AIR POLLUTION MONITORING SYSTEM

FOR SMART CITY

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Declaration

We hereby affirm that the work done for this thesis is based on results attained from our own work. All of the tools and materials used in this text have been properly acknowledged.Thisthesis,neither in whole norin part,hasbeenpreviously submitted to any other University or Instituteforthewardofany degree ordiploma.

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List of Abbreviation

LPG: Liquefied Petroleum Gas

SDG: Sustainable Development Goals

UN: United Nations

AQI: Air Quality Index

AQHI: Air Quality Health Index

GPRS: General Packet Radio Services

GUI: Graphical User Interface

GPIO: General-Purpose input/output

PCB: Printed circuit board

HTML: Hypertext Markup Language

PHP: Personal Home Page

API: Application Programming Interface

LDAP: Lightweight Directory Access Protocol

IMAP: Internet Message Access Protocol

SNMP: Simple Network Management Protocol

NNTP: Network News Transfer Protocol

HTTP: Hypertext Transfer Protocol

PPM: Parts Per million

ABSTRACT

Where pollution has become a major problem around the world, air pollution is the most dangerous, shocking and severe pollution among other pollutions e.g. water pollution, soil pollution, noise pollution, light pollution, thermal pollution etc. Air pollution is the major cause of diseases like asthma, cancer, bronchitis, birth defects and immune system like diseases. This system implements the combination of an android app, server, gas sensors (CO_2, CO, LPG, and CH_4) to sense the air quality of the environment and shows the real condition of air. Solving the draw backs of existing air quality sensors this device can be used to monitor various gasses at a time. The most demanding thing would be this system will give the real time data and will show the quality of the air based on the standard air quality. The system will give the user the indication of the air quality and based on given parameters it will let the user know how much the environmental air is polluted or safe. This system will do everything on behalf of human in such a way that for a smart city when people will have less time for spending and there will be more industry and air will be more polluted this device will let people know how safe the air is. The goal is to make the system as reasonable as possible so that people from every society background can use this and if some research organization wants to do further research then if some nominal amount of money is invested then it would be a great solution to install a weather station thus air quality monitoring system.

Keywords- Pollution, air pollution, gas, sensors, sound, monitoring, pie charts, real time graph, Android app, pollution parameter, real time data.

Chapter 1

Introduction

Considering the daily newspapers and any other electronic or print media, a devastating news which is spreading day by day is people is becoming sick and the climate is changing such a way that it has become miserable for living of people. From the aspect from top to bottom, every people are suffering the curse of climate change. The main reason for the climate change and people health is air pollution. It has brought changes in climate like global warming, global dimming, over raining, drought, storms, acid rain, foggy weather etc. The living things on earth and under water are suffering many problems like change in life due to lack of proper facilities of life.

Air is the most useful thing for each and every living thing. Researching on this serious issue this system's main purpose was to estimate the quality of air for people and any other living thing which exist on earth. Very important to know for our living is that how much safe we are now and how the weather and climate has changed for air pollution and it will sustain sound. This system will ease to know the answers for air quality.

Four major gas sensors which are responsible for the most air pollution mostly are being used in the system to know the best result of the whole condition of the air. CO_2, CO, LPG, Humidity are declared to be the most responsible for air pollution and in the system all are used. Noise sensor is also added to measure the presence of noise in the environment. A server and an android app have been made to know the statistics because now days almost everyone has an android operating device and access to internet.

1.1 Motivation

Not a single living thing can survive without air. Air is the most important element for living. According to the SDG (Sustainable Development Goals) by the UN (United Nations) there are seventeen goals to transform the world to clean, healthy and natural way to live in because at this time there are several problems in human life. The SDG says, Goal 3: Ensure healthy lives and promote well-being for all at all ages, Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all, Goal 12: Ensure sustainable consumption and

production patterns, Goal 13: Take urgent action to combat climate change and its impacts, Goal 14: Conserve and sustainably use the oceans, seas and marine resources, Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss. These are the main reason why the topic was chosen for the research purpose.

1.2 Thesis contribution

Previously some researchers have done some experiments on air pollution monitoring system. As we are moving forward to smart system day by day so according to the fact the objective for making the system was to take the environmental automatically and analyze the system using smart technologies. The system introduced the idea automatic data collection and analysis. The mean average and deviation is used to analysis the result of the system. We have found that this approach often fails to detect the pollution properly. As later steps usually require the output from this step, a failure to extract a blob in this step means the later steps do not even get the chance to present their own evaluation, resulting in poorer overall accuracy. We have taken a more liberal approach to overcome this limitation by taking the vote of all the rules and segmenting the image based on air pollution detecting decision. This increases the accuracy of detecting gasses even for further analysis wherever needed.

Another thing to take into account is that such detectors alone are not sufficient enough for detecting gasses in diverse environments. Many algorithms therefore incorporate other characteristics of fire gasses in order for more accurate identification. The model proposed in this paper incorporates normal emission and proposes an enhanced detection analysis of fire to eliminate the chances of producing air pollution as well as increasing the accuracy of detection. This approach has produced accuracy of temperature 94.34% and for humidity 98.43%.

1.3 Thesis Outline

- Chapter 2 outlines the previous works done in the field of air pollution.
- Chapter 3 describes the proposed model including the specific components and their description.
- Chapter 4 describes Air Pollution Monitoring and its importance,Air Quality Index (AQI), Safety Level of elements of Air, AQI mechanics, the standard charts of AQI, the

range of the danger levels of the gases and their side effects on human being, the standard base that is used to compare the taken data and their description.

- Chapter 5 illustrates the web programming and the android app for user and administrator.
- Chapter 6 shows the result and analysis of the system.
- Chapter 7 concludes the paper stating the challenges were found and the future work of the project.

Chapter 2

Literature Review

Pollution is increasing in an alarming rate every day. Air is the most sensitive element of the environment which is polluted momentarily by the elements emitted to air. To know the level of air pollution and air quality this proposed system is a wireless sensor network that works mainly monitoring the pollution happening in a smart city. It is a low budget monitoring system with cheap but efficient sensors.

Some previous works like Smart environment monitoring system [1] on vehicles was introduced on 2015. It basically figured out the emission rate of poisonous gasses which are responsible for air pollution. Industrial air pollution [2] monitoring system for safety and health enhancement was introduced to know the hazardous gasses and their impact. Low cost air quality system [3] was discussed on 2008 as because at that time the sensors were quiet expensive and also the system. By using mobile GPRS [4] system air pollution could be detected.Wireless sensor network based pollution monitoring system in metropolitan cities was introduced to know the air quality [5].Pollution Dynamic Monitoring System [6] is also done previously.

By reviewing the future researches which has done before we can say that air pollution has increased in an alarming rate. If it is not stopped immediately the whole world is going to face a filthy and extreme weather for the future. There are more pollutions e.g. water pollution, noise pollution, plastic pollution, soil contamination but from the future studies we can say that air pollution is the most alarming issue and this should be studied for the sake of saving the world.

According to World Health Organization: WHO, from smog hanging over cities to smoke inside the home, air pollution poses a major threat to health and climate. The combined effects of ambient (outdoor) and household air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO

guideline level of 10µg/m_3, with low- and middle-income countries suffering from the highest exposures.

The major outdoor pollution sources include vehicles, power generation, building heating systems, agriculture/waste incineration and industry. In addition, more than 3 billion people worldwide rely on polluting technologies and fuels (including biomass, coal and kerosene) for household cooking, heating and lighting, releasing smoke into the home and leaching pollutants outdoors.

From 9 out of 10 people worldwide breathe polluted air. To prevent the air pollution there should be launched green energy. World Health Organization: WHO estimates that ambient pollution alone caused some 4.2 million deaths in 2016, while household air pollution from cooking with polluting fuels and technologies caused an estimated 3.8 million deaths in the same period. So, the idea was to make such a system which will let people know what amount of toxic air is inhaled. This system includes the studies from previous research how much it is important to work on such a topic. To make such a device which will be portable and can easily be installed was the main idea. Android device user and internet user has increased tremendously. For ease of people the result of the device can be seen in a website as well as in android app.

By measuring pollution about air, water and sound on everyday life it would be great significance for the health of human if the level of pollution is measured. For detecting the air pollution different types of pollution monitoring gas sensors will be placed in different points of the city. The main priority will be the polluted area and the area that contains harmful particles to human. These sensors will collect practical data in real time from different affected areas on different gases (for air and water) which are present in the environment e.g. nitrogen dioxide (NO2), carbon monoxide (CO), methane (CH4) and humidity. It will also collect data about the pollution level of the sound inside the city. The proposed system allows monitoring mainly air quality, water quality, sound quality and the pollution condition of a smart city on a desktop/laptop computer through an application designed using graphical User Interface (GUI) programming that gives signal when pollution nature exceeds the acceptable levels.

Chapter 3

Proposed Model

The Proposed model of the system is as follows. Figure 3 shows how the whole system will work. The block diagram of the system is showing that for a particular area selected how will it work. The device will be set up to take the environmental data and there will be a base standard value. The device will collect data and based on the set values it will show the output.

