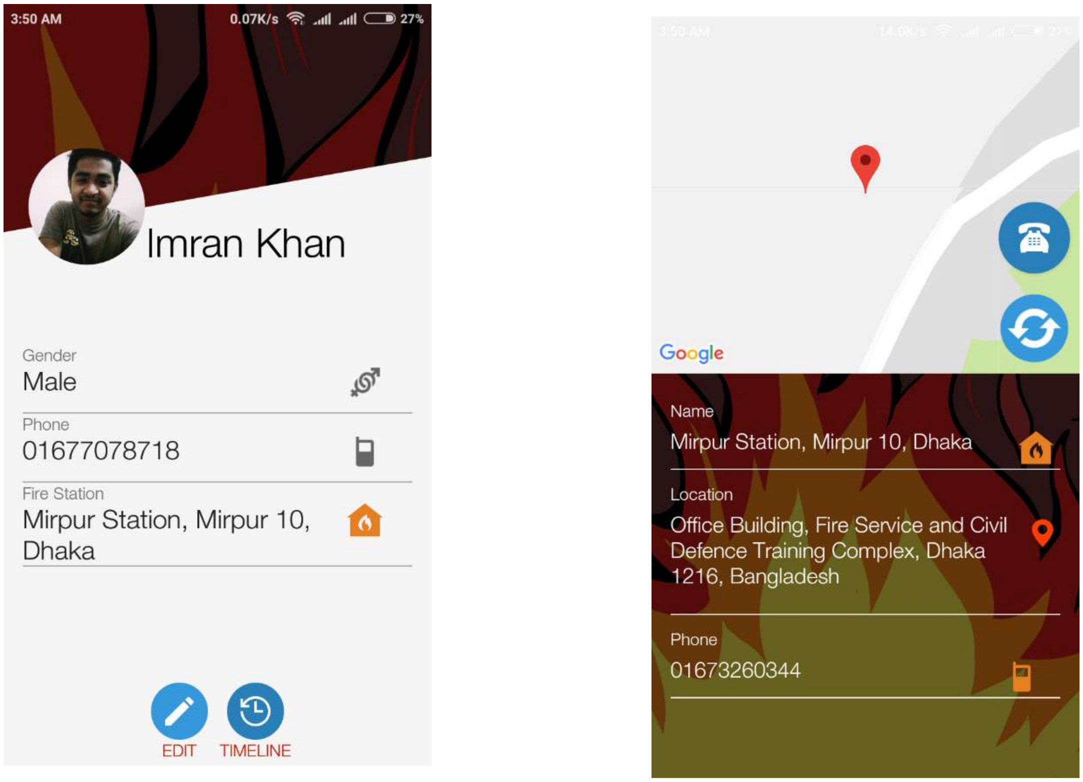


Figure: 5.2.3 User Dashboard and Menu

Figure: 5.2.1(c) shows the main dashboard of the user app. User must login to see this activity. In the dashboard the temperature data of the device is shown and there are also charts of smoke and flame data. There is a section where we can see the Device Condition COOL. If the sensor data changes the condition becomes HIGH. There is also a toggle button for turning the sensors on/off.

In the side drawer menu we can see the logged in users name and picture and different options.

User Profile and Fire Station



Imran Khan

Gender
Male

Phone
01677078718

Fire Station
Mirpur Station, Mirpur 10, Dhaka

Name
Mirpur Station, Mirpur 10, Dhaka

Location
Office Building, Fire Service and Civil Defence Training Complex, Dhaka 1216, Bangladesh

