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Islamabad Air

Bachelor of Science in Information Technology

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Certificate

We accept the work contained in the report titled "Islamabad Air", written by Mr. Faraz Asad and Abeer Ehsan Rashid as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Information Technology.

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June 17, 2019

ABSTRACT

Air pollution is the biggest challenge for the human health in the world today. It has adverse effects on the human health, environment and the ecosystem. Air pollution prompts antagonistic impact on Human life.Dust Particles like PM 2.5,1.0 and pollen also causes health problems in human body. Toxic gases from the industry, automobiles have polluted the air and increase the concentration of particulate matter in the atmosphere which is the main cause of air pollution. This makes a requirement for monitoring and analysis of real-time air quality monitoring system in order to take decision timely. We have tried our best to develop real-time air quality monitoring system. We have included various parameters: PM 2.5(Dust, Pollen particle), Propane, Methane, carbon dioxide, heat, temperature and humidity. Using IoT and Cloud Computing, that will give better management of data coming from various sensors using Raspberry pi and Arduino. Thus, reducing the cost and time, data will be delivered to the users through android App in real time and generate alerts if the concentration is high

ACKNOWLEDGEMENT

Thanks to Allah Almighty for enabling us to complete this project in time. We revere the patronage and moral support extended with love, by our parents whose financial support and passionate encouragement made it possible for us to complete this project. We submit our heartiest gratitude to our Supervisor Dr. MONEEB GOHAR for his sincere guidance and help for completing this project. We would also like to thank all concerned persons who helped us in this regard.

Faraz Asad, Abeer Ehsan Rashid
Islamabad, Pakistan
June 17, 2019

DEDICATION

We dedicate our work to our family and teachers who guided us and motivated us throughout the process. We appreciate our beloved parents who always support us through thick and thin and Dr. Moneeb Gohar for helping us to develop our technological skills, for the many hours of proof-reading and for helping us to overcome the problems that we faced.

“A father gives his child, Nothing better then a Good Education”

Prophet Muhammad P.B.U.H

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Chapter 1

Introduction

1.1 Introduction

Air pollution has a great effect on human health. More often air pollution exists as a result of human activities. The main cause of air pollution is burning the fossil fuel in transport and industrial sector. According to a recent report about two million people die every year because of the polluted air. Air pollution is a big problem not only for the people living in smog-choked cities but it has the potential to affect all of us. Ammonia is very common in agriculture related activities and it is one of the most hazardous gas presents in the atmosphere [1]. Particle pollution is a mixture of solid and liquid droplets present in air. Particle pollution comes in different shapes and sizes Like dust, smoke and pollen particles.

We are developing Islamabad Air an IoT based Air quality and pollution monitoring Project, which will measure the air quality and alert the user about the presence of different gases and pollution particles in the air.

1.2 Overview

The main purpose of this project is to provide an IoT based solution that will allow the people to check the air pollution, PM particles as well as different gasses concentration in the air and inform the user through the mobile application. The mobile application will keep people updated about their outdoor environment. This application will be for all type of people but the victims of the pollution and particle like pollen and dust will be the main user of this application and this application will help them during their outdoor activities. In order to experience an interactive session the users are required to download and install the application. After installing the application, the user can see the concentration of different gases around them as well as the particles and temperature concentration. The system will generate an alert if the concentration of pollen is high and maintains the database for the future prediction and for our future work.

1.3 Problem Statement

Develop a health concerning application for the user. This system will allow the users to remotely access the system and keep updated about the outdoor environment. The application will generate alert and warns the user if the concentration is high.

1.4 Problem Description

Air pollution is a biggest threat to human health specially with the increase of industry and vehicle usage. There are different particles in the air that can affect human health and leads to lungs infection and other dangerous diseases. The same side effects are seen due to the excess concentration of harmful gases in air. The gases emitted by transport vehicles like nitrogen oxides and Sulphur dioxide are the main causes of the air pollution that effect the human body. As we all know prevention is always better than cure. We have to aware and alert the people about the high concentration of the particles and other harmful gases like NO, SO2 and carbon dioxide before they suffer and take necessary precautions against it.

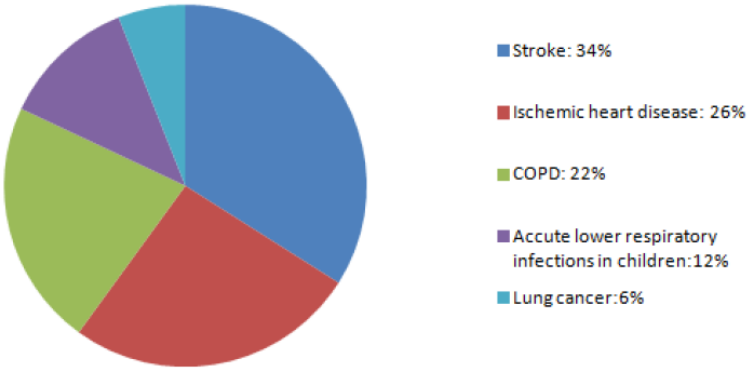

Figure 1.1: Diseases caused by air pollution.

The Figure 1.1 shows how air pollution has affected the human body, air pollution can now be linked to a larger number of conditions, including cardiovascular diseases and cancer, in addition to acute respiratory infections and chronic obstructive pulmonary diseases (COPD).

1.5 Objectives

Following are the objectives to be achieved through Islamabad Air:

- Real time IoT based air quality monitoring system.
- Measures the concentration of different gasses in the air and inform the user if the concentration is high.
- Develop a mobile application that will allow the user to easily access the data through cloud.
- Generate alert if the particles like dust and pollen concentration in the air is high.
- To keep the user updated about the outdoor environment

1.6 Project Scope

The scope of our project would be defined on the basis of functionality such as pollution particle detection from air, the concentration of different gases in the air, also detect the air quality, humidity and also the rain forecast. There are different sensor involved i.e. Particulate Matter (PM) sensor (PM 2.0, 1.0, pollen), Temperature sensor, Gas sensor that will detect the concentration of nitrogen oxide, Sulphur dioxide and other harmful gases. Our system will also detect the humidity from the air and forecast rain. We will collect the data from all the sensors and upload it on a cloud.We will develop a mobile application by using which one can check the air quality. We will also maintain a database on the cloud and then by using this database system will analyzing the data, generate graph and the user will access the data through Mobile App developed using Android Studio.

Chapter 2

Literature Review

2.1 Literature Review

The importance of research in climate and environmental sciences has increased unmistakably greater because of an Earth-wide temperature boost. Due to ascend in temperature; the physical processes have been occurring at a lot quicker rate than the past which results in outrageous climate variability embedded with extreme weather event. Climate change is directly or indirectly related to the human activities which change the composition of the global atmosphere. A recent research shows that the average temperature of the earth surface will be increase by 1 to 3.5°C (about 2 to 6°F) by the year 2100. Changing environment will have adverse effect on human health. According to the IPCC Report the effect of the climate change is slowly unfolding [2]. The amount of the crop yield is declining in most part of the world due to increase in temperature. Changes are also observed in rainfall variability. The major problem arising due to climate change is the availability of fresh water and it will affect more than one billion people by 2050.