Figure 3.1: proposed model of the system

Proposed Model block diagram

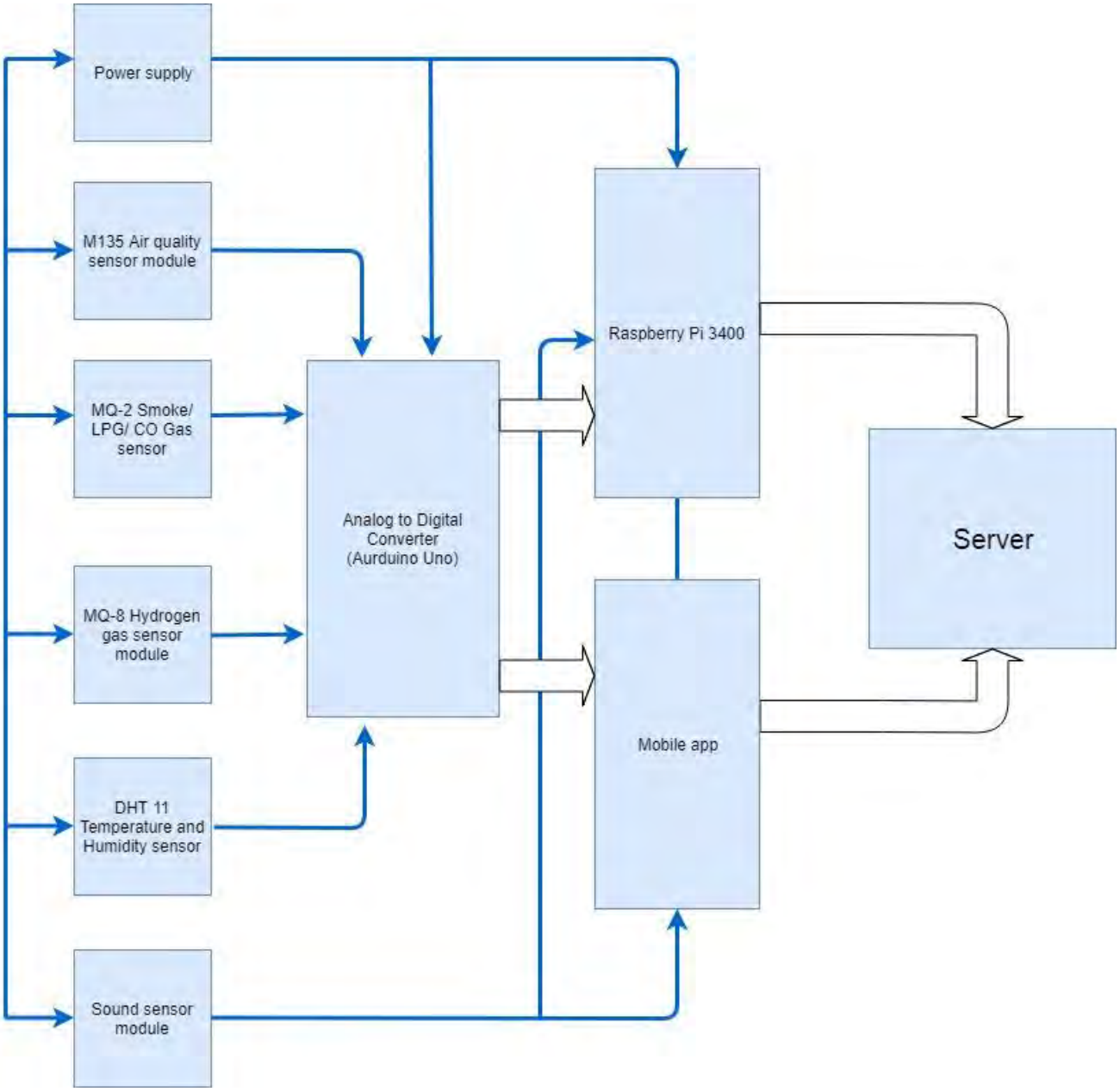

Figure 3.2: Block diagram for proposed model of the system

Proposed Model in Real Life

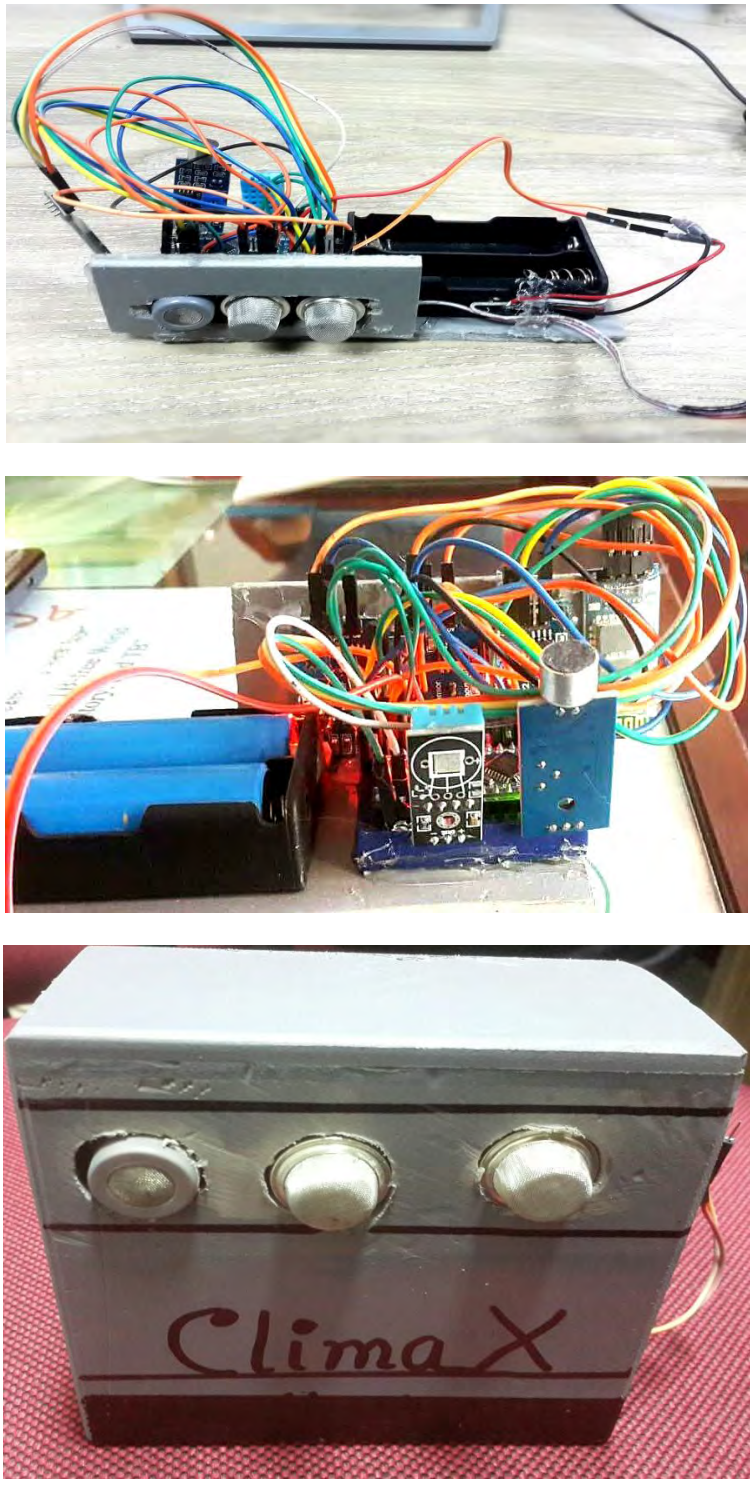

Figure 3.3: Proposed Model in Real Life

Proposed System Flow chart

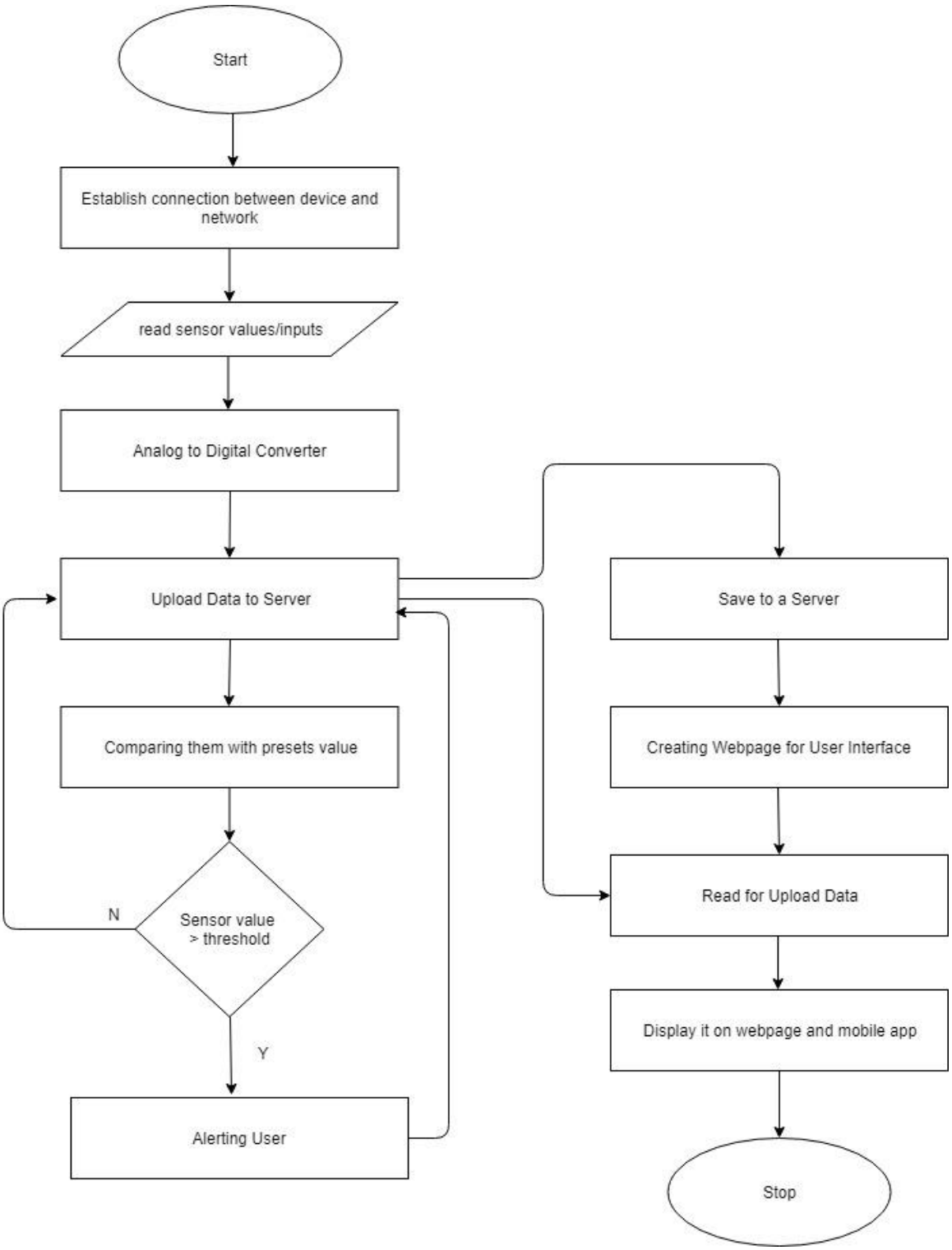

Figure 3.4: Flow chartfor the proposed system

3.1 Components of the Device

It's a device that takes data from the environment that has been selected for our research purpose. The device is built with various sensors and they take data by sensing from the environment. The sensors take analog data from the environment which later is converted into digital with the help of raspberry pi and then sent to the server where all the data's are stored. This device is consisting of the following components:

1. Raspberry Pi 3400
2. DHT 11 Temperature and Humidity sensor
3. MQ-2 Smoke/ LPG/ CO Gas sensor
4. M135 Air quality sensor module
5. MQ-8 Hydrogen gas sensor module
6. Sound sensor module
7. TP4056 Charger Module
8. 3.7V 3800 mAh
9. Android charger
10. Potentiometer/Buck Booster
11. Wire
12. Breadboard
13. Push Buttons
14. LED
15. Relay switches

These components are briefly discussed in the following section:

3.1.1 Raspberry Pi

The Raspberry Pi is a low cost device for performing various code base experiments. It is a credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. Generally, it is used for making software and hardware base devices. It is very popular for being small in size and capable of doing many thins simultaneously.

