AIR QUALITY PREDICTION USING IOT AND CLOUD APPLICATION

A Project Report Submitted

in Partial Fulfilment of the Requirements

for the Degree of

Bachelor of Technology (Hon.)

in

Computer Science And Engineering

by

HARSH KUMAR SINGH

(Roll No. 2015BCS0012)

to

DEPARTMENT OF COMPUTER SCIENCE

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY

KOTTAYAM - 695017, INDIA

April 2018

DECLARATION

I, **HARSH KUMAR SINGH** (**Roll No: 2015BCS0012**), hereby declare that, this report entitled **"AIR QUALITY PREDICTION USING IOT AND CLOUD APPLICATION"** submitted to **Indian Institute of Information Technology Kottayam** towards partial requirement of **Bachelor of Technology(Hon)** in **Computer Science And Engineering** is an original work carried out by me under the supervision of **Dr. Shajulin Benedict** and has not formed the basis for the award of any degree or diploma, in this or any other institution or university. I have sincerely tried to uphold the academic ethics and honesty. Whenever an external information or statement or result is used then, that have been duly acknowledged and cited.

Thiruvananthapuram - 695 017 **HARSH KUMAR SINGH**

April 2018

CERTIFICATE

This is to certify that the work contained in this project report entitled **"AIR QUALITY PREDICTION USING IOT AND CLOUD APPLICATION"** submitted by **HARSH KUMAR SINGH** (**Roll No: 2015BCS0012**) to Indian Institute of Information Technology Kottayam towards partial requirement of **Bachelor of Technology/Bachelor of Technology(Hon)/Master of Science** in **INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM** has been carried out by him under my supervision and that it has not been submitted elsewhere for the award of any degree.

Thiruvananthapuram - 695
April 2018

(Dr. Shajulin Benedict)
Project Supervisor

ABSTRACT

All living creature in the earth can't live without water, air, food. Air is the dimension of life for a human being. The level of air pollution has increased with times by a lot of factors such as increased vehicle utilization, misused industrialization, urbanization, and so forth. These factors have heavily affected the health of human being as they are exposed to it.

In this project, we have developed an air quality monitoring system that checks the pollution level from anywhere through browsers or smart phone devices using technologies such as IoT and cloud. In general, the analysis of air pollution data that are obtained from different places allows us to estimate how bad air pollution is from day to day in various place at various time.

As a result,large number of people can be benefited in greater extent.

We can use this device in car it will tell whether you need to wear mask to go out of car or not. We can even use this device to automate the switching ON/Off the air purifier whenever we need the purifier for optimization of power consumption.

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Chapter 1

Introduction to Project

In order to monitor the air quality level in the various location in various time interval this device can be used.It is necessary to monitor air quality and keep it under control for a better future and healthy living in large scale.

We are going to make an IOT(Internet of Things) based air pollution monitoring system in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down below a certain level, means when there is sufficient amount of harmful dust so that Asthma patient can use this at their home.

It will show the air quality in screen and as well as on web-page so that we can monitor it very easily.In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile.

This System is designed,implemented and tested to monitor the pinpoints of air pollution of any area like dust dimension of air.

1.1 Why using IOT ??

Due to flexibility and low cost Internet of things (IoT) is getting popular day by day.

Analysis of monitoring data allows us to estimate how bad air pollution is from day today. With the urbanization and with drastic increase in the number of vehicles on road the atmospheric conditions have considerably affected.

1.2 Existing Model in Market !!!!

The commercial meters available in the market are Fluke carbon monoxide meter for CO. Amprobe CO2 meter for CO2 carbon dioxide.

ForbixSemicon LPG gas leakage sensor alarm for LPG leakage detection.

The researchers in this field have proposed various air quality monitoring systems based on WSN (Wireless sensor network), GSM (Global System for Mobile Communications) and GIS (Geographic Information System).

GIS (Geographic Information System) based system is designed, implemented and tested to monitor the pinpoints of air pollution of any area like dust,nitrogen,carbon dioxide.It consists of a micro-controller like Arduino, gas sensors, mobile unit, a temporary memory buffer or cloud and a web server with internet connectivity which collects data from different locations along with coordinates information at multiples time during whole day. The Global Positioning System (GPS) module is attached to a system to provide accurate representation of pollution sources in any area. The recorded data is periodically transferred to a computer through a General Packet Radio Ser-

vice (GPRS) connection and then the data will be displayed on the dedicated website and smart phone as per the user needs.

1.3 Why this Project ??

We propose an air quality monitoring system that will allow us to monitor and check live air quality in an area through IOT and cloud application. System uses air sensors to sense presence of dust particles in the air and constantly transmit this data.The sensors interact with Arduino Uno which processes this data and transmits it over the application and web server and we can access it in our smart phone or computer.

This allows authorities to monitor air pollution in different areas and act against it accordingly. Also, authorities can keep an eye on the air pollution near schools, hospitals and various public areas where mass public is major concern.

Even we can use this device while travelling ,it will tell us whether we need to wear mask of not while going outside the car.