The death rate will be in increase due to heat stress and the areas where the people are not prepared to deal with the warmer temperature. There are chances that the vector borne diseases will be increased. According to WHO report, countries like China, India, Pakistan, and Bangladesh that have increasing trends in PM2.5 concentration in the air. However, while China has made some enhancement in handling air pollution, but Pakistan, India and Bangladesh have the most severe increment in air contamination levels since 2010 and now these countries have the most PM2.5 concentration [3].

2.2 Existing System

Students from School of Civil and Environmental Engineering at NUST identify the impacts of brick kiln discharge over the Islamabad and Rawalpindi air quality by utilizing geographic information system, GIS systems. As no real time air quality information is available, the measure of every day production was utilized to compute the concentration of carbon monoxide (CO), sulfur dioxide (SO2), and particulate issue (PM2.5). In their study they identify the impact on air quality from brick kiln emissions. The authors don't guarantee any exactness of the information because of the unavailability of real time air emission information [4].

The main air quality observing framework in Pakistan is mobile system that was either activated on when it was employed by to render its services or on a complaint. With just a single system, the whole nation had no effective system for observing environment and the air quality and therefore failed to identify the real causes of pollution and concentrations of CO, SO2, and PM2.5 [5].

Therefore, The government decided to purchase system from EPA to measure the air quality with cost them 80 million. EPA stations were monitoring and collect the data about air quality. EPA installed six stations to monitor the air quality but the data the system was providing was not realistic and was unable to help in monitoring the air quality. So, it was recommended that there is a need to execute a successful program to screen air quality discharges from stationary and diffused sources. Under this program, the air quality observing stations must be connected to a CEMS to gather data on high air contamination. But the EPA authorities have failed to implement the recommendations currently, all the air quality observing

stations have been closed down while laboratories are dysfunctional as they are working underneath their ability or capacity [6].

Dust hypersensitivity and pollen issues were featured after 2000 and it was seen that numerous patient of dust sensitivity has been admitted in various hospitals of Islamabad. So, Pakistan Meteorological Department assumed liability of observing every day pollen count .In this respects first instrument was introduced at PMD Airborne pollen grains is gathered on slides and identify the type of pollen. A rotor sampler working on a 10 percent duty cycle is utilized to count pollen in Islamabad. After measuring pollen, the data is categorized according to the severity index, developed by the American Academy of Allergy, Asthma Immunology [7].

2.3 Proposed System

As you can read in above description that is no system that provide the information about real time air quality. Our system will detect the particles concentration from the air as well as detect the concentrations of CO, SO2, PM2.5, humidity in the air, and forecast the rain. Our system will collect the real time data from the sensors. We are using Raspberry Pi, Arduino, there are different sensor involved i.e. Particulate Matter (PM) sensor, Gas sensor that will detect the concentration of nitrogen oxide, Sulphur dioxide and other harmful gases. Our system will also detect the humidity from the air and forecast rain. We will collect the data from all the sensors and upload it on a cloud. We will develop a mobile application by using which one can check the quality and the presence of the particles.

Chapter 3

Requirement Specification

3.1 Requirement Specification

Software Requirement Specification (SRS) is a detailed elucidation of the system being developed. SRS is usually made during the first stage of "requirements development", that is the beginning phase of development of products where the required information is not needed. This information collecting phase may involves field visits, interviews, surveys and a return-on-investment (ROI) analysis. Then, write down the real specifications after collecting and analyzing the requirements.

3.2 Purpose

The main purpose of this project is to yield a smart-phone mobile application by using which the users can get latest information about real time air quality.

3.3 Project Scope

Air contamination is the biggest ecological and public well-being challenge on the planet today. Air contamination prompts antagonistic consequences for Human health safety, atmosphere and biological system. Air is getting contaminated in view of arrival of Toxic gases by industries, vehicular outflows which result in abundance of dangerous gases and particulate matter in the climate. Particulate matter is a standout among-st the most vital parameter having the noteworthy commitment to the expansion in air contamination. Our complete project is divided in two phases. In first phase we will integrate different types of sensors including pollen sensor i.e. PM(2.5) and the sensors for different type of gases CO, SO2, sensor for temperature, sensors for humidity measure, rain forecast sensor. We will collect the data from all these sensors and send it to the minicomputer i.e. raspberry pi where we will use the existing data to draw prediction graphs. After integrating the sensors with the Raspberry Pi and Arduino and the data collected through the sensor will be transmitted to the cloud. In the second phase we have develop smart-phone mobile application. In which we will first develop the interface and the back-end of the application then the data from the cloud will be transferred to the application which will be available to the user. The users just need to download the application and use it. Our application will generate warning it the concentration of the gases or the pollen concentration in the environment is high and suggest medical advice to the users.

3.4 Overall Description

3.4.1 Project Perspective

This system has not been implemented in any of the known domain. This is totally a new product; however this system can be modified further in order implement on a larger scale. The main aspect of the system are highlighted in following block diagram:

Figure 3.1: Data is coming from different sensors, and are transfer to Arduino with convert analog values to digital, after those values are transfer to raspberry pi

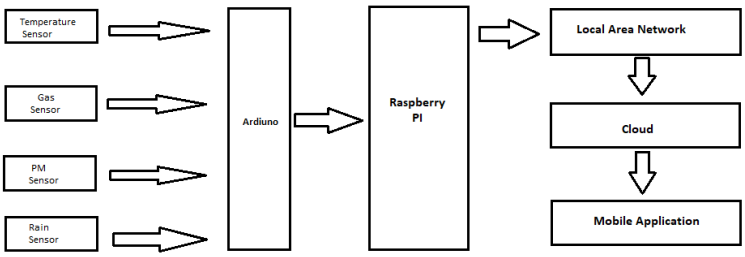

Figure 3.1: Basic Block Diagram

and they are transferred to cloud using Wi-Fi module using local area network and user accesses the data through Mobile App

3.4.2 Project Function

Our system will provide a platform that will serve the people where no other system provides this kind of functionality. This system can also be modified in order to implement it on a larger scale with respect to future perspective. The users just have to install the application and view the environmental report easily and can set his day plan accordingly if the concentration of any of the substance in the atmosphere is high the system will automatically generate the warning and alert the user about it.

3.4.3 User Classes and Characteristics

Different types of classes are involved in the system especially in the testing phase for the testing team and installation class for the users.

- The testing will make sure that the system is meeting the quality requirement and there is lesser chance of error occurring while using the system or while fetching the data. Whenever an update in the system is required it will easily amalgamated within the system and the patch is release as soon as possible for the users. Testing team will have the access to search the system for the bugs and report them as soon as possible and also provide the solution for it.