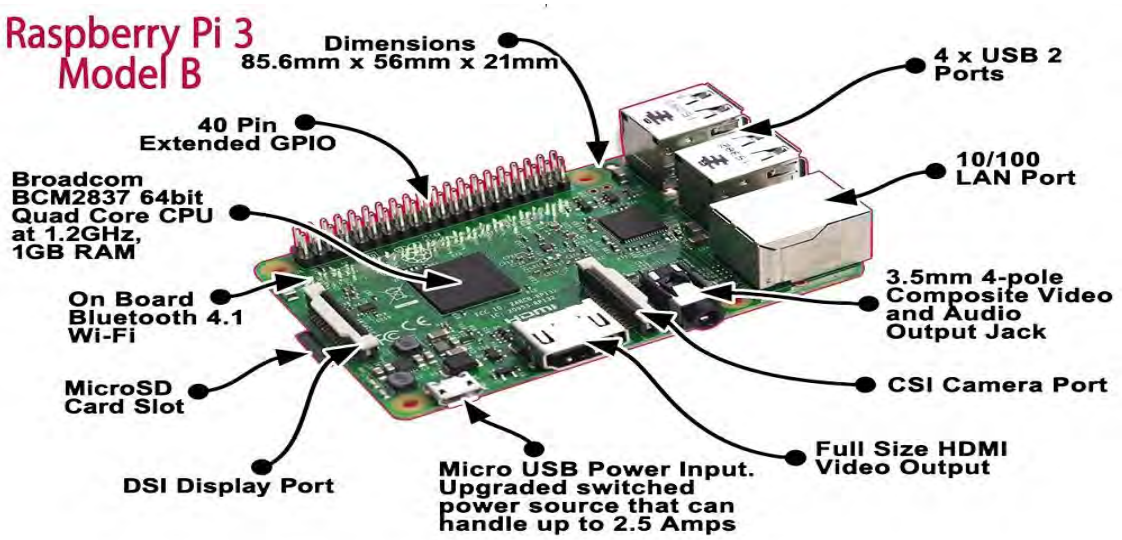

Figure 3.5: Raspberry Pi 3

This model has a 64 bit ARMv8 1.2 GHz quad core cortex A53 chip. It can store up to 1 GB of data's. It has four USB 2.0 ports (up to 480 megabits per second), 1 HDMI port,3.5mm 4-pole Composite Video and Audio jack,MicroUSB Power Input, DSI Display Port,CSI Camera Port,40-pin GPIO (Male headers). Raspberry Pi 3 communicates using 802.11n Wi-Fi wireless Networking which is IEEE 802.11a/g/b/n compatible and Bluetooth 4.1 wireless technology.

It requires 5V DC input voltage and 2.5 Amps. Raspberry Pi 3 uses official Operating System NOOBS, Raspbian and many third party Operating Systems such as Libreelec, Open Elec, OSMC, RISC OS, Pinet, Ubuntu Mate, Weather station, Xbian, Windows IOT core.

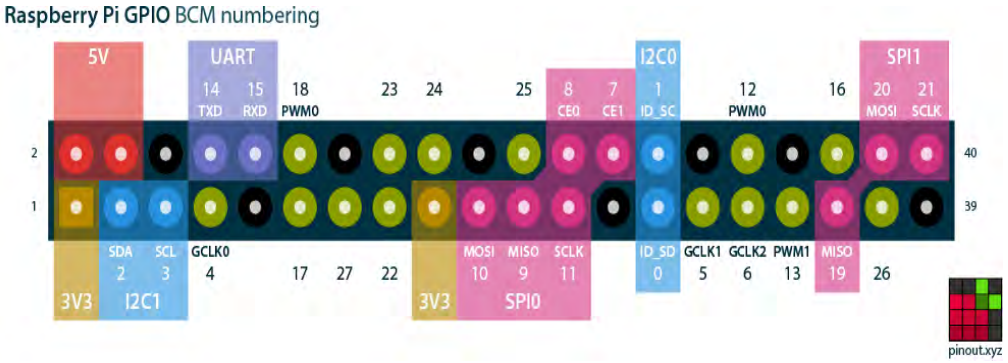

Figure3.6: GPIO Pin-Out

A useful and interesting feature of the Raspberry Pi 3 is the row of GPIO (general-purpose input/output) pins along the top edge of the board. A 40-pin GPIO header can be found on all current Raspberry Pi boards. Any of the GPIO pins can be designated (in software) as an input or output pin and used for a wide range of purpose. There are two 5V pins and two 3V3 pins on the board, as well as a number of ground pins (0V), these ground pins are not configured. The remaining pins are for all general purpose 3V3 pins, which means outputs are set to 3V3 and inputs are 3V3-tolerant.A GPIO pin designated as an output pin can be set to high (3V3) or low (0V).A GPIO pin designated as an input pin can be read as high (3V3) or low (0V). This is to make easier with the use of internal pull-up or pull-down resistors. Pins GPIO2 and GPIO3 have fixed pull-up resistors, but for other pins this can be configured with the help of software.

3.1.2Arduino Nano

Arduino Nano is a small board compatible to breadboards which is compatible to ATMega328. It has comparable usefulness to the Arduino Uno, however when it comes to DIP module package, it works with a Mini-B USB link. This Arduino clone board is superbly compatible with Arduino IDE and cases.

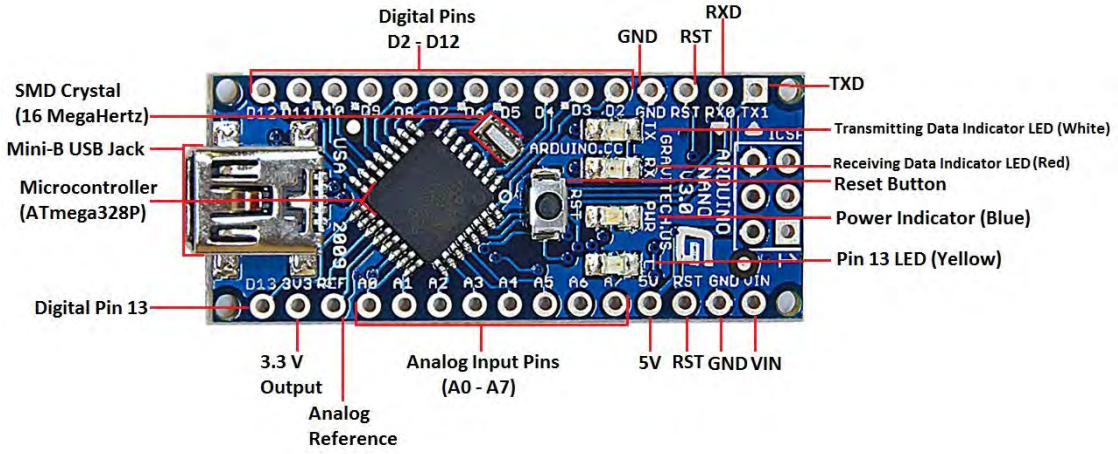

Figure 3.7: Arduino Nano

The Arduino Software (IDE), is used to program Arduino Nano. The Arduino Software is an Integrated Development Environment that is common to all Arduino boards and runs both online and offline.

3.1.3 DHT 11 Temperature and Humidity sensor

DHT11 Temperature & Humidity Sensor states a temperature & humidity sensor compound with a calibrated digital signal output. By using the high-class digital-signal-acquisition technique and temperature & humidity sensing technology, it guarantees high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, which offers excellent quality, fast response, anti-interference ability and cost-effectiveness.

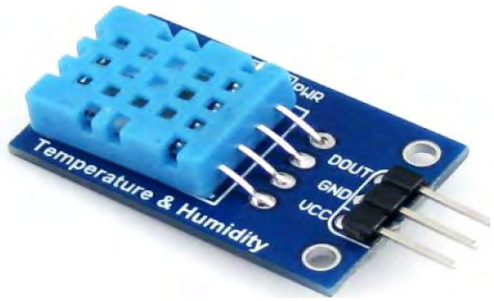

Figure 3.8: DHT 11 Temperature and Humidity sensor

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, it does not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

3.1.4 MQ-2 Smoke/ LPG/ CO Gas sensor

Figure 3.9:MQ-2 Smoke/ LPG/ CO Gas sensor

MQ2 gas sensor is used to detect the presence of LPG, Propane and Hydrogen. It is also used to detect Methane and other combustible steam. It is low cost and suitable for different

application. This sensor is sensitive to flammable gas and smoke. Smoke sensor is given 5 volts to power it. Smoke sensor indicates smoke by the voltage that it outputs, more smoke more output. A potentiometer is provided to adjust the sensitivity. SnO2 is the sensor used which is of low conductivity when the air is clean. But when smoke exist sensor provides an analog resistive output based on concentration of smoke. The circuit has a heater. Power is given to heater by VCC and GND from power supply. The circuit has a variable resistor. The resistance across the pin depends on the smoke in air in the sensor. The resistance will be lowered if the content is more and voltage is increased between the sensor and load resistor.

3.1.5 M135 Air quality sensor module

It is a unsafe gas detection components for the family, the environment, suitable for ammonia, aromatic compounds, Sulfur, benzene vapor, smoke and other gases harmful gas detection, gas-sensitive element test. Air quality sensor is for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. It is ideal to use in office or factory with simple drive and monitoring circuit.