We can even automate the air purifier with this device so that it will automatically switched On/Off according to the need of it and hence we can optimize the power consumption

Chapter 2

Definition

2.0.1 IOT (Internet of Things)

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer the data over a network without requiring human-to-human or human-to-computer interaction directly. Internet of Things has evolved from the convergence of wireless technologies, micro-electro mechanical systems (MEMS), micro services and the internet.

The convergence has helped tear down the silo walls between operational technology (OT) and information technology (IT).

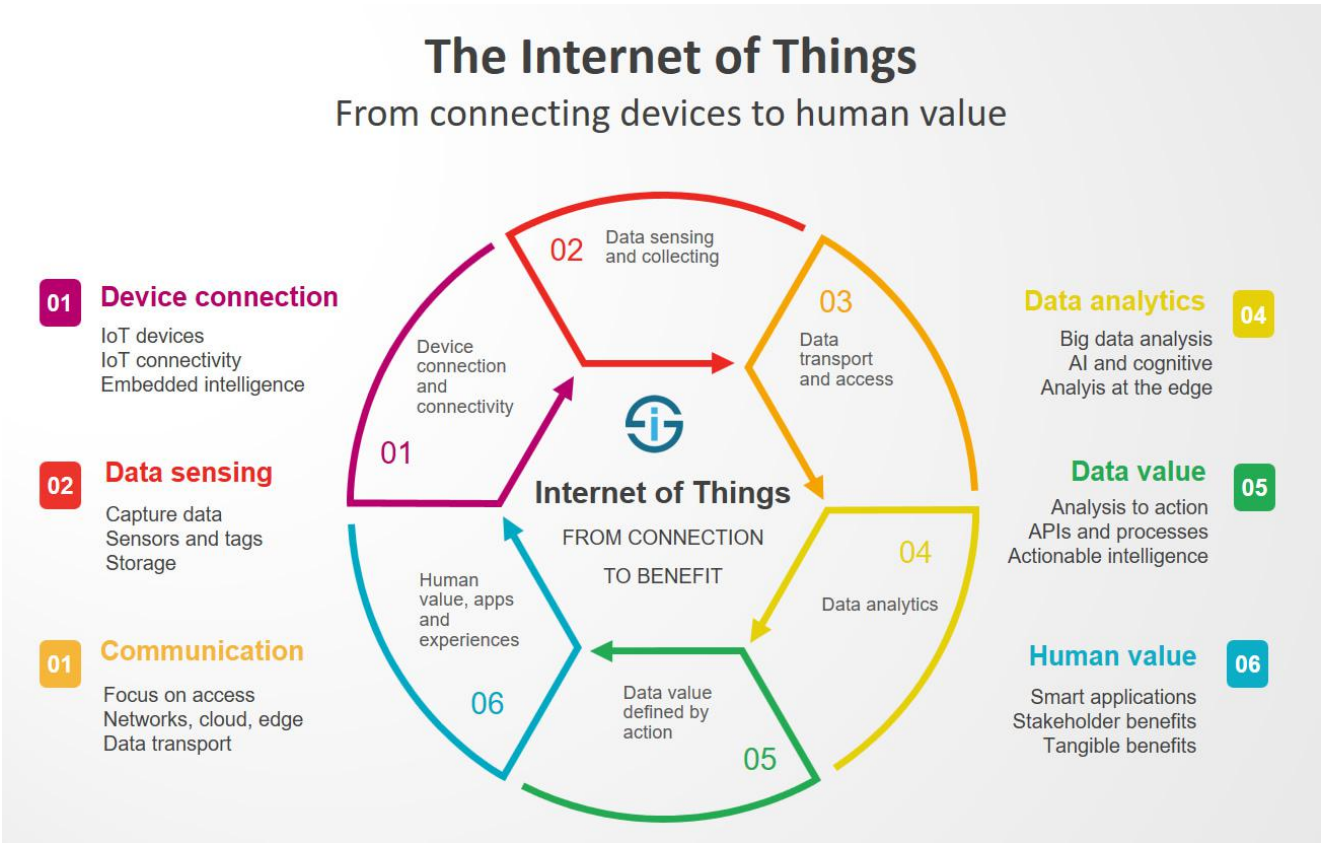

Figure 2.1: Conceptual diagram of IOT
src:https://goo.gl/images/ddK6lp

2.0.2 Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are capable of reading inputs - light on a sensor, a finger on a button, or Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online ,etc.

Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.