- All type of peoples can use this application to become aware of current environmental condition. This application will help them in keeping active look of the atmospheric condition. The user can also send back the feedback based on the their experience with the application with will help the maintaining team in making the application more efficient and effective

- People with the allergy are the main user of this application because the main purpose of our system is to help them in controlling the fever and seasonal diseases and they can send their feedback which help in improving the system

3.4.4 Operating Environment

The product of this project is an android based application which is connected with the fire base cloud to update data in real time. The android phone must be equipped with the Marshmallow 6.0 platform to run the application. In order to use the application user just need to install the application and use it.

3.4.5 Design and Implementation Constraints

The system will be simpler in order to lessen the cost and it can be modified or change easily according to the requirement. The developed system will be simple and real time air quality and pollution monitoring system. We will try to use most efficient algorithms for the graphs to increase the throughput of the system. The system should provide its full efficiency for concurrent calculations, that is getting data from the sensors and transform them into output. This may result in increasing the processing power and cause the quick decay of the battery being use, such type of the problems will be properly tackled in the later updates of the system or the application.

3.4.6 User Documentation

We will provide a video for the application for the users that will give an overview of the system and how to use the application. The user must need to see this tutorial in order use the application in a good way. The user can see the tutorial anytime anywhere he or she needed.

3.4.7 Assumption and Dependencies

- The main idea of this application is to provide an environment in which user especially the victims become aware of the current environmental conditions. In order to implement this system, the user should be familiar with the functionality of the application.
- To use the application effectively we are assuming that main class will be of the data that is being shown to all types of the users. The user interface will be design as efficiently as possible which will help the user in viewing the record more easily and provide them with friendly environment.
- This application will be easily installed in all type of smart phone without the problem of memory.

3.5 External Interface Requirements

3.5.1 User Interface

We will try over best in order to provide the simplest interface to the comfort the users. Design is the important part of any system developed because it attracts the user to use it or not. If design is user-friendly then user will definitely try to interact with the application and if it is not user-friendly user will be frustrated.

We will be keeping in mind all the techniques used for designing the user interface and try to increase the usability so that users interaction increase. We will include a menu with several buttons that will provide the user with different options, option to watch tutorial and other setting option to adjust the screen according

3.5.2 Hardware Interface

The main interface for the hardware will be the Raspberry Pi and Arduino and the screen for the displaying the data. The application would provide a platform that can be run on a smart phone. The efficiency of the application is somewhat dependent on the graphics memory and smart phone itself and on the performance of the hardware at the back-end as well as the smart phone. The simple data flow in hardware will be in the following order

- The data from different sensors will be collected and is transferred to the Arduino, which will convert analog values to digital.
- After that, these values are transfer to the raspberry pi that will use its Wi-Fi module to transfer data to the cloud.
- The cloud will transfer data to the mobile App, that will be available to the users of this system

3.5.3 Software Interface

The software will be our mobile application that will be created using Android Studio. We will try over best to keep the interface simple and friendly in order to attract the users. The users just need to install the application and use it. The user interface will be design as efficiently as possible which will help the user in viewing the record more easily and provide them with friendly environment. It is also an important component as without software the hardware is nothing, they are interconnect with each other, the hardware component require the software components to perform some functions for the user

3.5.4 Communication Interface

If the user is offline then the last available data will be shown to him. All the components require for the proper working of the application would be tested very carefully in order to lessen the chances of error

3.6 System Features

3.6.1 Functional Requirements

UI Functionality

User interface is an essential part of any software to attract the customer. The user interface for the Islamabad Air will be easy to operate and quick in response and it will be able to effectively handle the operational errors.

Functionality for Administration

The system shall be able to automatically store the record in the database or update the database as new data come from the sensors

Assumptions for users

The system shall be able to show the previous record of data to user to see the fluctuation in data with the data graph.

System Security Measures (assumption)

Our system shall be able to map any kind of misuse or attack along with the time like unauthorized person tried to login, when the system admin gain access to the system data or when he has modified the record. In case of any attack how long system will resist..

Well-built Model interaction

All the models must be well built and must look realistic in order to help the people in efficient manner. We will try over best to build best interaction model for this system.

3.7 Other Non-Functional Requirements

3.7.1 Performance requirements

Performance

In the normal routine the CPU should utilize at most 50 percent of the memory, other half for the background tasks. The response time of should be 1/100000 at its peak load.

Efficiency

Communication interface must be efficient enough to reduce the throughput of the system.

Reliability

The framework would utilize Artificial Intelligence to figure the prediction more accurately and more precisely. The calculations utilized must give right and dependable results.

Usability

The product of this project must be user friendly and simple to use. No Complicated settings would be required for the operation of the application.

Security Requirements

As the functionality of our application is online and the connection to the internet is must in order to update the information when require. We will make sure that no one will get access to admin portion of the application

3.7.2 Safety Requirements

During working, the application must not deplete memory of the host system. Additionally, the framework must not warm up the Host gadgets above 37'c. In the event that the application misbehave from its ordinary behavior, it should securely close itself down so not causing any harm to the host gadget.

3.8 Use Case

- Perform system testing
- Suggest system updates
- Use case of Notification
- Data flow monitoring

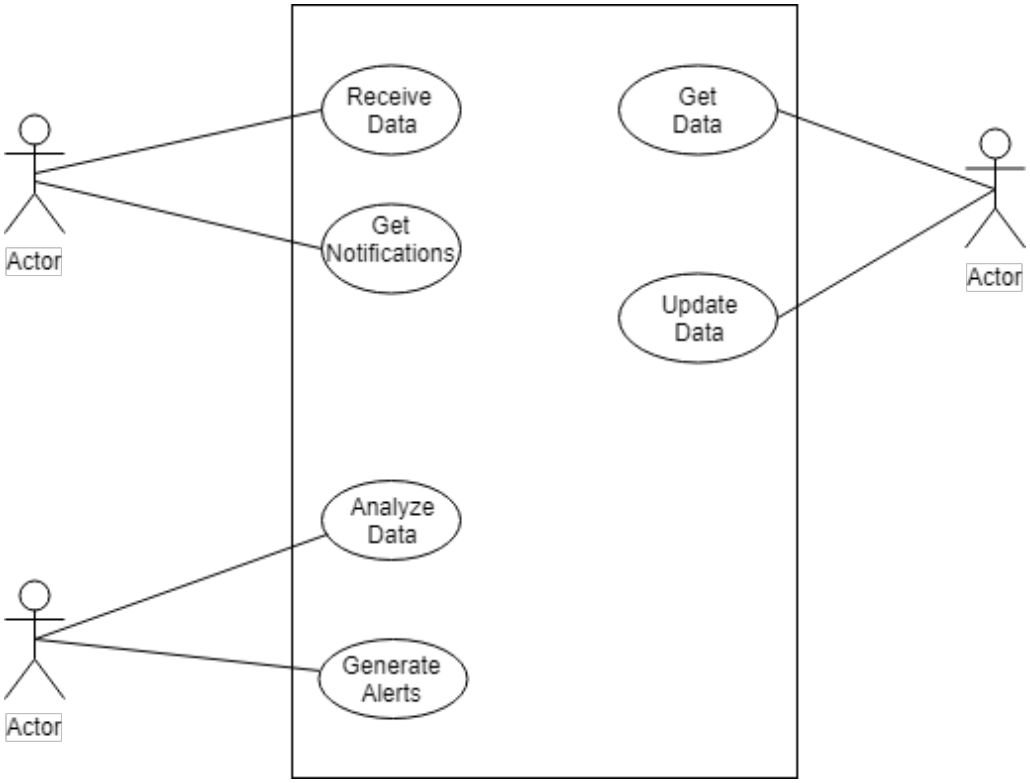

Figure 3.2: Use case Diagram 1

Fig 3.2 explain the various actors involved in the system along with their functionality. The first actor is the user that will view the data and get notifications. The second actor is raspberry pi that gets data from various sensors and update