Figure 3.10: M135 Air quality sensor module

3.1.6MQ-8 Hydrogen gas sensor module

This MQ-8 sensor module has a protection resistor and an adjustable resistor on-board. The MQ-8 gas sensor is highly sensitive hydrogen and less sensitive to alcohol, and cooking fume. It could be used in gas leakage detection appliance in family and industry. The resistance of the sensor component changes as the concentration of the target gas changes.

Figure 3.11: MQ-8 Hydrogen gas sensor module

This sensor contains some features like it has continuous Analog output, a 3-pin interlock connector. It is Low cost and compact in size.

3.1.7 Soundsensormodule

The sound sensor module provides an easy way to detect sound and is generally used for detecting sound intensity. Its accuracy can be easily adjusted for the convenience of usage. It uses a microphone which supplies the input to an amplifier, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage which is sent to a microcontroller then performs necessary processing.

Figure 3.12: Sound sensor module

Its operating voltage is 3.3V-5V. The sensor uses digital outputs 0 for low level and 1 for high level. It has a mounting screw hole and its PCB size is 3.4cm * 1.6cm.

3.1.8 TP4056 Charger Module

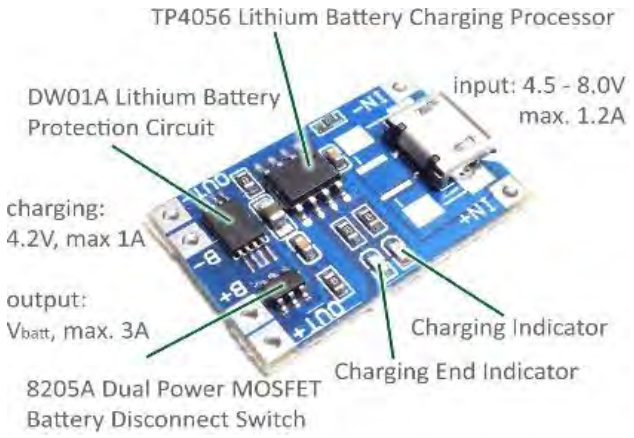

Figure 3.13: TP4056 Charger Module

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component count make the TP4056 ideally suited for portable applications. Besides, the TP4056 can work within USB and wall adapter. No blocking diode is compulsory due to the internal PMOSFET architecture and have prevent negative Charge Current Circuit. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The TP4056 automatically dismisses the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached. The other features of TP4056 are monitoring current, under voltage lockout, automatic recharge and two status pin to indicate charge termination and the presence of an input voltage.

3.2 Temperature and Humidity Sensor and its function

The temperature and humidity sensor is connected to the raspberry Pi3 in the existed ports. These sensors are capable of taking data's of the environment around. The data's it takes are in analog form which is converted to digital form by the raspberry Pi3 so that we can send these data's to the server. The data's this sensor takes are many in numbers and they are stored to the server after 12 seconds of interval in a continuous process. To get the best accurate result, a standard mean value is calculated to get the most average output of those data's.

The mean is the average that is used to, where adding up all the numbers and then divide by the number of numbers.

$$\bar{x} = \frac{\sum_i x_i}{n}$$ …… (I)

To get a measure of the dispersion of the data we will report a standard deviation. The Standard Deviation is a measure of how spread out numbers is. The equation is:

$$s = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{n-1}}$$ …… (II)

For temperature sensor data's the data's are sorted and displayed using basic equation of transformation of Celsius(C) to Fahrenheit (F). This sensor takes the data's in Fahrenheit (F) form and then using the convertor equation the data's are shown in Celsius(C) form when necessary.

The temperature T in degrees Fahrenheit (°F) is equal to the temperature T in degrees Celsius (°C) times 9/5 plus 32:

T(°F) = T(°C) × 9/5 + 32……..….(III)

For starter, the data's are always shown in the default Fahrenheit (F) form the moment they are saved in the server but to see them in Celsius (C) the upper equation is used.

Chapter 4

Air Pollution Monitoring and its importance

Air is one of the most basic and important elements for human being to survive. Clean and Sound air is the key to a good and healthy life. But now days in city life it has become the most threatened factor. Pollution of air has become the most concerned and affected issue now for us. A variety of air pollutants have known or suspected harmful effects on human health and the environment. In most areas, these pollutants are principally the products of combustion from space heating, power generation or from motor vehicle traffic. Pollutants from these sources may not only prove a problem in the immediate locality of these sources but can travel long distances.

Generally if someone is young and in a good state of health, moderate air pollution levels are unlikely to have any serious short term effects. However, higher levels and long term exposure to air pollution can lead to more serious symptoms and conditions causing human health. This not only affects the respiratory and inflammatory response systems, but can also lead to more serious conditions such as heart disease and cancer. People with lung or heart conditions may be more susceptible to the effects of air pollution. Air pollution has also been recognized by doctors as one of the world's greatest 10 killers seeing some 29,000 premature deaths in UK and 430,000 worldwide in one year. [1]

Air pollution can cause both short term and long term effects on health and many people are concerned about pollution in the air that they breathe. These people may include:

- People with heart or lung conditions, or other breathing problems, whose health may be affected by air pollution.
- Parents, careers and healthcare professionals who look after someone whose health is sensitive to pollution.
- People who want to know more about air pollution, its causes, and what they can do to help reduce it. [2]

Monitoring air quality is essential for local authorities as well as for major public and private industries to understand and prevent air pollution and measure emission sources, in order

to preserve health and contribute to the fight against the greenhouse effect. Industrial operators use air quality monitoring equipment to cost effectively monitor and manage emissions on their perimeter, which helps them improve relationships with regulators and communities. With air quality regulation shifting the burden from publicly funded monitoring to monitoring funded by industry, it has been increasingly important for businesses to acquire their own quality monitoring equipment. To get the best results from the environment about the pollution level of air, toxicity and harmfulness for human, air quality monitoring device is vastly used.

An air quality monitor is a device that measures the level of common air pollutants. Monitors are available for both indoor and outdoor settings. Indoor air quality monitors are typically sensor based instruments. Some of them are able to measure ppb levels and come as either mixed gas or portable units. Sensor based instruments and air quality monitoring systems are used widely in outdoor ambient applications.

4.1.1 Air Quality Index (AQI) and Safety Level of elements of Air

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects. Different countries have their own air quality indices, corresponding to different national air quality standards.

There are many elements in the air that become dangerous and harmful for human if they increase in numbers. For our, project purposes we have considered four elements here,CO2,CO,LPG and CH4.They can damage a real good to human if increased immensely in numbers. Here some of the safety levels of gases and AQI are given:

Table 4.1 Toxicity levels of CO2 and its effect on human

250-350ppm	Normal background concentration in outdoor ambient air
350-1,000ppm	Concentrations typical of occupied indoor spaces with good air exchange
1,000-2,000ppm	Complaints of drowsiness and poor air.
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present
5,000	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death

Here in this table the toxicity level of CO2 is shown. We can see that below 1000ppm it is acceptable and is not harmful but when it is over 2000ppm it becomes danger for the human being and after that of its rising over 5000ppm may lead to serious health issue such as permanent brain damage, coma, even death.

Table 4.2 Toxicity levels of CO and its effect on human

9 ppm	CO Max prolonged exposure (ASHRAE standard)
35 ppm	CO Max exposure for 8 hour work day (OSHA)
800 ppm	CO Death within 2 to 3 hours
12,800 ppm	CO Death within 1 to 3 minutes

This table shows the toxicity levels of CO in the air and their danger limits. CO is a very dangerous gas for human being. Here we can see that even 9ppm can damage real good to a healthy human being. The more the toxicity level, the higher the chance to be dead. If it is over 35ppm and close to 800 and people can die within 2-3 hours and if this level crosses 800 ppm then it becomes so dangerous that people can die within 1-3 minutes.

4.1.2Air Quality Health Index (AQHI)

The Air Quality Health Index provides a number from 1 to 10+ to indicate the level of health risk associated with local air quality. On occasion, when the amount of air pollution is abnormally high, the number may exceed 10.

Figure 4.1: Air Quality Health Index scale

Table 4.3 Air Quality Health Index (AQHI) and Health Messages

Health Risk	Air Quality Health Index	Health Messages	
		At Risk population	General Population
Low	1–3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities
Moderate	4–6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7–10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.

Very high	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

This table shows that the air quality health and its risk through a 1-10 base scale. It is divided into four parts ie: low, moderate, high, and very high. It detects the air pollution level and indicates the risk through this scale. When the updated data will be compared to the base data then it will show us the result accordingly to this scale. If the compared data is between 1-2 it will show us that health risk is low and indicate green, when it will rise up to 4-6 it will show us that the pollution in the air is considered dangerous for human being and we should take some steps quickly. If it exceeds 7 then the affected area is highly dangerous for human and necessary steps are must**.**

4.1.3 AQI Mechanics

An individual score (Individual Air Quality Index, IAQI) is assigned to each pollutant and the final AQI is the highest of these six scores. The final AQI value can be calculated with two options either per hour or per 24 hours. The concentrations of pollutants can be measured quite otherwise. If the AQI value is calculated hourly, then SO2, NO2, CO concentrations are measured as average per 24hour, O3 concentration is measured as average per hour and the moving average per 8h, PM2.5 and PM10 concentrations are measured as average per hour and per 24h. If the AQI value is calculated per 24h, then SO2, NO2, CO, PM2.5 and PM10 concentrations are measured as average per 24h, while O3 concentration is measured as the maximum 1h average and the maximum 24h moving average. The IAQI of each pollutant is calculated according to a formula published by the MEP.

The score for each pollutant is non-linear, as is the final AQI score. Thus an AQI of 300 does not mean twice the pollution of AQI at 150, nor does it mean the air is twice as harmful. The concentration of a pollutant when its IAQI is 100 does not equal twice its concentration when its IAQI is 50, nor does it mean the pollutant is twice as harmful. While an AQI of 50 from day 1 to 182 and AQI of 100 from day 183 to 365 does provide an annual average of 75, it does

not mean the pollution is acceptable even if the benchmark of 100 is deemed safe. Because the benchmark is a 24-hour target, and the annual average must match the annual target, it is entirely possible to have safe air every day of the year but still fail the annual pollution benchmark.