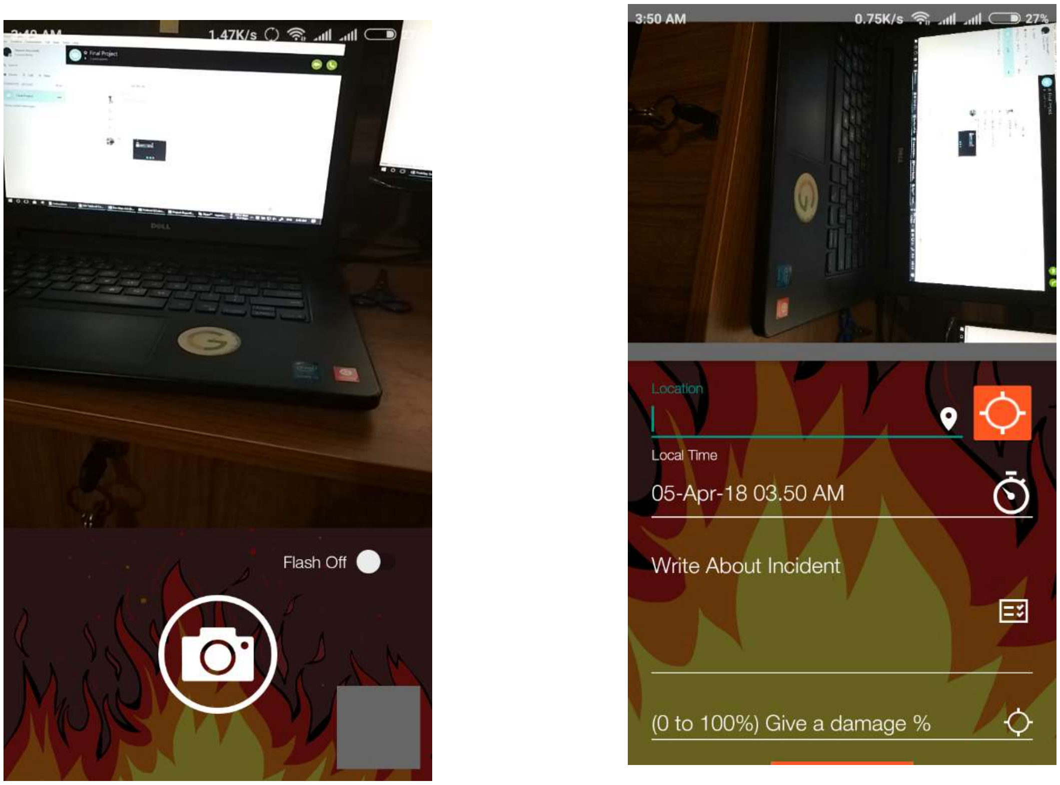
Phone
01673260344

Figure: 5.2.4 User Profile and Fire Station

Figure: 5.2.1(d) shows the use profile and the nearest fire station to him. In the user profile user information and two buttons are shown. Edit button is used for editing the user profile and timeline button to view the users previous incident history.

In the Fire Station Activity a user can see his nearest fire station on the Google map and call the fire station in case of any emergency by using the call button.

Posting a Threat



Local Time
05-Apr-18 03.50 AM

Figure: 5.2.5 Posting a Threat

Figure: 5.2.1(d) shows the activity for posting a threat of an occurrence. If a user want to post a threat manually he must capture the image, provide the location of the incident, time of the incident, description and the damage of the incident and click the post button to submit.