from time to time. The last actor is cloud that will receive data, analyze the data and generate alerts for the users.

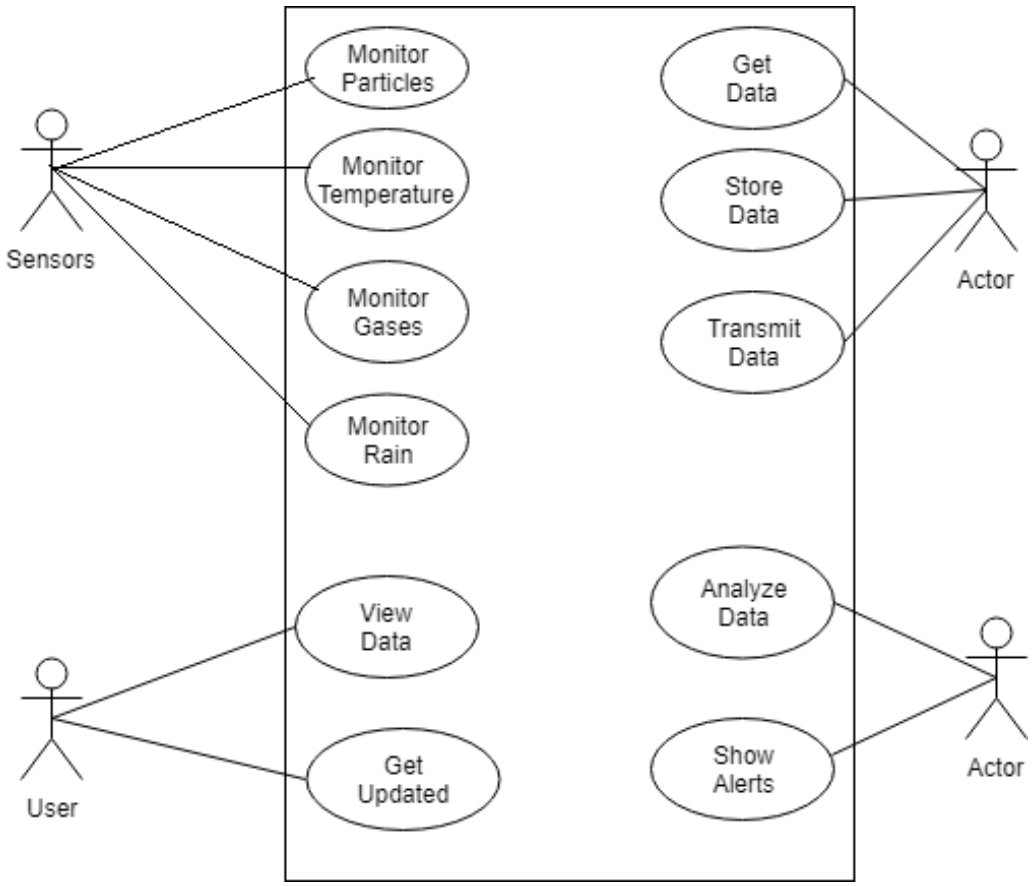

Figure 3.3: Use case Diagram 2

Fig 3.3 explains the first actor is the various sensors involved in the system. The second actor is raspberry pi that gets data from various sensors and update from time to time. The third actors are the user that gets notifications and view data. The last actor is cloud that will receive data, analyze the data and generate alerts for the users.

Table 3.1: Use Case 1

No.	**Title**	**Perform System Testing**
1	Description	All Objects and sub systems are tested for bugs and errors
2	Actor	System Tester
3	Pre-requisite	Integrated and complete system
4	Basic Flow	If errors are found suggest updates and patches
5	Alternative Flow	Use current system
6	Post Condition	Suggest system update and patches

Table 3.1 provides the description that all the objects and sub system are tested for the bugs and error. The actor will be the system tester and the Pre-Requisite for the system is integrated and complete system and the post condition is suggesting system update.

Table 3.2: Use Case 2

No.	**Title**	**Suggest system updates and patches**
1	Description	System is suggested update and patches if current system is facing error
2	Actor	System Tester
3	Pre-requisite	Perform System Testing
4	Basic Flow	New updates are suggested by developers
5	Alternative Flow	Current system is maintained
6	Post Condition	Developer is notified of errors

Table 3.2 provides the description that system will suggested update and patches if current system is facing error. The actor is System Tester. The pre-requisition is perform system testing and post-condition is that developer is notified of errors.

Table 3.3: Use Case 3

No.	**Title**	**Alert generated by system**
1	Description	System will generate alert if level increased then normal
2	Actor	Application
3	Pre-requisite	Analyze data
4	Basic Flow	Alerts generated by the system
5	Alternative Flow	The system will not generate an alert
6	Post Condition	Notification received to user

Table 3.3 provides the description that system will generate alerts if the level is increased. The actor is Mobile App. The pre-requisite is analyze the data and post-condition is that user is notified through notification.

Table 3.4: Use Case 4

No.	**Title**	**Data flow monitoring**
1	Description	Data coming from sensors
2	Actor	Tester
3	Pre-requisite	Monitor the data flow
4	Basic Flow	Real time data is coming
5	Alternative Flow	The Application will show the previous data stored
6	Post Condition	Updated data

Table 3.4 provides the use case about data flow from sensors to cloud and then on mobile application. The actor will be the tester of the system and the pre-requisite for the system is monitor the data flow. The post condition is Updated data.

Chapter 4

System Design

4.1 System Architecture

The system we have designed get the data from the sensors send it to the Raspberry pi, after performing prediction upload it to the cloud and store in the database. The user will interact with data through the application. Following is the basic interaction of this application:

- The user will interact with the user interface of the mobile application and the back-end of mobile application is getting the data from the database of cloud
- The database i.e. cloud will use to store the record that will be used for prediction for later and provides the reading to the mobile application.
- The system using the AI and the existing record from the database to do prediction and collect data from the sensors.
- Different types of sensors are used to collect the readings from the environment.