Chart 4.1 AQI mechanics

AQI	Air Pollution Level	Air Pollution Category	Health Implications	Recommended Precautions
0–50	Level 1	Excellent	No health implications.	Everyone can continue their outdoor activities normally.
51–100	Level 2	Good	Some pollutants may slightly affect very few hypersensitive individuals.	Only very few hypersensitive people should reduce outdoor activities.
101–150	Level 3	Lightly Polluted	Healthy people may experience slight irritations and sensitive individuals will be slightly affected to a larger extent.	Children, seniors and individuals with respiratory or heart diseases should reduce sustained and high-intensity outdoor exercises.
151–200	Level 4	Moderately Polluted	Sensitive individuals will experience more serious conditions. The hearts and respiratory systems of healthy people may be affected.	Children, seniors and individuals with respiratory or heart diseases should avoid sustained and high-intensity outdoor exercises. General population should moderately reduce outdoor activities.
201–300	Level 5	Heavily Polluted	Healthy people will commonly show symptoms. People with respiratory or heart diseases will be significantly affected and will experience reduced endurance in activities.	Children, seniors and individuals with heart or lung diseases should stay indoors and avoid outdoor activities. General population should reduce outdoor activities.
>300	Level 6	Severely Polluted	Healthy people will experience reduced endurance in activities and may also show noticeably strong symptoms. Other illnesses may be triggered in healthy people. Elders and the sick should remain indoors and avoid exercise. Healthy individuals should avoid outdoor activities.	Children, seniors and the sick should stay indoors and avoid physical exertion. General population should avoid outdoor activities.

4.1.4 Setting up Base standard

In order to, measure the conditions of the air of our country we set India's AQI category as a base standard of our system. As India and our country show similar environmental conditions and we have no accurate AQI in our country, their AQI category is the best suitable one for us to set base standard perimeter for our system so that it can identify the range of pollution and condition and take necessary steps for future betterment. Here is the AQI category of India:

Chart 4.2 AQI Category,Pollutants and Health Breakpoints

AQI Category (Range)	PM_{10} (24hr)	$PM_{2.5}$ (24hr)	NO_2 (24hr)	O_3 (8hr)	CO (8hr)	SO_2 (24hr)	NH_3 (24hr)	Pb (24hr)
Good (0–50)	0–50	0–30	0–40	0–50	0–1.0	0–40	0–200	0–0.5
Satisfactory (51–100)	51–100	31–60	41–80	51–100	1.1–2.0	41–80	201–400	0.5–1.0
Moderately polluted (101–200)	101–250	61–90	81–180	101–168	2.1–10	81–380	401–800	1.1–2.0
Poor (201–300)	251–350	91–120	181–280	169–208	10–17	381–800	801–1200	2.1–3.0
Very poor (301–400)	351–430	121–250	281–400	209–748	17–34	801–1600	1200–1800	3.1–3.5
Severe (401–500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

Here we can see that when the AQI range is between 0-50 it is good and are shown in pure green color, when the AQI range is 51-100 it means that the data's are satisfactory and are shown in greenish color. After that if the data range is 101-200 it will indicate that the aria is moderately polluted and after that if the range exceeds over 201 it means that the area has become polluted badly and when it goes to the range of 301-400, the AQI category becomes very poor and the area becomes highly polluted and unsafe for human.

Table 4.4 AQI levels and Associated Health Impacts

AQI	Associated Health Impacts
Good (0–50)	Minimal impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201–300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease
Very poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401–500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts

	may be experienced even during light physical activity.

This table shows the AQI range and Associated Health Impacts according to it. That means this AQI table shows the impact of the pollution to our health. When the AQI is good, the impact is minimal. When it is satisfactory, it may cause minor breathing discomfort to sensitive people. Moderately polluted range indicates discomfort in breathing, lunge disease, asthma, heart disease to children and older adults. Poor means breathing discomfort and heart disease to people on prolonged exposure. Very poor indicates respiratory illness with lung and heart disease. And last but not least Severe means it is highly dangerous and it may cause respiratory impact even on healthy people and serious health impacts on people with lung or heart cancer

4.1.5 Data Comparison

Using this device we have taken data's of temperature and humidity from around the country. To check how accurate our data's are we have taken help from a trusted website. We have compared our data's with the data's of this website and found the result below:

Table 4.5 Temperature Comparison (11-20th July):

System Data	Website Data (accuweather)
36º C	34º C
34º C	32º C
35º C	33º C
36º C	35º C
33º C	33º C
35º C	33º C
33º C	31º C
35º C	34º C
38º C	37º C
35º C	36º C

Table 4.6 Humidity Comparison (11-20th July, 6-12pm):

System data	Website Data (timeanddate)
78%	80%
77%	80%
73%	71%
75%	79%
79%	82%
73%	72%
78%	81%
73%	71%
73%	75%
73%	73%

Chart 4.3 Data chart of the sensors

SN	Time	Teperature	Humidity	CO2	CO	H2	LPG	Sound
1	2018-06-11 11:29:41	33.00	68	641	15	287	540	0
2	2018-06-11 11:29:41	33.00	68	641	15	287	540	0
3	2018-06-11 11:29:40	33.00	68	641	15	287	540	0
4	2018-06-11 11:29:40	33.00	68	641	15	287	540	0
5	2018-06-11 11:29:39	33.00	68	641	15	287	540	0
6	2018-06-11 11:29:39	33.00	68	641	15	287	540	0
7	2018-06-11 11:29:38	33.00	68	641	15	287	540	0
8	2018-06-11 11:29:38	33.00	68	641	15	287	540	0
9	2018-06-11 11:29:37	33.00	68	641	15	287	540	0
10	2018-06-11 11:29:37	33.00	68	641	15	287	540	0
11	2018-06-11 11:27:55	33.00	68	648	14	290	557	0
12	2018-06-11 11:27:54	33.00	68	648	14	290	557	0
13	2018-06-11 11:27:53	33.00	68	648	14	290	557	0
14	2018-06-11 11:27:53	33.00	68	648	14	290	557	0
15	2018-06-11 11:27:52	33.00	68	648	14	290	557	0
16	2018-06-11 11:27:52	33.00	68	648	14	290	557	0
17	2018-06-11 11:27:49	32.00	71	652	19	610	575	0
18	2018-06-11 11:27:48	33.00	68	648	14	290	557	0
19	2018-06-11 11:27:48	32.00	71	652	19	610	575	0
20	2018-06-11 11:27:48	33.00	68	648	14	290	557	0
21	2018-06-11 11:27:47	32.00	71	652	19	610	575	0
22	2018-06-11 11:27:47	33.00	68	648	14	290	557	0
23	2018-06-11 11:27:47	32.00	71	652	19	610	575	0
24	2018-06-11 11:27:46	33.00	68	648	14	290	557	0
25	2018-06-11 11:27:46	32.00	71	652	19	610	575	0

This chart represents the data that are collected and saved to the server and these data will be calculated through mean and standard deviation and we will the result in graph like below:

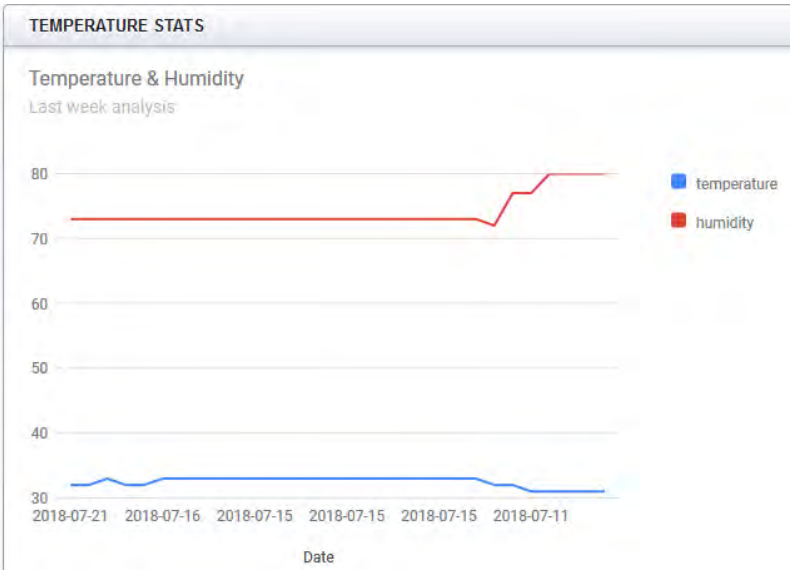

Figure 4.2: Temperature and humidity graph

This graph shows us the real time readings of temperature and humidity. The blue color indicates the temperature graph and the red color indicates the humidity graph. Here we have taken a week of data and using the mean equation and standard deviation we got some results and then it was shown in the graph. This data processes automatically and they change when new data are saved in the website.

Chapter 5

Programming for Website and Mobile App

5.1 Web Programming

Two key portions of internet programming are Front-End and Back-End. Front end programming is about design portion of a web page where all the design works and layout of the page contains properly. Front end is all about user interface and what are visible to the user. In the front page here actually appears the content design of the page that shows how the webpage would look like properly. In the front end side, on the other hand back end programming is all about programming that is done on background side of the webpage completely. On backside of the webpage there contains all the language that is thought to use for programming to make a webpage efficient and useful. Back-end programming is the structure of the webpage and is the core part of a webpage. At first, we had to count both side of the programming. At the very beginning we had to consider front end portion and then back end portion for the webpage.

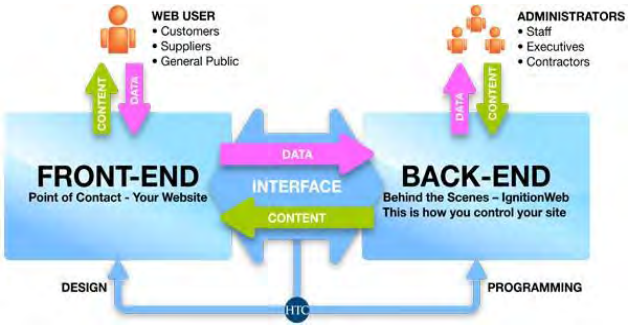

Figure 5.1: Two way programming deployment

5.1.1 Implementation on Languages

Two core languages to take initiative for implementation of the back-end codes are HTML and then PHP in addition with CSS and JavaScript. HTML is the standard markup language for creating web pages that stands for “Hypertext Markup Language”. The structure of the web page stands with the support of HTML basically. HTML elements are building blocks and are represented by tags. The CSS part is for the design only and outlook of the website that is visible to a user. CSS (Cascading Style Sheets) describes exactly how html elements are

described on the screen. CSS defines the look and layout of the webpage. The browser receives HTML documents from web server and then sends the documents into webpages. HTML elements are the building blocks of HTML pages. HTML provides semantics for test like chart, table, image and also diagram. HTML can be written in scripting language called JavaScript. JavaScript is a client side script that is executed before the webpage appears visible after the client receives the returned information from the server. Another one is known as server-side script that is PHP. PHP code may be embedded into HTML code.

