“AIR QUALITY MONITORING SYSTEM”

PROJECT REPORT

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Internet Of Things(CSE3009)

Slot: F2

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(SCHOOL OF COMPUTER SCIENCE AND ENGINEERING)

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

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CERTIFICATE

This is to certify that the project work entitled “Air Quality Monitoring System” that is being submitted by “Utkarsh Sharma (16BCE0226), Shubham Gupta (16BCE0232), Kusumakar Kashyap(16BCE0351) for CSE3009 Internet of Things is a record of bonafide work done under my supervision. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted for any other CAL course.

Place: Vellore

Date:

Signature of Student:

Signature of Faculty:

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Signature of Student

ABSTRACT

The level of pollution has increased with times by a lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor quality of air, a Wireless sensor network (WSN) based new framework is proposed which is based on data acquisition and transmission. The parameters of the environment to be monitored are chosen as temperature, humidity, volume of CO, volume of CO2, detection of leakage of any gas - smoke, alcohol, LPG.

Thus the proposed model will be extremely useful in assessing the quality of air to ensure good health and wellbeing of the masses by monitoring the various elements present in air.

In this project we are going to make an IOT Based Air Quality Monitoring System in which the Air Quality over a webserver using internet will be monitored and an alarm will be triggered when the air quality goes down beyond a certain level. In other words, when the amount of harmful gases presents in the air like CO2, smoke, alcohol, benzene and NH3 exceed the normal safety standards, the model will notify the same. It will show the air quality in PPM on the LCD and as well as on webpage 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.

1. INTRODUCTION

Air contamination is the most serious issue of each country, regardless of whether it is produced or creating. Medical issues have been developing at quicker rate particularly in urban territories of creating nations where industrialization and developing number of vehicles prompts arrival of parcel of vaporous poisons. The primary goal of IOT Air and Sound Monitoring System is that the Air and sound contamination is a developing issue nowadays. It is important to screen air quality and monitor it for a superior future and solid living for all. Because of adaptability and ease Internet of things (IoT) is getting well known step by step. With the urbanization and with the expansion in the vehicles on street the barometrical conditions have significantly influenced. Destructive impacts of contamination incorporate mellow unfavourably susceptible responses, for example, bothering of the throat, eyes and nose and in addition some difficult issues like bronchitis, heart maladies, pneumonia, lung and disturbed asthma. Observing gives estimations of air poison and sound contamination focuses, which would then be able to be broke down deciphered and displayed. This data would then be able to be relevant from various perspectives. Investigation of observing information enables us to survey how terrible air contamination and sound contamination is from every day.

Different sorts of anthropogenic emissions named as essential toxins are directed into the air that experiences synthetic response and further prompts the development of new poisons ordinarily called as optional contaminations. For example, as indicated by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), almost all atmosphere modifying toxins either specifically or in a roundabout way (by adding to optional poisons in the air) are in charge of medical issues. Relatively every subject invests 90% of their energy in indoor air. Open air nature of the urban areas of created nations enhanced impressively in late decades. Rather than this, indoor air quality corrupted amid this equivalent period as a result of numerous variables like diminished ventilation, vitality preservation and the prologue to new sources and new materials that reason indoor contamination. The plan of structures for lower control utilization brought about reduction of ventilation which additionally diminishes the nature of air inside the building. This expands the requirement for indoor air quality (IAQ) observing Due to this reality and utilization of new building materials, IAQ frequently reaches to unsatisfactory levels.

2. EXISTING MODEL

The business meters accessible in the market are Fluke CO220 carbon monoxide meter for CO, Amprobe CO2 meter for CO2, Forbix Semicon LPG gas spillage sensor alert for LPG spillage location. The specialists in this field have proposed different air quality observing frameworks dependent on WSN, GSM and GIS. Presently every innovation has constrained employments as indicated by the expected capacity, as Zigbee is intended for clients with Zigbee trans-recipient, Bluetooth. GIS based framework is planned, actualized and tried to screen the pinpoints of air contamination of any region. It comprises of a microcontroller, gas sensors, versatile unit, an impermanent memory support and a web server with web network which gathers information from various areas alongside organizer's data at certain season of multi day. The readings for specific area are arrived at the midpoint of in a shut time also, space. The Global Positioning System (GPS) module is connected to a framework to give precise portrayal of contamination sources in a region. The recorded information is intermittently exchanged to a PC through a General Bundle Radio Service (GPRS) association and afterward the information will be shown on the devoted site with client acknowledgment. Therefore extensive number of individuals can be profited with the huge.