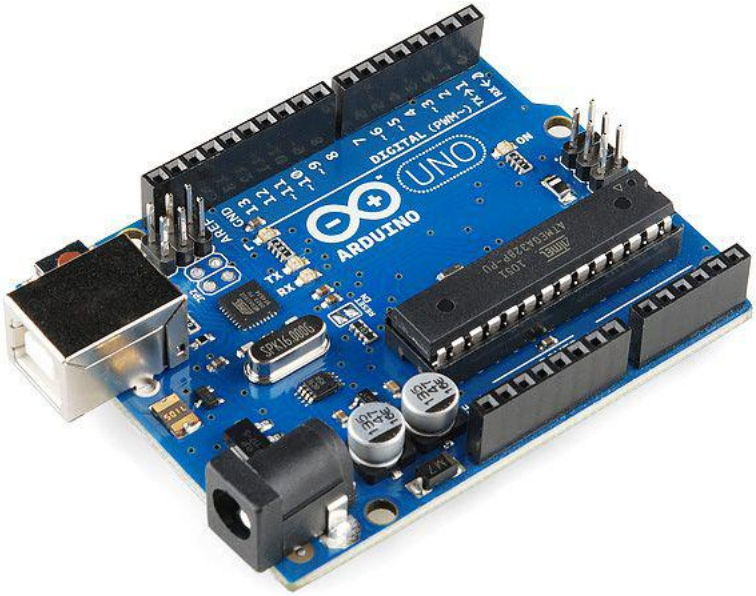

Figure 2.2: Ardunio Uno Board
src:https://goo.gl/images/czkVCD

Chapter 3

Survey

This survey work summarizes the production of (IAPs) indoor air pollutants through household products and activities and also the probable health symptoms of IAPs. The IAPs are categorized as physical, chemical and biological surveyed as per the product(s) usage in the closed room of buildings.Indoor air pollution is a concern in the developed countries, where energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising pollutant levels. The survey results of IAPs generated from household products and activities,these are asbestos, fine particulate matters and ash as physical pollutants.

The chemical pollutants are carbon mono and dioxide gases, phthalates, DDT,chlordane, heptachlor, o-phenylphenol; PBDEs, Formaldehyde, Other Aldehydes, lead, benzene, chloroform, para-dichlorobenzene, methylene chloride, perchloroethylene, styrene, benzene, formaldehyde, pesticides, PAH, NOx, terpenes, styrene, phthalate esters, toluene, Propellant, acrylamide, VOCs, acetone, HCl gas and biological pollutants are bacteria, fungi, viruses,

house dust particles, animal dander; cockroaches, microbial spore.

The physical, chemical and biological pollutants found in indoor air often several times higher than outdoors.In closed chamber, these cause effects ranging from odour, annoyance and irritation to illness, cancer and even death.Health effects due to indoor air pollutants may be short-term as well as long-term. Short-term problems include a stuffy, odorous environment and symptoms such as burning eyes, skin irritation, and headaches. Long-term health problems have a longer latency period or are chronic in nature. Overall, poor air quality may be responsible for a decrease in work performance, general feeling of poor health, reduced ability to concentrate, or illness (WHO, 2002).

As per the survey conducted by Department of Environmental Science,University of Calcutta, A survey of dust sizes from coal mines in the (sampled up to 100m from the source) found that dust had a median size of 24m.

Chapter 4

Air Quality parameters

Some important parameters that are considered in the Air Quality Monitoring framework include:-

4.0.1 IOT (Smoke Dust)

About 1 million people are in habit of tobacco and smoking globally of which majority of population is from developing countries.

Every year nearly 4.9 million people died due to smoking according to 2007 report. In addition, smoke and dust is serious threat to the health of people of all ages causes 41000 deaths each year. In various construction sites due to lots of dusts particles sometimes it get worst to breathe. This dimension of air is my most concerned part of my project hence this device will be dust concerned device.

4.0.2 IOT (Carbon Dioxide (CO2))

CO2 is odorless gas, non-combustible gas and colorless. Moreover, it is considered under the category of asphyxiate(cause to die,unconsciousness) gases that have capability of interfering the availability of oxygen for tissues.

Carbon Dioxide is a gas essential to life in the planet, because it is one of the most important elements evolving photosynthesis process, which converts solar into chemical energy. The concentration of carbon dioxide (CO2) has increased due mainly to massive amount of fossil fuels burning. This increase makes plants grow rapidly. The rapid growth of undesirable plants leads to the increase use of chemicals to eliminate them.

4.0.3 Sulphur Dioxide (SO2)

Sulphur Dioxide is colorless gas,which is detectable by the distinct odour and taste like CO2, it is mainly produced due to fossil fuels burning and to industrial processes. In high concentrations it may cause respiratory problems, especially in sensitive groups, like asthmatics. It also contributes to acid rains which is dangerous.

4.0.4 Nitrogen Dioxide (NO2)

Nitrogen Dioxide is a brownish gas that is easily detectable for its odour, very corrosive and highly oxidant by its nature. It is produced as the result of fossil fuels burning. Usually NO gas thrown to the atmosphere is converted in NO2 by chemical processes. In high concentrations, NO2 may lead to respiratory problems and like SO2, it contributes to acid rains.

4.0.5 LPG(Liquefied petroleum gas)

Liquefied petroleum gas (LPG) is an colorless and odorless liquid which evaporates readily into a gas. Leakage is normally detected by adding an odorant(a substance used to give a particular odour to a product) into it. It is considered under the category of highly flammable gases and it can be classified as a carcinogen and mutagen. If it leaks in the form of a liquid it evaporates quickly and will eventually form large cloud of gas in air which is relatively heavier than air thus drops to the ground. Gas leads to burn or sometimes explode after getting in touch with a source of ignition.

Chapter 5

Air Pollution Monitoring Equipment

The different components of the equipment along with their intended purpose and specifications are discussed below:

5.0.1 Arduino Uno R3 microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are capable of reading inputs - light on a sensor, a finger on a button, or Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online ,etc.

Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.You can see the pin diagram of Arduino Uno board below here.

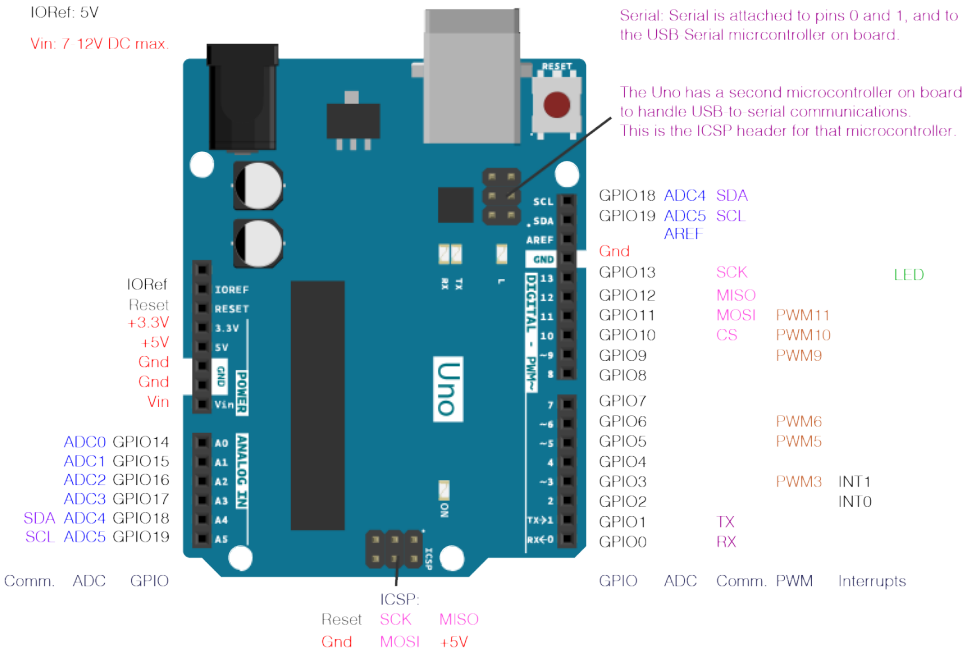

Figure 5.1: Arduino Uno R3 microcontroller
src:https://goo.gl/images/tBjHLD

5.0.2 GP2Y1010AU0F Air Quality Sensor

Sharp's GP2Y1010AU0F is an optical air quality sensor and it is also known as optical dust sensor.It is designed to sense dust particles. An infrared emitting diode and a phototransistor are diagonally arranged into this device, to allow it to detect the reflected light of dust in air. It is even effective in detecting very fine particles like cigarette smoke and is commonly used in air purifier systems.

To interface with this sensor, you need to connect to its 6-pin, 1.5mm pitch connector by using mating connector.

Specifications:

* Low Current Consumption (MAX: 20mA)

* Typical Operating Voltage: 4.5V to 5.5V (MAX: 7V)

* The presence of dust can be detected by the photometry of only one pulse

* Enable to distinguish smoke from house dust

Figure 5.2: GP2Y1010AU0F Air Quality Sensor
src:https://goo.gl/images/5A8j7s

Chapter 6

Proposed Architecture and Equipment

Component needed

1. GP2Y1010AU0F Air Quality Sensor
2. Arduino Uno
3. WiFi module ESP8266
4. Jumper wire(M-M,M-F)
5. Breadboard
6. 1K ohm resistors
7. 220 ohm resistor
8. Buzzer