5.1.2 Server-Side Script

Server side scripting language runs on the server that is embedded in the code of the particular webpage. This is responsible for the transfer of information from server to browser. It plays a big rule to access database and connects with the server that will send to browser next. This builds dynamic webpages that is powerful than static webpages. It builds application programming interfaces (APIs) that controls what application is shared by the webpage.

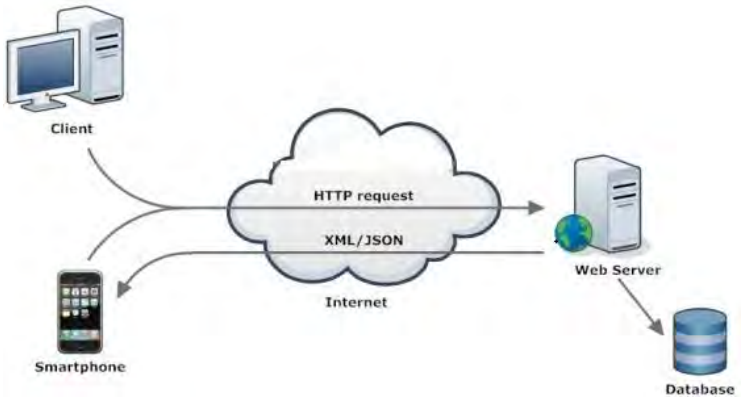

Figure 5.2: Server-side scripting transfer process

The popular server-side languages are PHP, Python, Ruby, C#, C++, Java and their server-side frameworks are Ruby on Rails, ASP.NET, Django, Node.js, Express.js & Koa. PHP is the most popular server-side language that is designed to pull, edit and change data in the database. This is written in the SQL language that keeps connection with databases. PHP is the most common scripting language that is used by the developers. This language is compatible with all of the modern frameworks. This is easy to establish and run. One can make a PHP script

to run it without any server or browser. Thus there is the necessity of PHP parser. In addition to that these scripts can be used for simple text processing task. PHP is not the very best programming language for writing desktop programs and applications. But, if one knows the language well the person can write the necessary programs by using advanced PHP features.PHP can be used in all major operating systems like Linux, several UNIX variants (including HP-UX, Solaris and Open BSD), Windows operating system, Mac OS and others also. Like Apache, IIS most of the web server has support on PHP. PHP works either as a module or as a CGI processor. PHP's abilities include outputting image, PDF files and even flash movies. I can output any text in a comparative easy process such as XHTML and any other XML file. PHP can auto generate files and save them in the file system instead of print out copies. One of the most effective features in PHP is its support for a wide range of databases. Writing a database-enabled webpage is simple using one of the database specific extensions. PHP is supportive for other services such as LDAP, IMAP, SNMP, NNTP, POP3, HTTP, COM (on Windows) and others also. With PHP I have the freedom of choosing an operating system and a web server. PHP file containing text, markup language tags and scripts. PHP files also have file extension like .php, .php3 and .phtml. This is simple and fast to learn. PHP is most popular and commonly used free and good alternative to the competitors like Java and JSP. PHP is better suitable for web development and can be included directly into the HTML code. According to different reports more than 80% of websites today are using PHP as their server side script language. It happens because PHP is an open source language and developers prefer this language and experience on it more effectively. Many professional developers and newbies that look to create website prefer PHP language as most favorite because of:

- PHP is an open source
- Frameworks
- Cost-effective solution
- Resources for getting support
- Simplicity of use in PHP

```
function drawChart() {
    $.ajax({
    type: 'POST',
    url: "<?php echo base_url() . 'Welcome/getTempData' ?>",

    success: function (data1) {
    // Create our data table out of JSON data loaded from server.
    var data = new google.visualization.DataTable();

    data.addColumn('string', 'Date');
    data.addColumn('number', 'temperature');
    data.addColumn('number', 'humidity');

    var jsonData = $.parseJSON(data1);

    for (var i = 0; i < jsonData.length; i++) {
        data.addRow([jsonData[i].date, parseInt(jsonData[i].temperature), parseInt(jsonData[i].humidity)]);
    }

    var options = {
        chart: {
            title: 'Temperature & Humidity',
            subtitle: 'Last week analysis'
        },
        width: 600,
        height: 400,
        axes: {
            x: {
            0: {side: 'bottom'}
            }
        }
    };
    var chart = new google.charts.Line(document.getElementById('line_chart'));
    chart.draw(data, options);
    }
});
}
```

Figure 5.3: A particular PHP code

Function “drawChart()” function performs. After that it creates data table out of JSON data loaded from the server. Then add data columns for date (in String), temperature (in number) and humidity (in number). There is a condition that means iteration will be started from 0 and it will be continued till it is less than Jason data length. Every time it will add date, temperature and humidity to each row. The “parseInt()” function parses a String and returns an integer. It adds title named “Temperature and Humidity” with the subtitle “Last week analysis” with width of 600 and height of 400 and axis is from side bottom. Run time environment of this PHP code is recent popular “Sublime.”

5.1.3 Client-Side Script

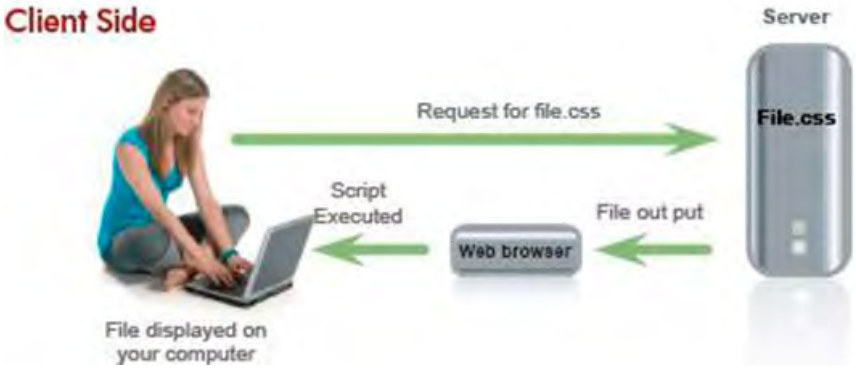

Figure 5.4: Client-Side Scripting process

Clint side scripting is all about user level access. The language that we've used for client side script is JavaScript. JavaScript is run on the browser when there is existence of client side scripting after server side script execution.

We have worked on and experienced with PHP coding so that in near future we can work in different fields. In addition to, PHP developer cost vary with location, quality and hourly rates. While talk about the costs for PHP development, it can be divided into three levels according to one's budget.

5.1.4 Database and Server Construction

Database is collection of information that is organized in one place and that can be efficiently used. Database is broadly effective and important data source of the web page. One who administrates data can submit information and edit that information according to necessity any time from the database directly. Database is a core part of a website which includes all the information of the webpage to show in static way.

We have taken data from the field to our server with our device. We have taken values for CO2, CO, CH4, and LPG. We have randomly taken data that is comparable with the rates that we considered as standard value. We have taken values from the environment that is shown in the real time figure for our system. We can compare these achieved values with our table which values we taken as standard. That is, like for CO2 250 to 350 ppm and 350-1000 is at low

risk according to the table. Then, 1000 to 2000 and 2000 to 5000 range is at moderate level. For 5000 it is at high level and at last above 40,000 ppm it is at very high level.

After that we have an option that is by the server it sends a message that how the level is varying on everyday basis and at which level such as low, moderate, high to the mobile app.

In the server there is a real-time graph that shows data form morning to night continuously. In addition to that, we have whole graph that represents data from the very first day when we had been started and till the last date.

5.1.5 User Interface

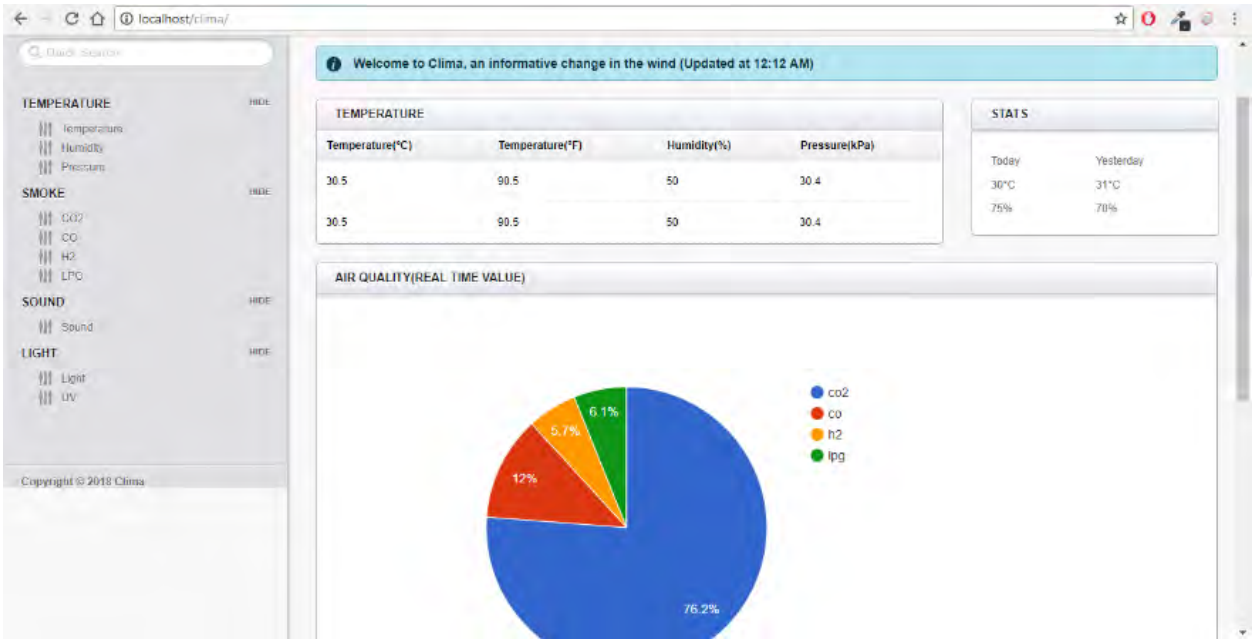

Figure 5.5: Web user interface

In the user interface there appear temperature, smoke, sound, and light parts on webpage. Under temperature here are three parts and those are temperature, humidity, pressure. on smoke portion there appears CO2, CO, H2, LPG and CH4.