5.2.2 Firefighter Admin

Fighter Sign in and Registration

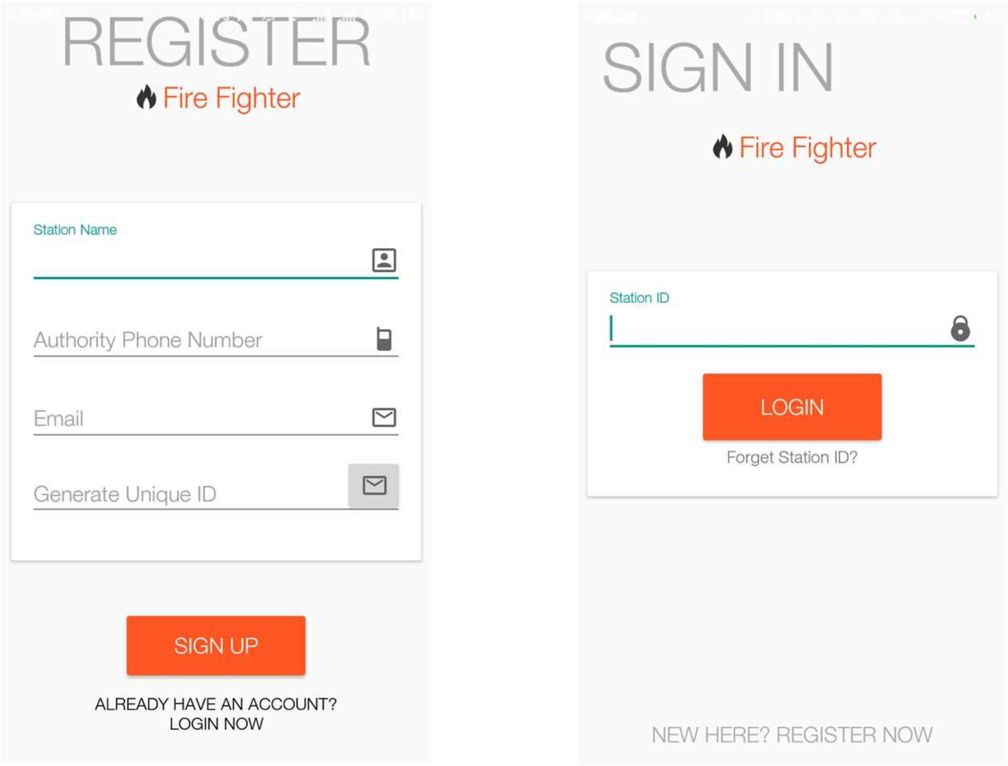


Figure: 5.2.6 Fighter Sign in and Registration

Figure: 5.2.2(a) shows the implementation of the firefighter registration and login procedure. For Registering a firefighter must provide name, contact no of his fire station, official email and a unique id will be generated.

For login in the fire fighter must provide his unique id that will be provided while registering.

Firefighter Dashboard

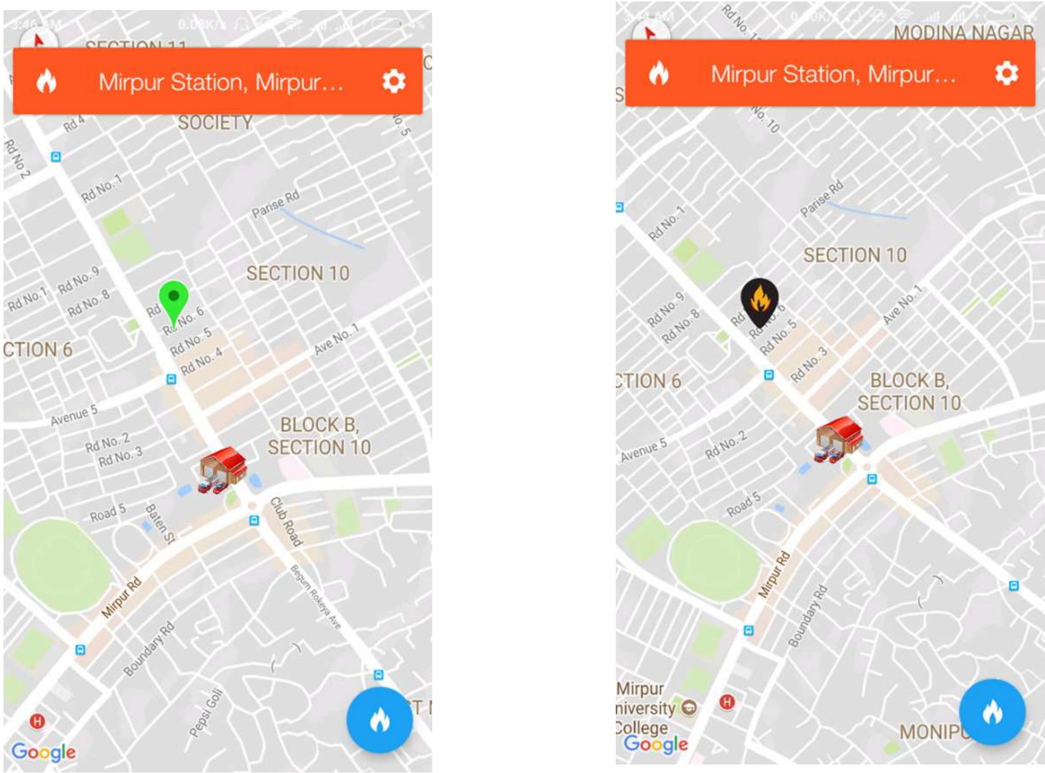
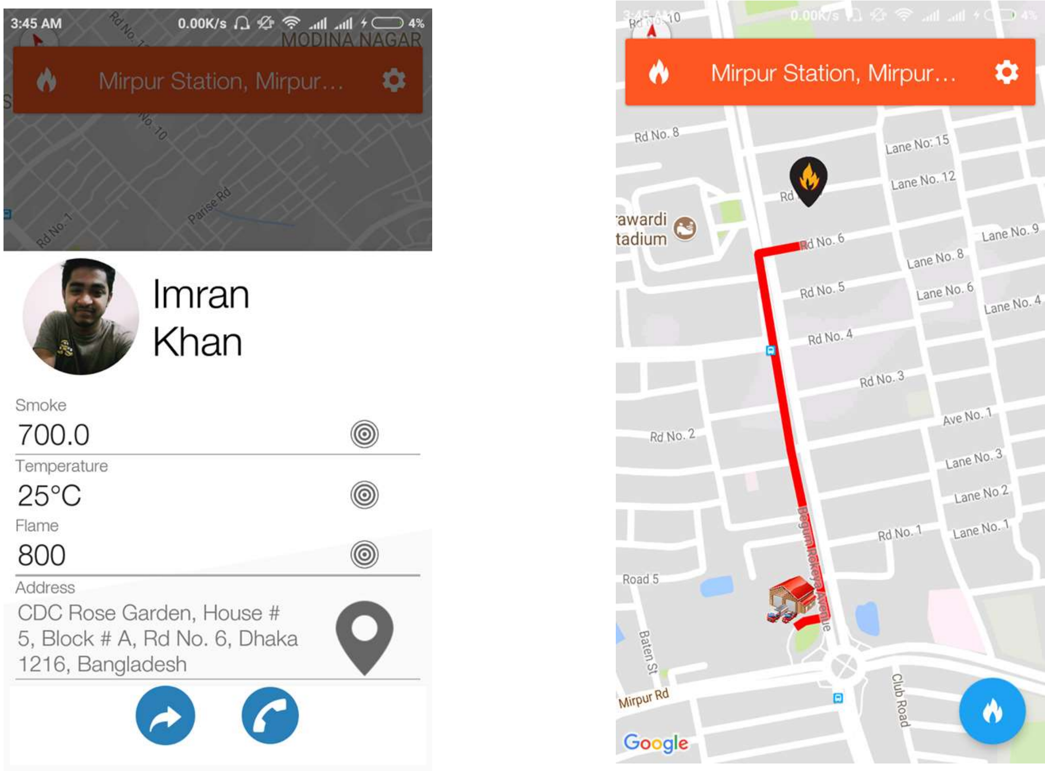