Proposed Architecture

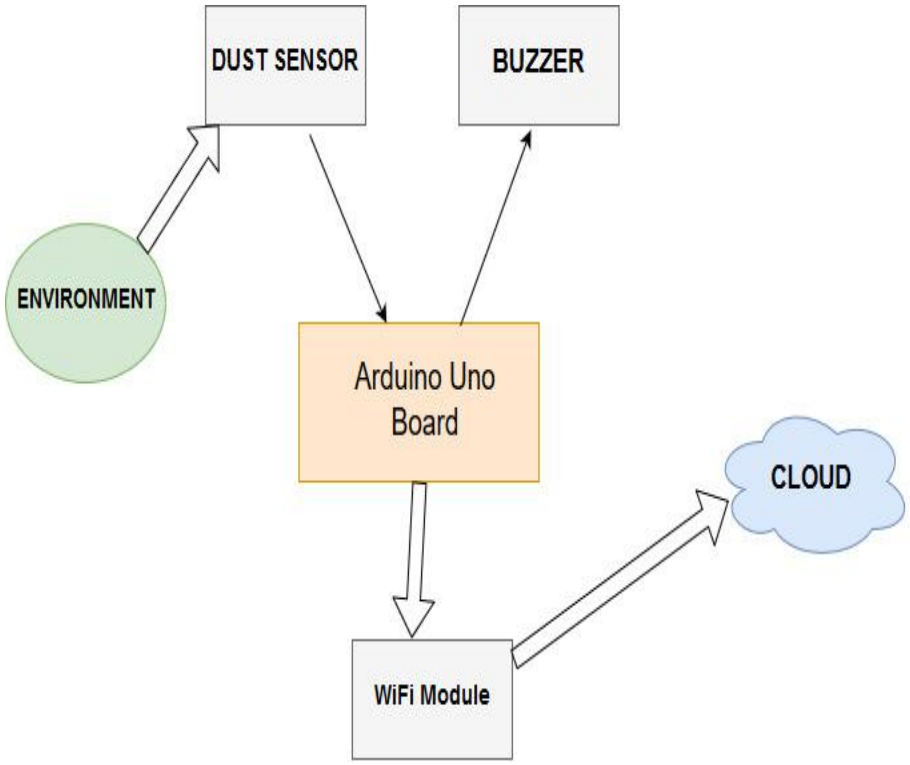

Figure 6.1: Proposed Architecture

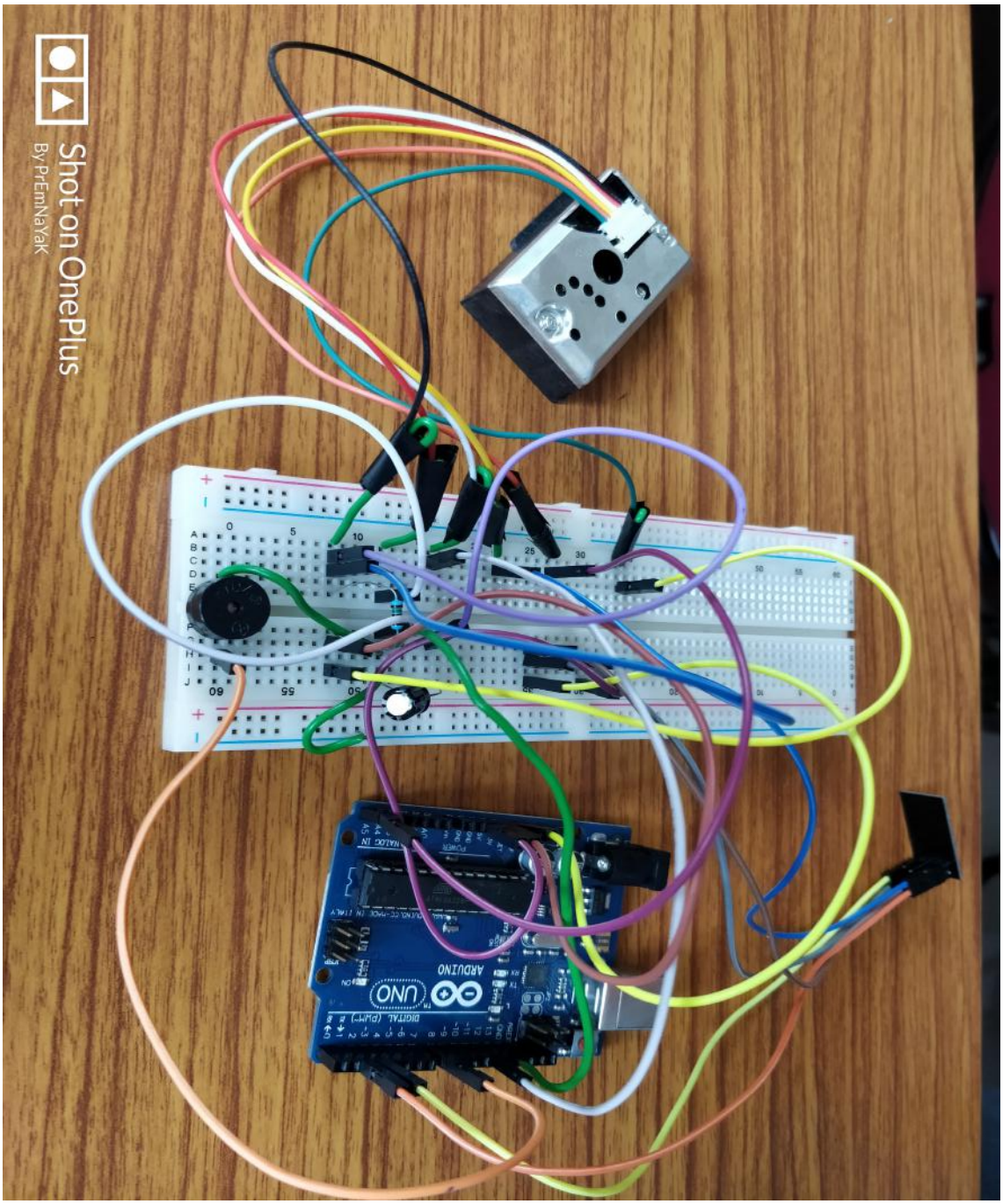

Figure 6.2: Proposed Architecture

Chapter 7

Experimental Analysis

7.0.1 Setting up !

We start with connecting the ESP8266 with the Arduino. ESP8266 runs on 3.3V and if you will give it 5V from the Arduino then it wont work properly and it may get damage.

Connect the VCC to the 3.3V pin of Arduino. The RX pin of ESP8266 works on 3.3V and it will not communicate with the Arduino when we will connect it directly to the Arduino.