There is another portion that is only sound. Under light portion there appears light and UV. There is air quality (Real Time Value) portion. Under this portion there is a pie chart with four types of indication of colors. Blue color represents the existence of CO2 that is 76.2%, red

color represents the presence of CO that is 12%, yellow shows the presence of H2 with 5.7%, and green represents the presence of LPG with 6.1%.

There is another portion that shows statistics with a table which shows temperature rate of two consecutive days. Here, it shows last days temperature was 31 degree Celsius and present days temperature is 30 degree Celsius. It represents the temperature rate in percentage also that shows past day percentage was 70% and present day percentage is 75%. The main table shows temperature (both in Celsius and Fahrenheit), humidity and pressure.

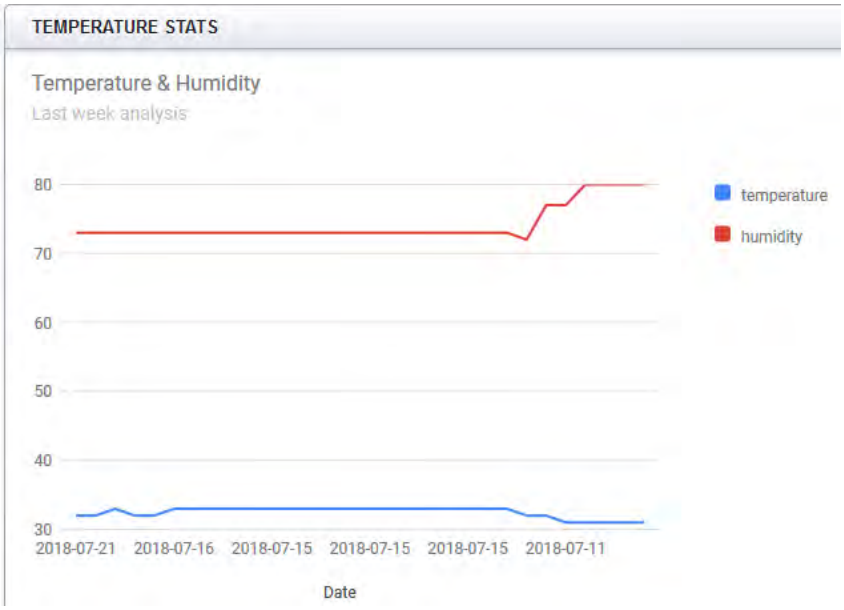

Figure 5.6: Temperature & Humidity analysis

The linear graph shows temperature and humidity amount and variation with particular time. The blue line represents the temperature and the red line represents humidity.

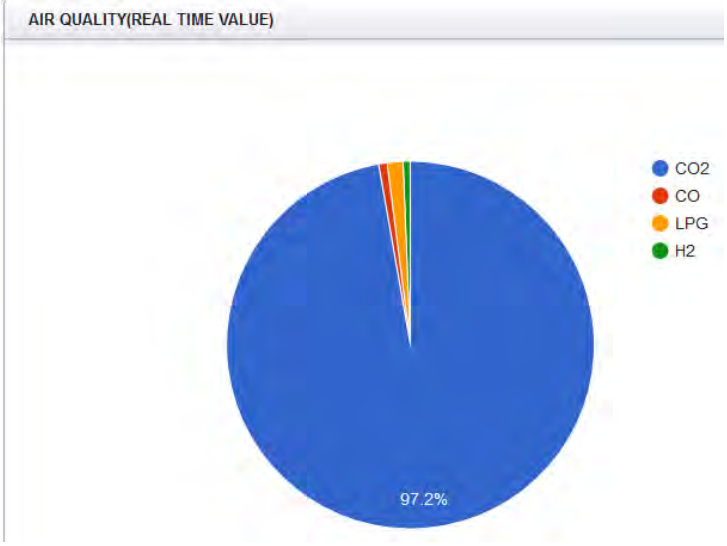

Figure 5.7: Pie chart for air quality representation

This Pie chart shows the amount of CO2, CO, LPG and H2 in the atmosphere that is real time value. There are four portions that show four types of gases individually with different colors and percentage also.

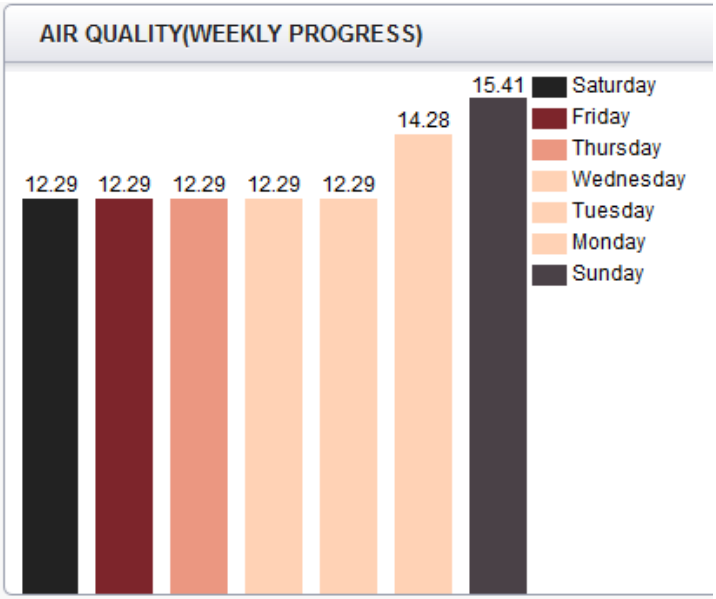

Figure 5.8: Weekly air quality progress

Above graph represents the progression of air quality on weekly basis. From the very beginning, our device that we have built had been giving rating continuously. But, for particular

information representation on the website we have taken seven days value (Sunday to Saturday). At the bottom of the website, it shows three types of alert: A rising alert, a danger alert and a warning alert.

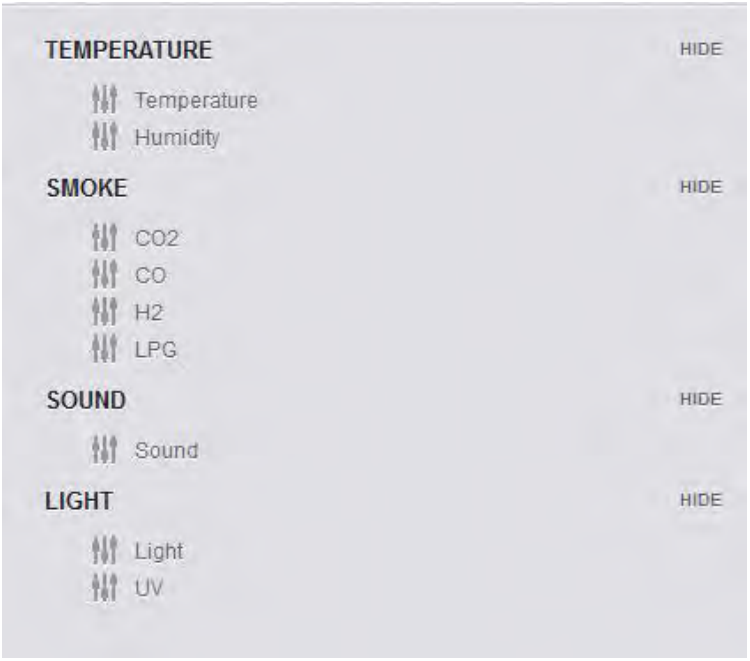

Figure 5.9: Column for temperature, smoke, sound and light

There is one column on left side that includes temperature, smoke, sound (Future work) and light (Future work).

SN	Updated Time	Temperature(°C)	Temperature(°F)	Humidity(%)
1	02:21:47	32	89.6	73
2	02:18:59	32	89.6	73
3	02:15:42	33	91.4	73
4	02:15:29	32	89.6	73

Figure 5.10: Real time value of temperature & humidity

The chart comes visible while clicking on temperature that shows real time data (four rows) with time when rating had been taken in, temperature (degree Celsius & Fahrenheit) and humidity (Percentage).

SN	Updated Time	CO2	CO	LPG	H2
1	02:21:47	849	12.29	26	10.94
2	02:18:59	849	12.29	26	10.94
3	02:15:42	849	12.29	26	10.94
4	02:15:29	849	12.29	26	10.94

Figure 5.11: Real time value of CO2, CO, LPG and H2

Above figure comes visible while clicking on CO2, CO, LPG and H2 that shows real time data (four rows) with different time.

We had created our linear graph chart by JavaScript programming that does synchronize with database which shows graph changing effectively and continuously which is done by AJAX. AJAX(Asynchronous JavaScript and XML). XML is software and hardware independent tool for storing and transferring data. The pie-chart had been developed using Google visualization API(Application Programming Interface). The JSON data had been done by using JavaScript and real time data retrieved by using PHP. Temperature and statistics table had been constructed by using JavaScript. The framework used for PHP implementation is "CodeIgniter."

5.2 Android Application

The main idea behind Android existence is to provide developers with the freedom and power to formulate pioneer mobile applications along with the capability of using all the abilities that are provided by the mobile handset. Thus, the development of mobile applications was made free to all users and anyone can get benefitted from these capabilities since it is open source. In addition to that, it is rather easy to incorporate the use of the GPS location system that is present in the mobile handset. The application can also use the Internet to transfer data from the cellular phone to certain servers online. For the development of mobile application this is necessary to take into consideration about certain constraints and features. Mobile application development requires the use of integrated development environments. For mobile application design user interface (UI) is essential. This user interface considers screen size (for wide length array), constraints and other circumstances. Mobile front-end is completely dependent on back-end. The mobile back-end provides security, data routing, authentication and also authorization.