Figure: 5.2.7 Firefighter Dashboard

Firefighter must login to see this dashboard of Figure: 5.2.2(b). Firefighter dashboard is mainly a map activity where he can see all the devices and users on the map. The green icon on the map means the device is safe.

When the marker turns into fire icon and animates then it indicates the danger.

Communicating with User



Imran Khan

Smoke
700.0

Temperature
25°C

Flame
800

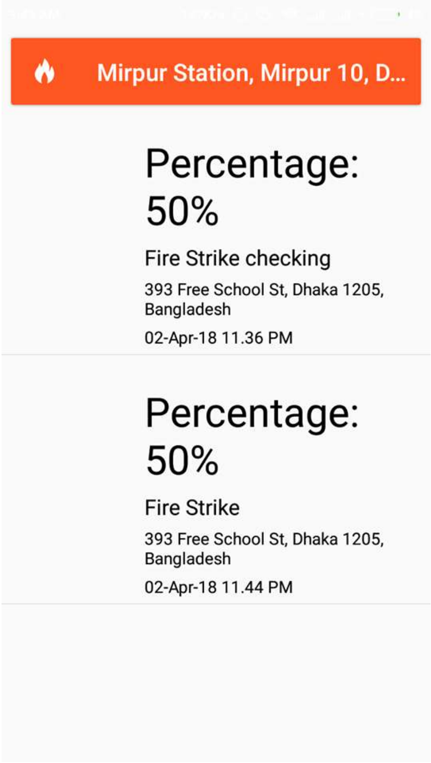
Address
CDC Rose Garden, House # 5, Block # A, Rd No. 6, Dhaka 1216, Bangladesh

Figure: 5.2.8 Communicating with User

If and alarm is triggered then clicking on the icon of the map firefighter can see the registered user there and can also see the sensor data of that device. By clicking on the path button firefighter can see the shortest path from his fire station to the incident location.