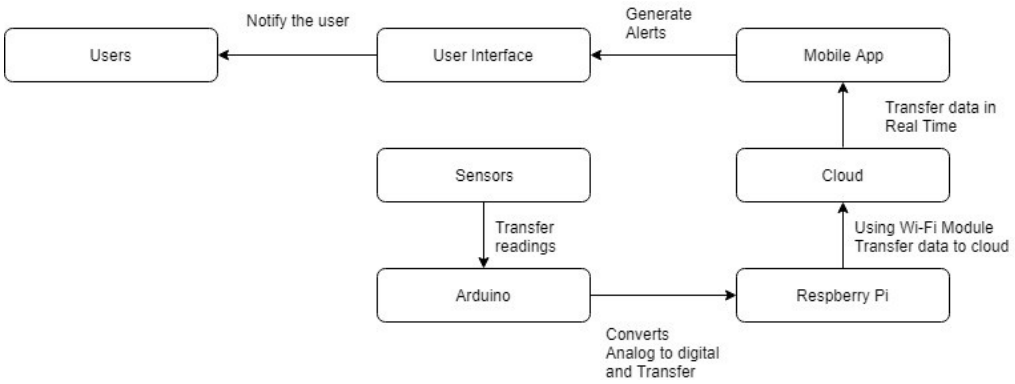

Figure 4.1: System Architecture

Fig 4.1 explains the overall architecture of the system: readings from the various are transfer to Arduino. Arduino converts Analog signals to digital and transfer to Raspberry, using Wi-Fi transfer data to the cloud, transfer the real time data to the mobile App and user can view the data through user interface.

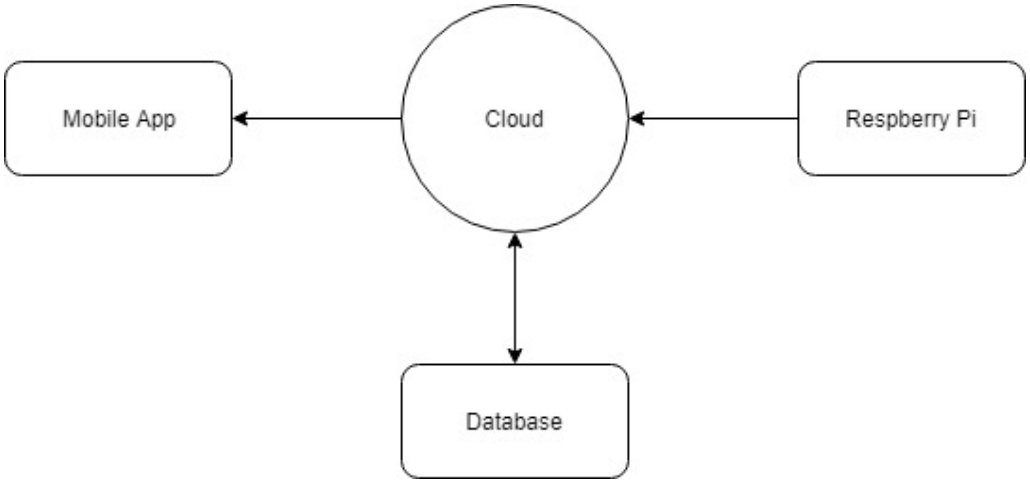

Figure 4.2: Context diagram

Fig 4.2 shows the Context Diagram for the system. The main entities are Mobile App that will show data to the users. Cloud is used as central body. Raspberry transfer data to the cloud and database that will be maintained on the cloud

4.2 Design Constraints

- Sensors will send data to Raspberry pi.
- Mobile Application is must require to see output of system.
- System will only comply with Android devices.
- Android version should be 6.0 or above.

4.3 Design Methodology

4.3.1 Process Model

We have adopted the iterative model in order to develop our system. It is because this model does not start with the full specification of the requirements. Initially we create a simple set of requirements which iterative enhance the evolving version until all of the requirements are met and full fledged system is available for use.

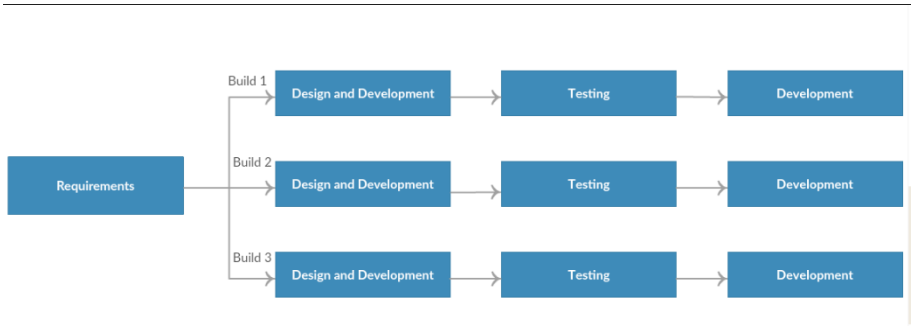

Figure 4.3: Process Model (Iterative).

Fig 4.3 explains that project is composed of different features, so we have utilized iterative model. The motivation to pick this model is on the grounds that the iterative technique takes the waterfall model and goes through it a few times in little augmentations Rather than stretching the entire project across the phases of the SDLC, each step is turned into several mini-projects that can add value as the product evolves

4.4 High Level Design

4.4.1 Process

The data will be available to the user on the smart phone mobile application and user will interact with the user interface. The back end of the mobile application is getting data from the cloud where the data is stored. The data on the cloud is uploaded from Raspberry pi. The initial data is coming from different types of sensors and this data is transferred to the raspberry pi. Following is a simple version of interaction sequence diagram for use:

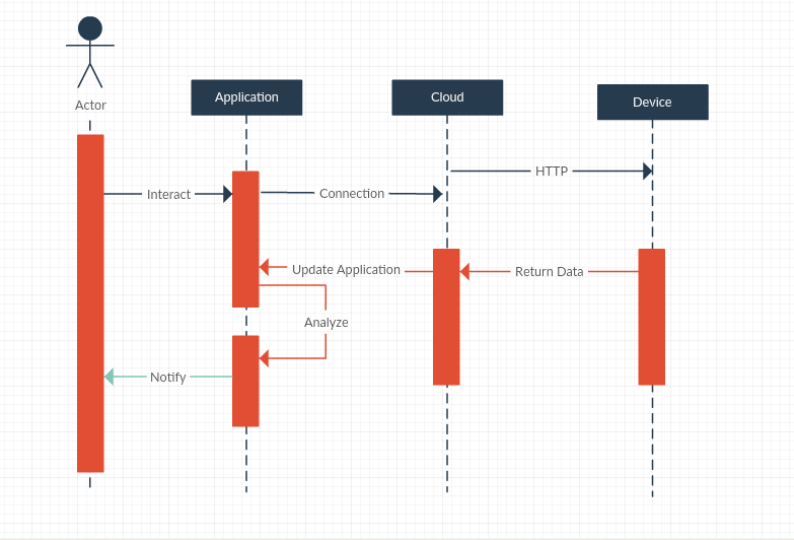

Figure 4.4: Sequence Diagram

4.4.2 Package Diagram

Our team has divided this project in three packages

- Mobile Application/Users
- Cloud
- Hardware

Fig 4.4: Sequence Diagram explain the various process that will take place within the system whenever the user interact with the system