Connect the TX pin of the ESP8266 to the pin 3 of the Arduino and the RX pin of the esp8266 to the pin 2 of Arduino through the resistors.

ESP8266 Wifi module gives your projects access to Wifi or internet. It is a very cheap device and makes your projects very powerful. It can communicate with any microcontroller and it is used in most leading devices based on the IOT platform. Optionally you can connect MQ135 sensor with the Arduino for covering more dimensions of air.

Connect the VCC and the ground pin of the sensor to the 5V and ground of the Arduino and the Analog pin of sensor to the A5 of the Arduino. Connect a buzzer to the pin 8 of the Arduino which will start to beep when the condition becomes true.

The GP2Y1010AU0F sensor can sense smoke and dust so it is perfect gas sensor for our Air Quality Monitoring Project.When we will connect it to the Arduino board then it will start sensing the dust particles, and we will get the Pollution level in the form of dust density. GP2Y1010AU0F sensor gives the output in form of voltage levels and we need to convert it into dust density.

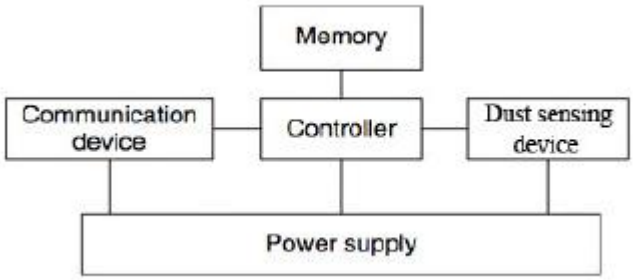

Figure 7.1: Sensor Node Structure

7.0.2 Sensor data Conversion

Conversion of output in dust density is detailed discussed in the code.

In the code we have used 3 variables for the sensor data

-voMeasured

-calcVoltage

-dustDensity

```
void loop(){

digitalWrite(ledPower,LOW);
  delayMicroseconds(samplingTime);

  voMeasured = analogRead(measurePin);

  delayMicroseconds(deltaTime);
  digitalWrite(ledPower,HIGH);
  delayMicroseconds(sleepTime);

  calcVoltage = voMeasured*(5.0/1024);
  dustDensity = 0.17*calcVoltage-0.1;
```

Figure 7.2: Variable portion of Code

"voMeasured" is the analog reading taken by the Sharp GP2Y1010AU0F air quality sensor form the environment through the pin A5.

Then we calculate the "calcVoltage" from the "voMeasured" by the mathematical equation :

calcVoltage = voMeasured*(5.0/1024);

Then we will calculate "dustDensity" from the "calcVoltage" by the mathematical equation :

dustDensity = 0.17*calcVoltage-0.1;

We have connected the Pizeo buzzer in pin 8 so that whenever the dust concentration is above some level it will start ringing and make the user alert about the environment and he can wear mask and use air Purifier.