Firefighter can also call the user by clicking the call button.

Viewing User Feeds



Mirpur Station, Mirpur 10, D...

Percentage: 50%

Fire Strike checking

393 Free School St, Dhaka 1205, Bangladesh

02-Apr-18 11.36 PM

Percentage: 50%

Fire Strike

393 Free School St, Dhaka 1205, Bangladesh

02-Apr-18 11.44 PM

Figure: 5.2.9 Viewing User Feeds

Figure: 5.2.2(d) shows the threat manually posted by the users. Here firefighter can see the overall damage caused, the location of the incident and the time of the incident.

5.3 Testing Implementation

5.3.1 Content Testing:

Our project has both hardware and android application sides. So both sides can produce different kinds of errors .Content Testing’s objective is to uncover this and many other problems before the user face them.

5.3.2 Testing Strategy:

Hardware Testing

The hardware device plays a vital role in this project. As this is an automatic alarm system that is trigger by fire and a certain amount of smoke and temperature so the hardware needs to functioning all the time. And it must be ensured that all the sensors are picking up the data properly. All the data collected from sensors are sent to an online data base so it must be ensured that it doesn't face any errors while data transaction. **Application Testing**

There are two separate android application for Home Users and Firefighter. Both of the app has different types of activities and tasks. Most of the app functions are based on hardware readings.

The readings came via a real-time database. So there many scope of error occurrence. That's why beta testing of the both app needs to be done before make these available for users.

Database Testing

A real time firebase data base is working as a bridge between the hardware and the apps. The database structure needs to be well established. Database also needs to be highly secured. Any kind of database failure can cause fatal malfunction to the whole system. So the database must be well tested and properly established.

5.3.3 Test Cases:

Test Plan:

Table: 5.3.3(a) Test Plan

S.no	Test Objective
1.	To check whether device is ruining or not.
2.	To check if the device is collecting data or not.
3.	To check device is sending alert or not.
4.	To check if the apps are running or not.
5.	To check if both of the users can register or not.
6.	To check if the users can login or not.
7.	To check if the sensors data is showing properly or not.
8.	To check if the home users can post a thread or not.
9.	To check if the home users can see and contact the nearest fire service or not.
10.	To check if the firefighter can see the home user on the map or not.
11.	To check if firefighter can see the fire incident icon or not.
12.	To check if firefighter can see shortest path to the location or not.
13.	To check if firefighter can see users feed or not.

Test:

Table: 5.3.3(b) Device Testing

Test Case	**1**
Test Objective	To check whether device is ruining or not.
Test Data	Running the device.
Expected Result	The device should powered up successfully and connected to WIFI
Test Result	The device powers up successfully and connects to WIFI
Conclusion	Expected result matches actual result.

Table: 5.3.3(c) Sensor Testing

Test Case	**2**
Test Objective	To check if the device is collecting data or not.
Test Data	Collecting the sensors readings.
Expected Result	The sensors should collect smoke, temperature and flame data
Test Result	The sensors successfully collects smoke, temperature and flame data
Conclusion	Expected result matches actual result.

Table: 5.3.3(d) Alert Testing

Test Case	**3**
Test Objective	To check device is sending alert or not.
Test Data	Sending the Alert if fire occurs
Expected Result	The users should receive alert if the smoke and temperature crosses the threshold value.
Test Result	The users successfully receives alert
Conclusion	Expected result matches actual result.

Table: 5.3.3(e) Apps running

Test Case	**4**
Test Objective	To check if the apps are running or not.
Test Data	Running the apps.
Expected Result	Main screen should display successfully.
Test Result	Main screen appears correctly.
Conclusion	Expected result matches actual result.

Table: 5.3.3(f) Registration Testing

Test Case	**5**
Test Objective	To check if both of the users can register or not.
Test Data	Run program and fill-up the required fields.
Expected Result	Success message should be shown.
Test Result	Registered Successfully and Dashboard is loaded.
Conclusion	Expected result matches actual result.

Table: 5.3.3(g) Login Testing

Test Case	**6**
Test Objective	To check if the users can login or not.
Test Data	Run program and give username and password
Expected Result	Success message should be shown.
Test Result	Login Successfully as a registered user
Conclusion	Expected result matches actual result.