Mobile Application/User

- The user can view the readings by using the application
- The user can provide feedback with will help in improving the system

Cloud

When the system will perform calculation the data will be uploaded to the cloud

- The cloud contain the data that is transferred from the hardware
- The cloud contains a database that will contain the previous readings that will be used for maintaining records

Hardware

The hardware is the main component of our project. Hardware of our system will perform the following activities

- Gather the reading from the sensor and pass it to the cloud
- From cloud the data is integrated to the mobile application

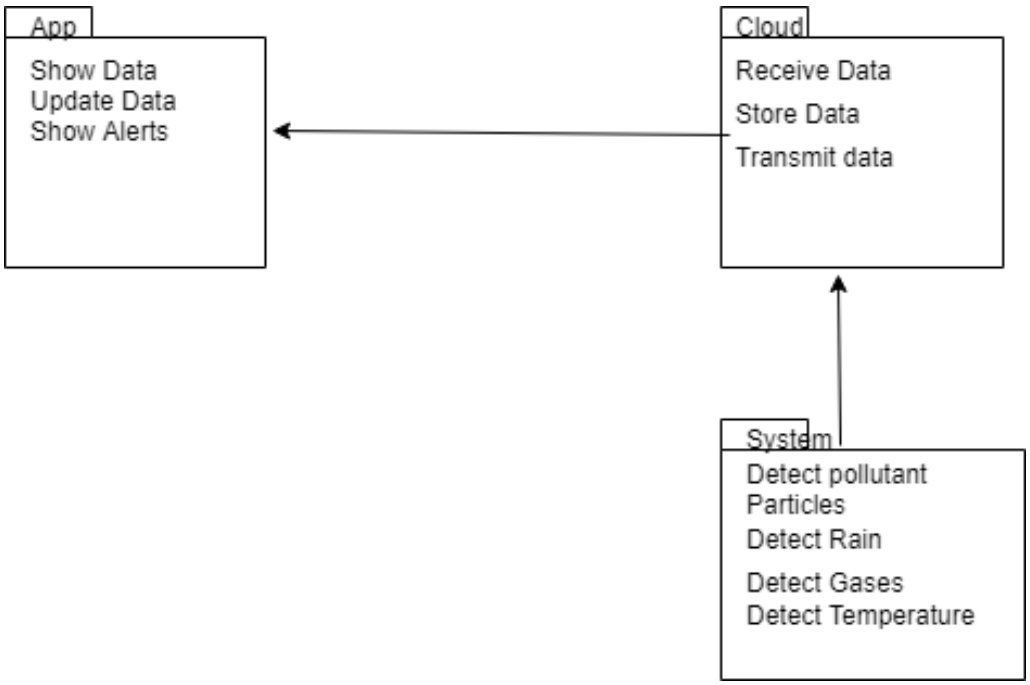

Figure 4.5: Package Diagram.

Fig 4.5 shows package diagram for our system. The system is divided into three packages Mobile Application, Cloud, Hardware

4.5 Low Level Design

The data will be available to the user on the smartphone mobile application and user will interact with the user interface. The data will be available to the user on the smartphone mobile application and user will interact with the user interface. The backend of the mobile application is getting data from the cloud where the data is stored. The data on the cloud is uploaded from Raspberry pi. The UML diagram for the system is given below:

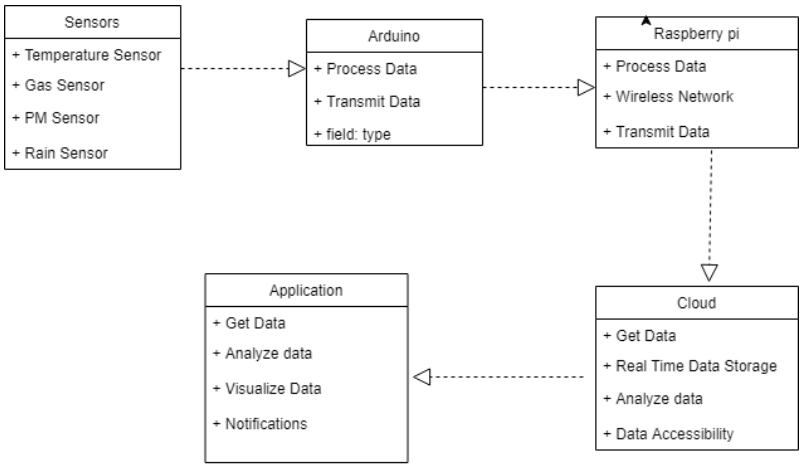

Figure 4.6: Uml Diagram

Fig 4.6 is the UML class diagram of our system which represents the interface of our system. How different system components interact with each other

4.6 GUI Design

The interface will be simple and friendly in order to attract the users. The users just need to install the application and use it. The user interface will be design as efficiently as possible which will help the user in viewing the record more easily and provide them with friendly environment.

Chapter 5

System Implementation

5.1 System Architecture

The system consists of various sensors, Arduino, raspberry pi, local network, cloud and mobile application. Arduino will read data from the sensors and transmit it to the cloud using local network. The mobile app is sync with the cloud that will display data to the users in real time environment. The project mainly aims on overall environmental conditions based on value of different gases, humidity, temperature, rain forecast and dust particle (PM) in the air and alerts the user if the concentration is higher than its limit

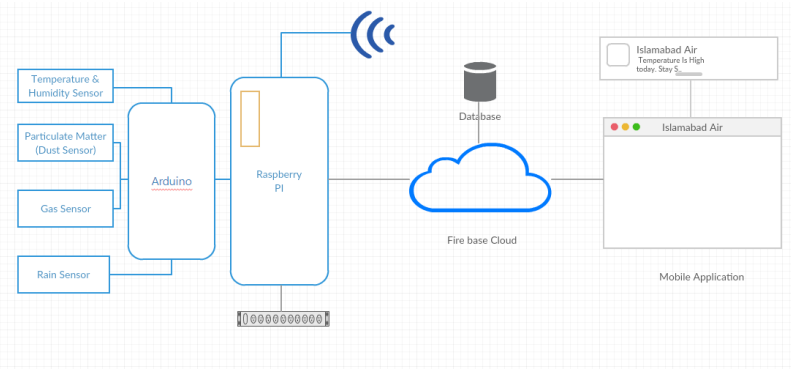

Figure 5.1: Structure Diagram

Fig 5.1 explains the system architecture of the system: reading values from the various are transfer to Arduino. Arduino converts Analog signals to digital and transfer to Raspberry, using Wi-Fi module, transfer data to the cloud, transfer the real time data to the mobile App and user can view the data through user interface.