7.0.3 Result

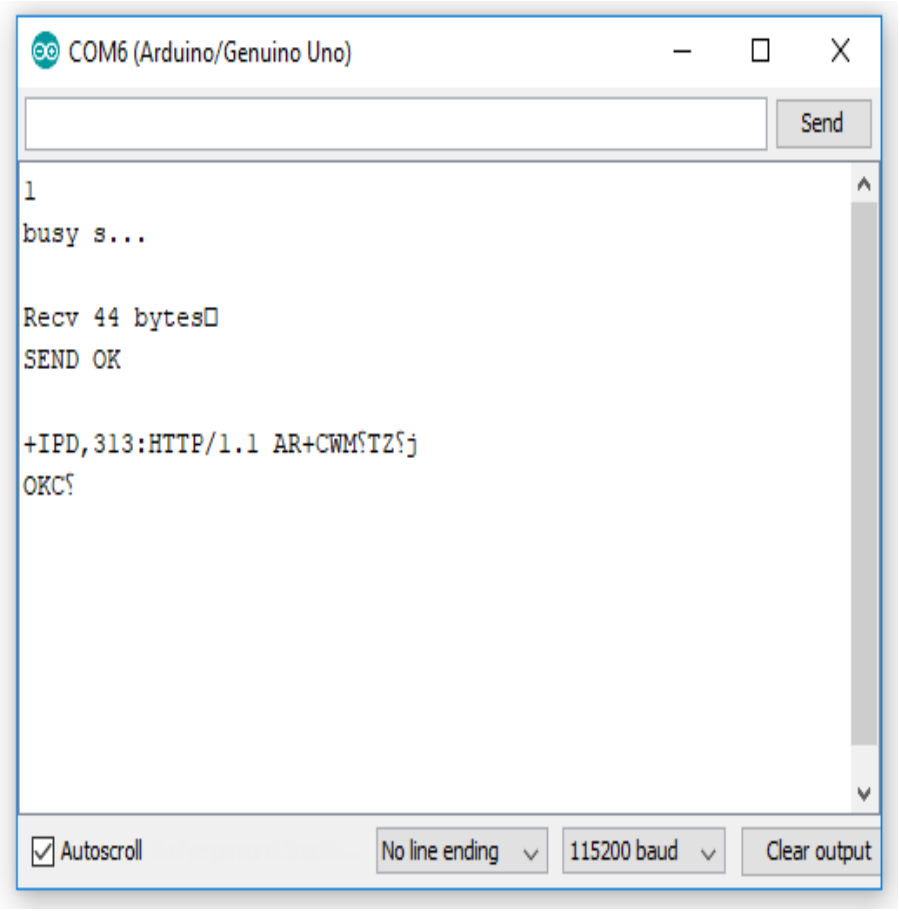

Figure 7.3: wifi connection

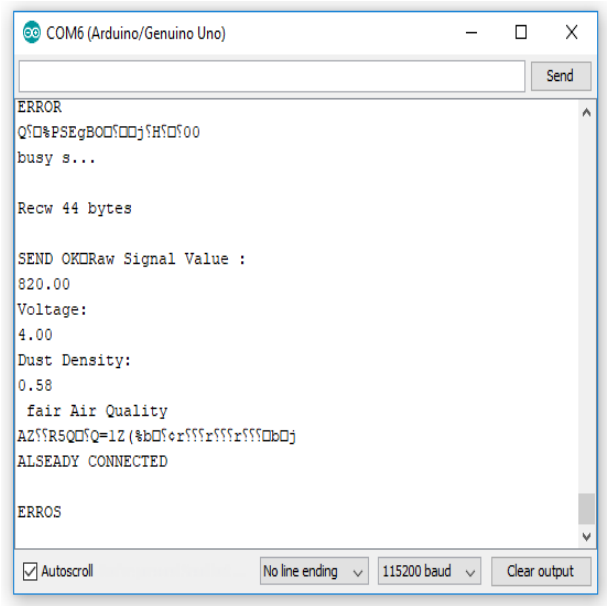

Figure 7.4: T1:Sample result 1

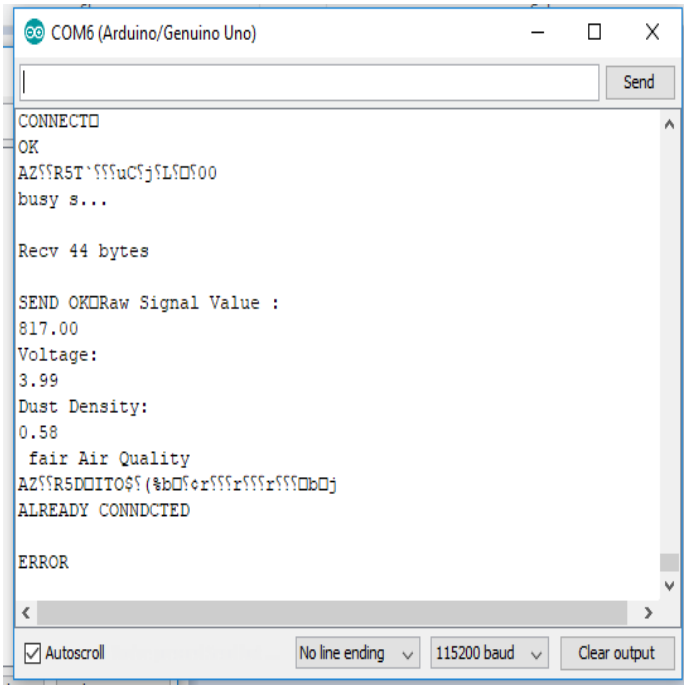

Figure 7.5: T2:Sample result 2

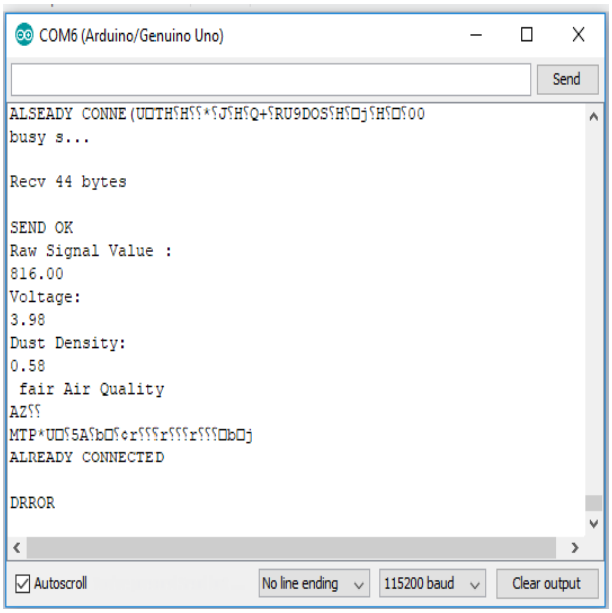

Figure 7.6: T3:Sample result 3

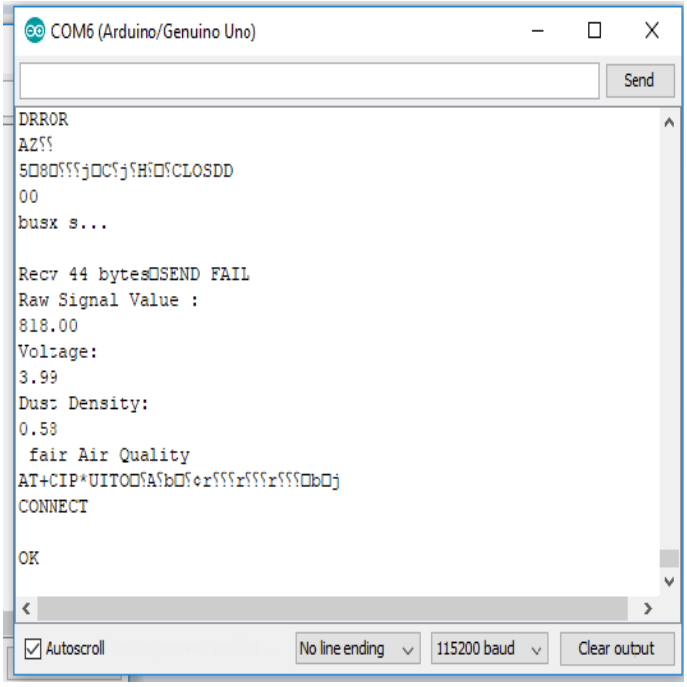

Figure 7.7: T4:Sample result 4

Chapter 8

Different levels of Dust concentration

I have categorized the air quality levels in 5 levels :-

-Very poor Air Quality

-Poor Air Quality

-fair Air Quality

-very Good Air Quality

-Excellent Air Quality

8.0.1 Very poor Air Quality

Condition: if(voMeasured greater than 3000)

Action tone(piezoPin, 1000, 500);

buzzer will start ringing when we will enter in this level

8.0.2 Poor Air Quality

Condition: if(voMeasured greater than 1050 voMeasured less than 3000)

Action tone(piezoPin, 1000, 100);

buzzer will start ringing when we will enter in this level with different frequency.