Table: 5.3.3(h) Sensor Data Testing

Test Case	**7**
Test Objective	To check if the sensors data is showing properly or not.
Test Data	Viewing the smoke and temperature value
Expected Result	The both App should show the correct sensor values.
Test Result	The both App successfully showed the correct sensor values.
Conclusion	Expected result matches actual result.

Table: 5.3.3(i) Threat Post Testing

Test Case	**8**
Test Objective	To check if the home users can post a thread or not.
Test Data	Take a photo from the app using cell phone camera and fill-up the fields
Expected Result	A new threat should be posted and Success message should be shown.
Test Result	A new threat successfully be posted and Success message should be shown
Conclusion	Expected result matches actual result.

Table: 5.3.3(j) Contact Testing

Test Case	**9**
Test Objective	To check if the home users can see and contact the nearest fire service or not
Test Data	Viewing the nearest fire station on the map and click the call button
Expected Result	User must see the nearest fire station and a call should start on that fire station's contact number.
Test Result	User can see the nearest fire station and a call has been made to that fire station's contact number.
Conclusion	Expected result matches actual result.

Table: 5.3.3(k) Firefighter Map Activity Testing

Test Case	**10**
Test Objective	To check if the firefighter can see the home user on the map or not.
Test Data	Viewing the users on the map
Expected Result	All the registered users must be shown in the map.
Test Result	All the registered users properly shown in the map.
Conclusion	Expected result matches actual result.

Table: 5.3.3(l) Alert Indication testing

Test Case	**11**
Test Objective	To check if firefighter can see the fire incident icon or not.
Test Data	The sensor threshold must be crossed
Expected Result	The icon of the incident's place will animate
Test Result	The icon of the incident's place animates correctly
Conclusion	Expected result matches actual result.

Table: 5.3.3(m) Shortest Path Testing

Test Case	**12**
Test Objective	To check if firefighter can see shortest path to the location or not.
Test Data	Select a specific user and click the shortest path button.
Expected Result	A shortest path should be shown from fire station to users location on the map
Test Result	A shortest path successfully shown from fire station to users location on the map
Conclusion	Expected result matches actual result.

Table: 5.3.3(n) Feed Testing

Test Case	**13**
Test Objective	To check if firefighter can see users feed or not.
Test Data	The threats must be posted by the users
Expected Result	All posts should be showed properly.
Test Result	All posts are properly visible.
Conclusion	Expected result matches actual result.

5.4 Test Results and Reports

Table: 5.4 Test Results

S.no	Test Objective	Result
1.	To check whether device is ruining or not.	Successful
2.	To check if the device is collecting data or not.	Successful
3.	To check device is sending alert or not.	Successful
4.	To check if the apps are running or not.	Successful
5.	To check if both of the users can register or not.	Successful
6.	To check if the users can login or not.	Successful
7.	To check if the sensors data is showing properly or not.	Successful
8.	To check if the home users can post a thread or not.	Successful
9.	To check if the home users can see and contact the nearest fire service or not.	Successful
10.	To check if the firefighter can see the home user on the map or not.	Successful
11.	To check if firefighter can see the fire incident icon or not.	Successful
12.	To check if firefighter can see shortest path to the location or not.	Successful
13.	To check if firefighter can see users feed or not.	Successful

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Discussion and Conclusion

At last we can say that we have tried our best to complete all the tasks of our project. Our main purpose was to made technology more human friendly and helpful for emergency situation. We have tried to make our project as simple as possible for our user to use and understand. IoT is a new concept of the technology and day by day it is becoming popular and creating new scopes for future experiments. We had many other ideas for our final project but we selected this idea because it's unique at its genre. We also noticed that apps are very popular nowadays and so we have tried to merge the apps to a small hardware to build this automated system. We have separated our project in two different apps because it makes the system more feasible. We have learned a lot while working on this project. Hope that our project will serve its goal and have a great significance on the growing technological world.

6.2 Scope for Further Developments

We have made our project as feasible as possible though there are some lacking. Some parts of our project can be more improved. Future Studies and research can dig up more features for our system. Let's see some of the aspects that can be implemented in future

Fire Station Resource

We will add an option to keep the fire station's information in details. There will be information of how many heavy and lite vehicles a fire station contains. How many men working under that station and what kinds of tools they have. This will help to understand and keep track of a stations capabilities.