Most importantly, the Android app will work on Android version 6.0 to upper Android versions. There are two parts in the Android application. They are:

1. Administrative application.

2. User application.

5.2.1Administrative Application

After getting all the measurements of gases, sounds, temperature and humidity, those values will go to the device, and then through device the data will go to the application and from application it will go the server.

5.2.2 User Application

After sending all the values and measurements to server, the application will show the Android app UI.There will be the 3 colors to differentiate the values, which was send by the device and these colors are green, yellow and red. After calculating the values, if the values are reasonable and match with the standard base value, then it will show the green color. If the values are in moderate level, it will show the users yellow color and when the values are too much higher than the standard base, that means it will be too much risky and it will show red color to the users. In that time the app users will receive a message from the server and it will indicate to the users to take necessary steps to bring the values down. End users will see the real time graphs and all other charts related to the values and it will show the charts which will be find after a full measurement of all the values.

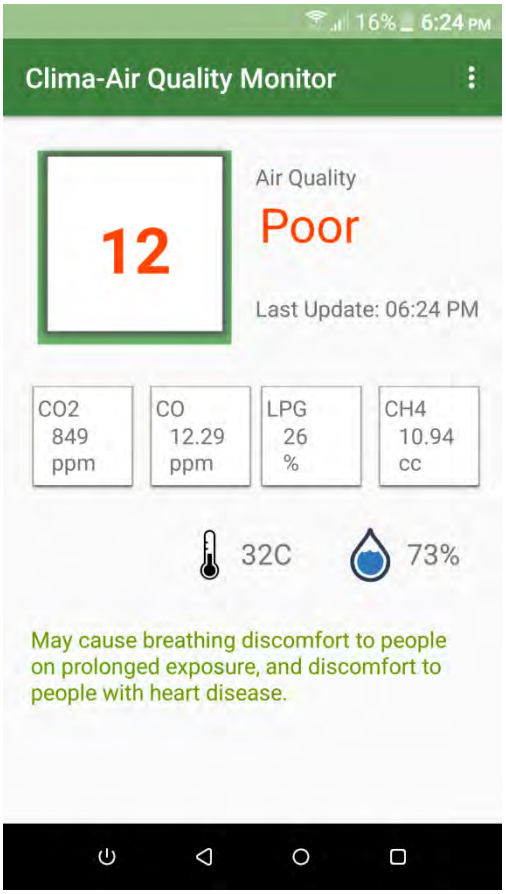

Figure5.11: Android app UI

Here, we can see a UI of our android app which will be provided to the users. In this user interface there are several parts. On the upper side, it has shown that, the air quality is “poor”, it means that the condition of the air is not good enough and it’s unsafe. In the middle there are the names of the gases and beside them their real time reading. On the lower part,temperature sign which is shown in Celsius form along with the humidity percentage. Most importantly, in basis of the measurements, the app will give some comments which will give the idea about the problems which are going to be faced by the people because of the air condition.

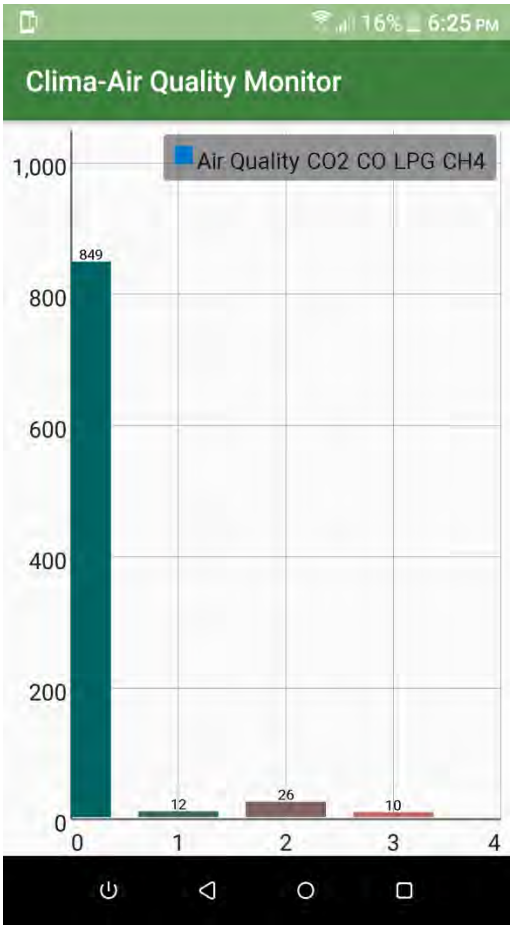

Figure 5.12: Air quality of CO2, CO, LPG, and CH4

Here, we can see a UI of our android app which will give us the idea about the air quality of CO2, CO, LPG, and CH4. The part column we can see the real time reading of CO2, which is 849ppm, the second column is representing the real time reading of CO, which is 12ppm; the third column is about the real time reading of LPG, which is 26%, the forth column is about the real time reading CH4,which is 10cc.

Figure 5.137: Real time graph of Temperature and Humidity

Here, we can see the real time graph of Temperature and Humidity. The Red line is representing the temperature states of the real time and the Blue line is representing the humidity states of real time. And the line is about continues reading,and the dot(.) in between of the lines are representing a particular time's reading. When we click on a dot it will show us the actual reading of that particular time.

Chapter 6

Experimental Result Analysis

We have taken the last 10 days of data from 11-20th July, 2018 and stored them in the server. After that we have taken two trusted website www.accuweather.com and www.timeanddate.com for comparing our data's of temperature and humidity respectively. We found the below result for each table:

For temperature:

Mean of System data:

$Ts = \frac{350}{10} = 35℃$[Ts = System temperature]

Mean of Website data:

$$Tw = \frac{371}{10} = 37.1$$[Tw = Website temperature]

Percentage of error:

$$E = \frac{37.1-35}{37.1} \times 100 = 5.66\ \%$$

Percentage of accuracy:

$$A = (100 - 5.66)\% = 94.34\ \%$$

For Humidity:

Mean of System data:

$$Hs = \frac{752}{10} = 75.2[\text{ Hs = System humidity }]$$

Mean of Website data:

$$Hw = \frac{764}{10} = 76.4[\text{ Hw = Website humidity }]$$

Percentage of error:

$$\boldsymbol{E} = \frac{76.4 - 75.2}{76.4} \times 100 = 1.57\%$$

Percentage of Accuracy:

$$A = (100 - 1.57)\% = 98.43\%$$

6.1Analysis

Here, we have seen that our device is capable of taking almost accurate results of temperature and humidity. Though there is a margin of error and it is 5.66% for temperature and 1.57% for humidity. So, we can say that our device is working perfectly.

There are some problems for which the data are not exact as the found in the website. The sensors are cheap and fragile and they intend to damage quicker. There range of taking data's is also low and limited and that's why we couldn't take more and accurate results.

Our device working rate is very good and it has a very high accuracy. If we use more expensive sensors, our result would have been more accurate and perfect.

Data chart of the sensors

$C0_2$ (ppm)	CO (ppm)	H_2 (ppm)	LPG (ppm)
641	15	287	540
643	15	287	542
641	13	287	537
641	11	287	545
641	15	287	547
647	15	287	547
648	16	287	547
641	15	287	545
641	15	287	542
654	15	287	542
648	14	290	541
648	15	290	543
648	14	288	537
648	14	290	545
648	14	290	547
648	14	310	547
652	19	290	548
648	14	310	552
652	19	280	552
646	15	285	557

Here is the chart of the sensors that is used to take the readings of a certain place. In this chart we have seen that CO2 result is in between 350-1000 ppm, which states that concentrations typical of occupied indoor spaces with good air exchange. It mean that CO2 level, is good for human.

The chart shows the result of the level of CO below 35 ppm, which is in tolerable range but if anyone stays in this area with prolonged exposure it may cause them heart disease.

The other sensor MQ 8 gives us the result in the range of 540-567 ppm which is in the range of normal standard value.

The MQ2 sensor delivers the result within the range of 540-570 which is also states in normal condition.

Chapter 7

Conclusion and Future Works

7.1 Conclusion

The smart way to monitor environment and air as well as sound pollution being a low cost but efficient and embedded system is presented in this paper. In the proposed architecture functions of different sensors and their working procedure were discussed. How they work, their functionality, their optimal uses and their data taking procedures and comparison with standard base data's are also discussed here. The noise and air pollution monitoring system was tested for monitoring the gas levels on different parts of the country. It also sent the sensor parameters to the data server. Our project device showed that it is effective and cheap and with some highly working sensors it can really be a reliable one to everybody and its data's will be a key to take some necessary steps for the betterment of the society as it will help to identify the affected area so that we can take early steps to reduce damages for the next generation.

7.2 Future Work

Our work can demonstrate vast opportunities to work on the device, on the app and also on the field using the device that we have worked with. The device can be used any time efficiently in different locations of a city and then research with the achieved data for that particular area in that city. The device can be updated with additional sensors that can sense data from the existence of other gases such as O2 and H2. These gases will provide the condition of the atmosphere and authority can take into further decisions accordingly. The sensors that we have been worked with can also be reset according to most recent time update. The android app which we have developed for turning on and off the device can be updated with newer features by implementing necessary codes. In future time, our device can be kept testing for checking whether the sensors still runs properly and give real time data. The webpage that we have designed, there is more opportunities to add options like related tables, pie chart, diagram that will be implemented by back-end programming(server side) so that those options can be visible to the administrator and user as well. With the future plan programmer can add PHP programs to

create additional tables to show amount of O2 or H2 and pie chart to show which color represents which particular gas and also diagram that can show relations with gas and time. Like Through-out the year on which time the amount of gases are in what level and also the increase and decrease level and rates of the gases. Related app can notify when it is actual time to take data reading by sending the notification to user that will be programmed on the server-side by PHP language. Also other language can be used. In the hardware device it can be added light system. Light system will be work like automatic way. Such as, there are four lights for four types of gases. While a particular sensor detects the gas for that sensor, the related light beside that gas will be on and while the sensor stops getting that particular gas the light will be off automatically. For this matter, there will be necessity of PHP back-end code implementation also that is must.

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