5.2 Implementation tools and technologies

5.2.1 Sensors

Humidity and temperature sensor DHT-22

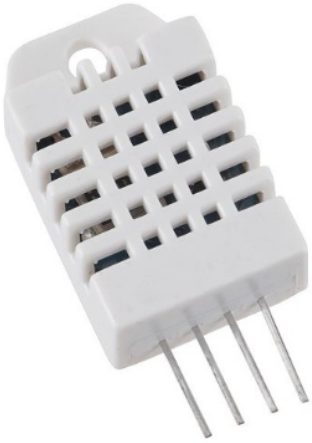

Figure 5.2: Temperature Sensor

Fig 5.2 shows DHT-22 (additionally named as AM2302) is an advanced yield, relative moistness, and temperature sensor. It utilizes a capacitive stickiness sensor and a thermistor to gauge the encompassing air, and sends an advanced flag on the data pin.

Gas Sensor MQ-2

Figure 5.3: Gas Sensor

Fig 5.3 shows MQ-2 smoke sensor is touchy to smoke and detect the following gases: LPG, Butane, Propane, Methane, and Hydrogen. The response of the sensor for each gas is distinctive. The smoke sensor consists of a potentiometer that enables you to modify the sensor affect ability as per how exact you need to identify gas.

Rain sensor Module

Figure 5.4: Rain Sensor

Fig 5.4 shows that this module permits you to measure dampness by means of simple yield (analog) pins and it also give output in digital form when the dampness exceeds a certain limit. It incorporates the hardware module and a printed circuit board that "gathers" the water drops. As drops are gathered on the circuit board, they make ways of parallel opposition that are estimated by means of the operation

amp. When the water is more, the lower the voltage yields. Alternately, the less water, the more the yield voltage.

PM 2.5 Air Quality Sensor

Figure 5.5: PM 2.5 Air quality sensor

Checking and Controlling Air encompassing is vital now days because of expanding contamination level of the air. PM 2.5 is used for the particles that are 2.5 microns or smaller in width. This sensor utilizes laser dissipating to emanate suspending particles noticeable all around, at that point gathers dispersing light to get the bend or curve of the dispersing light change with time. We get PM1.0, PM2.5 and PM10.0 concentration using this sensor. By using this sensor we will be able to detect PM per 0.1L air, arranged into 0.3um and 0.5um size bins as shown in fig 5.5.

Arduino

Figure 5.6: Arduino

Fig 5.6 shows about arduino. Arduino is an open-source platform that allows the simple use of equipment and programming.[9] It's proposed for anybody making intuitive ventures. Arduino takes the input from various sensors and control the various devices like motors, lights and other actuators.

Raspberry PI

Figure 5.7: Raspberry Pi

Figure 5.7 shows about raspberry pi. The thing about the Raspberry Pi is that you can do anything with it that you can do with a PC. It can do a few things that a common PC can't do. Also the Wi-Fi module of the Raspberry Pi allows you to access the cloud directly or send data over it.

5.2.2 Development environment and Language

- Java is used for Android Mobile Application
- Python for raspberry pi
- Embedded C for Arduino
- Firebase as a Cloud

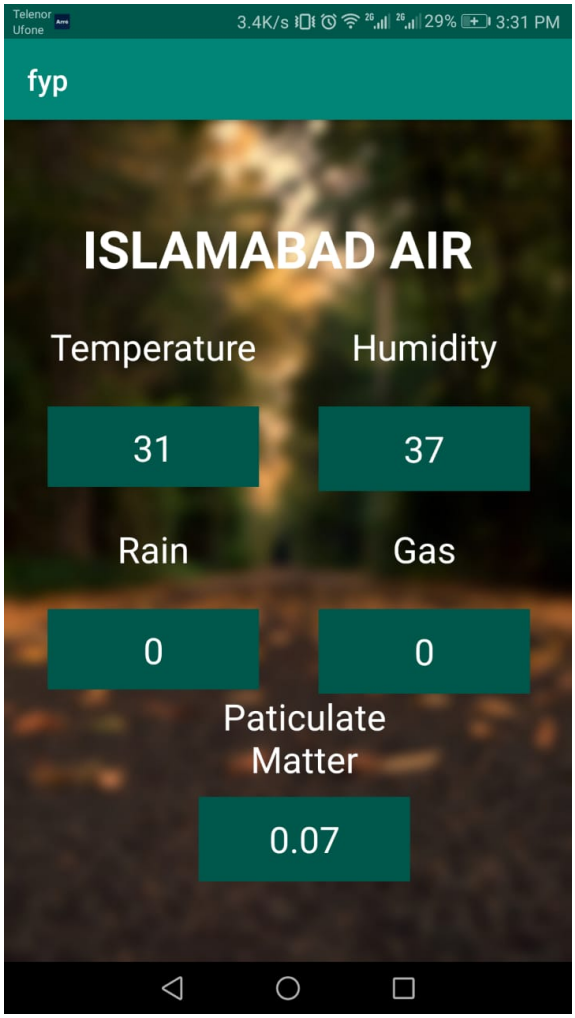

Figure 5.8: Application Interface

Fig 5.8 explains the App interface in which different sensors: PM, Rain, Gas, Humidity and Temperature. Values are shown to the users in Real-time.

Figure 5.9: Graph

Fig 5.9 explains the graph view of values. It shows the fluctuation of values with time. If value increases or decreases the graph will be updated with the change of the values. It shows a record of data up to current state.

Figure 5.10: Fire-base Cloud

Fire-base by Google can be used for the following: Fire-base manages all data real-time in the database. So, the exchange of data to and fro from the database is easy and quick. Hence, if you are looking to develop mobile apps such as live streaming, chat messaging, etc., you can use Fire-base.

Fire base allow syncing the real-time data across all the devices- Android, iOS, and the web without refreshing the screen Fire-base offers integration to Google Ads, AdMob, Double Click, Play Store, Data Studio, Big Query, and Slack, to make your app development with efficient and accurate management and maintenance[10].

Everything from databases, analytic to crashing reports are included in Fire-base. So, the app development teams can stay focused on improving the user experience.

We have used cloud in our project which made it easy for the user to access the real time data dynamically in no time. We will use this cloud to maintain a database and perform prediction on the data in near future. We will use the cloud data to perform prediction that will allow the user to view the upcoming event.

5.3 Methodology

This project is composed of different features so we have utilized iterative model. The motivation to pick this model is on the grounds that the iterative technique takes the waterfall model and goes through it a few times in little augmentations

Rather than stretching the entire project across the phases of the SDLC, each step is turned into several mini-projects that can add value as the product evolves. The iterative methodology shares a significant number of same objectives with the agile model, with the exception of external clients are less included and with the view that the scope of each increment is typically fixed

The iterative approach consists of the following stages.