Handling Busy Status

In future we will built a mechanism to determine a fire station's status. If a station is busy with a task then even if another occurrence happens within its area the alert will be sent to next nearest fire station. This will help to make the system more responsive to cope up with multiple fire incidents at same time.

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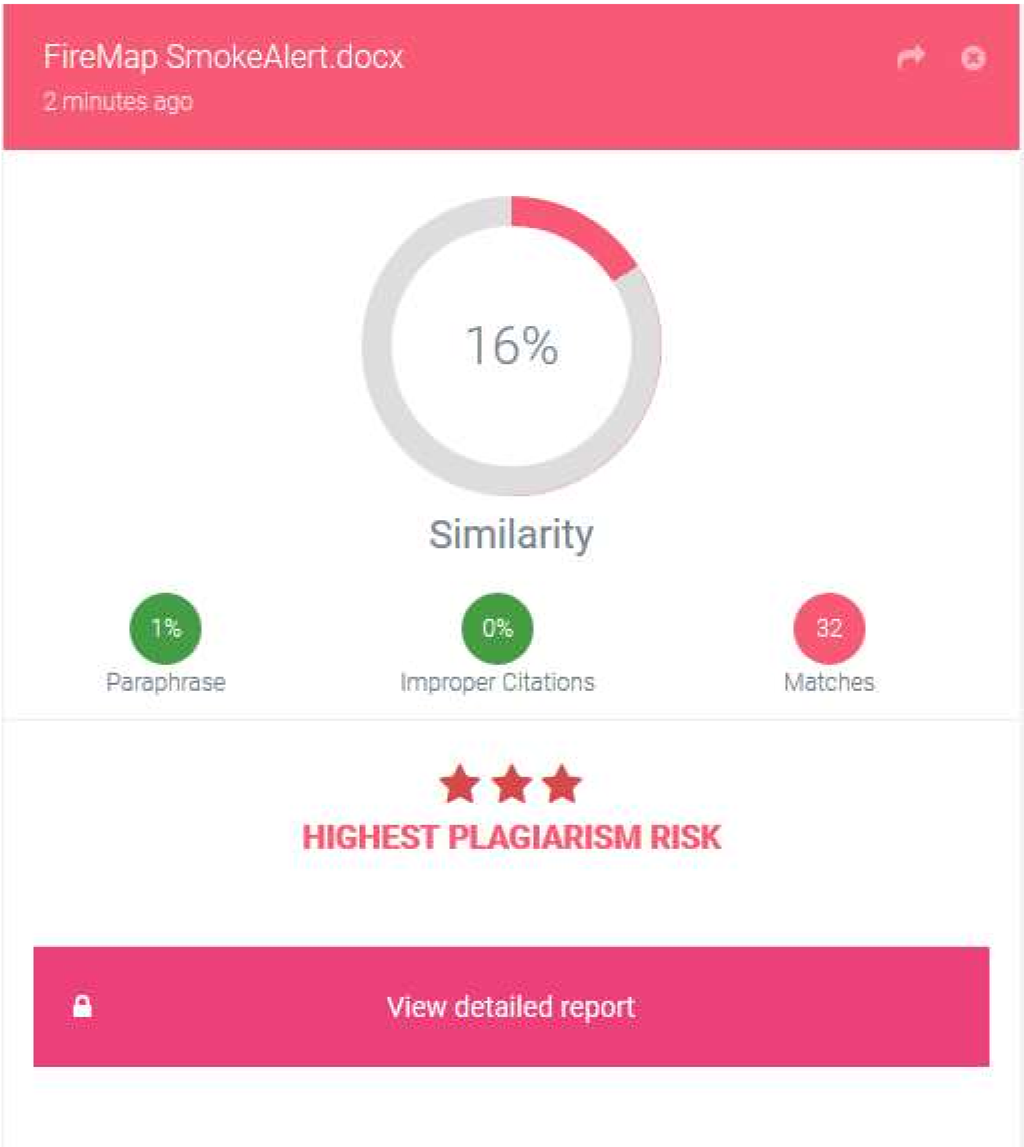

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