8.0.3 Fair Air Quality

Condition: if(voMeasured greater than 300 voMeasured less than 1050)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

8.0.4 very Good Air Quality

Condition: if(voMeasured greater than 300 voMeasured less than 1050)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

8.0.5 Excellent Air Quality

Condition: if(voMeasured greater than300 voMeasured less than 1050)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

Chapter 9

IoT Analytics - ThingSpeak Internet of Things

After all this condition checking at last in this project we are casting the result in the screen with all the output values and we are connecting the application to the Things.

We will send the data collected by the sensor to the cloud so that we can access the data from anywhere just by a click.

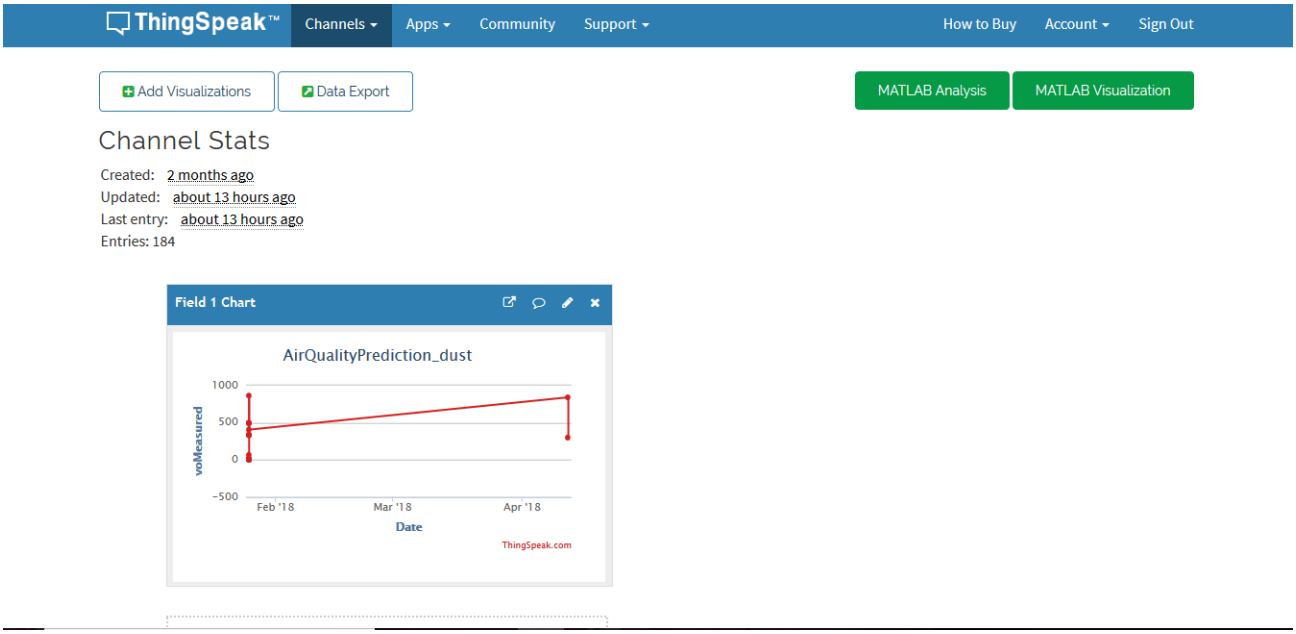

Figure 9.1: Connection of sensor with cloud using ThingSpeak

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