5.3.1 Requirement Gathering

First we have enlisted down and gather the information about the entire items that were required to develop this system and completing this project

5.3.2 Analysis

In this phase we have searched the market and we have chosen specific sensors and components after considering a number of factors: Reliability, Accuracy, Usability and Cost.

5.3.3 Design

Designing is the core part of any system being developed because it attracts the user to use the system or not. If design is user-friendly then user will automatically adopt the application. If GUI is not user-friendly, the user will be frustrated. We made sure to design and develop a simple and user friendly GUI and make sure increase the usability of the system so that user should interaction easily.

5.3.4 Development

Using a flawless system is impossible as it can't be developed but our team has tried its level best to provide a flawless, effective and efficient system with real-time updating facility to the user by using the tools discussed in the Tools/Technology.

5.3.5 Deployment

We have deployed the system in particular environment and ensure that it should achieve its objectives, as stated in the proposal.

5.3.6 Testing

Testing techniques will be applied to the developed system like functionality testing, performance testing, acceptance testing and merging hardware and software to ensure that the application meet its functional and non-functional requirements.

5.3.7 Evaluation

The system is evaluated carefully to make sure that actual output meets the accepted output. By working iterative, the project team goes through a cycle where we evaluate the each iteration, and determine what changes are needed to produce a satisfactory end product

Chapter 6

System Testing and Evaluation

It is an investigation conducted to provide stakeholders with information about the quality of the software product or service under test. By using the software testing we are able to know either our project achieves the desired goals and in which user can also check the project for error and performs debugging.

6.1 Deriving Test

The test case specifications are developed from the software requirements specifications and the use cases. In this test user checks either software is working correct or not and it also helps to check the quality of the software as a test designer. The test specifications performed for system testing of "Air quality monitoring system" by keeping in mind several issues that are discussed below:

6.2 Test Environment

Test Environment consists of elements that support test execution with software and hardware on which the testing team performs testing of the newly built software.

6.2.1 Hardware

- Raspberry Pi
- Arduino
- PM Sensor
- Gas Sensor
- Humidity Sensor
- Rain Sensor

6.3 Test Procedure

Test procedure consists of detailed sequence of steps that has to be followed for executing a test. Test procedure is written from a test case and are complete, self-contained, self-validating and execute automatically. Each test case will be having corresponding test procedure although a single test procedure may execute one or more test cases.

Following strategies are used for the testing of the "Air Quality Monitoring System":

6.4 Unit Testing

Source code are tested or checked either they are fit for use. Unit testing is a software development process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Unit testing should test every path and every line in each module.

6.4.1 White Box Testing

It is the testing based on an analysis of the internal structure of the component or system. It is that software testing technique where by explicit knowledge of the internal workings of the item being tested are used to select the test data. White box testing uses specific knowledge of programming code to examine outputs. The test is accurate only if the tester knows what the program is supposed to do. In this method of testing the test cases are calculated based on analysis internal structure of the system based on Code coverage, branches coverage, paths coverage, condition Coverage etc.

6.5 Integration Testing

It is a software development process in which program units are combined and tested as groups in multiple ways. In this context, a unit is defined as the smallest testable part of an application. Integration testing verifies that the units can be correctly integrated into sub-systems. Test performs in such a way and it will make sure that the components are working properly after the integration.

6.6 System Testing

The testing in which the complete and integrated software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements. System testing requires no knowledge of coding, logics and inner design.

6.6.1 Recovery Testing

In this testing we check how soon the application recovers when it is crashed or if hardware gets failed. Our software system is fault tolerant. As for our hardware system, there are some limitations as are for every other hardware systems. Because no hardware system is 100% secure. If any part of the hardware is crashed or is broken, this can be corrected and maintained by replacing it with a new part. All hardware parts of our project are present in market.

6.6.2 Security Testing

In which software or application is tested either it is secure or not. Vulnerability of the software checks in this phase. Our system has different security layers, only an authorized user can have access to the system when correct username and password is given. After entering correct username and password it is necessary to give the correct answers of the security questions then the user will be able to access the system. If anyone of the above-mentioned steps is done wrong user will not be able to access the robot through the system.

6.7 Test Plan

It is necessary for the testing to be planned. Test plan has the detailed understanding of the workflow of the system. This reflects the whole project testing schedule. It is a document describing the scope, approach, objectives, resources, and schedule of a software testing effort. It identifies the items to be tested, items not be tested, what will be the pass/fail criteria, training needs for team, the testing schedule etc.

6.8 Test Cases

Table 6.1: Test Case 1

Test case id	2
Function to be tested	Usability Testing of System
Initial State	New user will test the system
Input	New user will operate the environment successfully.
Expected Output	User will easily understand the system
Output	User Understand the application easily
Status	Pass

Table 6.1 shows the test case about usability testing of system. In initial state new user will test the system. The expected output of the system is New user will operate the environment successfully. As expected the new user understand the application easily. The status of the test case is pass.

Table 6.2: Test Case 2

Test case id	2
Function to be tested	System performance testing
Initial State	Measuring the startup of the system
Input	To measure the startup time of the system
Expected Output	System should not take more then 5 seconds to run
Output	The system performance is efficient
Status	Pass

Table 6.2 shows the test case about the performance of the system. At initial state the startup time of the system is measured which is taken as input. The expected output of the system is that system should not take more than 5 seconds to run and as system performance is as expected.

Table 6.3: Test Case 3

Test case id	2
Function to be tested	Network connectivity Testing
Initial State	The connectivity of the system with network
Input	The system will connect to the network
Expected Output	Fast and efficient responses from server
Output	Efficient response from server
Status	Pass

Table 6.3 shows the test case about network connectivity. The initial state is connectivity of the system with network. The connection of the system with the network is taken as input. The expected output of the system is Fast and efficient response from server. The status of the test case is pass

Chapter 7

Conclusion and Future Work

7.1 Discussion

In this project "ISLAMABAD AIR" we created an application for the android users which provide AIR Quality Monitoring System to the user to view the air quality in real-time. Due to ascend in temperature; the physical processes have been occurring at a lot quicker rate than the past which results in outrageous climate variability embedded with extreme weather event. Air pollution problems are becoming adverse day by day and it has affected many people. Dust hypersensitivity and pollen issues have become a major issue in the last ten years. There had been some traditional techniques like information from the newspapers. But with new technologies like Real Time Air Monitoring System one will be able to check the concentration of different gases in air in real time. We have developed the system based on the modern requirements of the user. Our system will generate an alert if the concentration of PM particles is high and maintains the database for the future prediction.

7.2 Conclusion

By the grace of GOD almighty we are happy that we are completed our final year project and with our application we would be able to help people from all walks of life. This system is developed for monitoring air quality and pollution remotely. Such systems help to prevent hazardous health problems. It is cost and energy efficient. Some of the learning benefits from our project are as follows:

- Improved Knowledge in the field of IOT
- Improved Knowledge of android studio
- Sensor integration with Raspberry Pi and Arduino..
- New Tools and Technologies
- Testing and Reviewing
- Documentation.

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