3. OBJECTIVE OF THE WORK

Air pollution has become a common phenomenon everywhere. Specially in the urban areas, air pollution is a real-life problem. A lot of people get sick only due to air pollution. In the urban areas, the increased number of petrol and diesel vehicles and the presence of industrial areas at the outskirts of the major cities are the main causes of air pollution. Thus, it is now important to monitor air pollution in real time in most of the urban areas. This project is aimed at developing an IOT device which can monitor air pollution in real time and log.

4. AIR QUALITY PARAMETERS

The critical parameters that are considered in the proposed system include:

4.1 Carbon monoxide gas: CO is scentless, dry, boring and exceedingly toxic gas. It is discharged when fuel in motor does not copy appropriately and street activity is the essential wellspring of 91% of all CO discharges. Moreover, in the wake of consolidating with the haemoglobin of blood, it shapes carboxyhaemoglobin (HbCo) which prompts decrease in oxygen conveying limit of blood hence causes hypoxia. Human wellbeing is generally in risk with the introduction to at least 100ppm. Persistent introduction of CO even at low levels can cause discouragement, perplexity, and memory misfortune. Carboxy haemoglobin can be returned to haemoglobin yet the recuperation procedure is moderate in view of the dependability of HbCo complex. The ideal treatment for CO harming in spite of the fact that remaining parts disputable, yet giving hyperbaric oxygen treatment is considered as a treatment regardless of whether it gives important outcomes. Half-existence of CO gets abbreviates from 320 minutes to 80 minutes on ordinary air by overseeing oxygen by means of non-rebreathe veil.

4.2 Carbon dioxide gas: CO2 is colourless, odourless gas and non-ignitable gas. In addition, it is considered under the classification of suffocate gases that have ability of meddling the accessibility of oxygen for tissues. It is ensured examine that if the oxygen is inaccessible for 3 to 5 minutes, it can cause mind harm or passing. Ordinarily, inhabitant created CO2 go about as a substitute for estimation of Internal Air Quality. The prerequisite of outside air can be effortlessly anticipated by the substance of CO2 and as indicated CO2 levels must be under 1000ppm. For the most part CO2 levels of open air air are under 350ppm.

4.3 Smoke: Around 1 million individuals are in propensity for tobacco smoking all-inclusive of which dominant part populace is from creating nations. Consistently almost 4.9 million individuals passed on because of smoking as per 2007 report. What's more, second hand smoke is not kidding danger to the wellbeing of individuals of every one of age's causes 41000 passing’s every year.

4.4 LPG: Melted oil gas (LPG) is an unscented and colourless fluid which dissipates promptly into a gas. Spillage is regularly distinguished by including an odorant into it. It is

considered under the classification of exceedingly combustible gases and it can be delegated a cancer-causing agent and mutagen if Butadiene content is over 0.1%. LPG may spill as a gas or on the other hand a fluid. On the off chance that it spills as a fluid it dissipates rapidly and will in the end shape huge billow of gas in air which is generally heavier than air in this way drops to the ground. Though, LPG vapours travel along the ground for a long remove and gets gathered in channels or cellars. Gas prompts consume or detonate subsequent to connecting with a wellspring of start.

4.5 Sulphur Dioxide (SO2): Sulphur Dioxide is a boring gas, discernible by the particular scent and taste. Like CO2, it is essentially because of petroleum derivatives consuming and to modern procedures. In high fixations may cause respiratory issues, particularly in touchy gatherings, similar to asthmatics. It adds to corrosive downpours.

4.6 Nitrogen Dioxide (NO2): Nitrogen Dioxide is a caramel gas, effortlessly noticeable for its smell, exceptionally destructive and exceedingly oxidant. It is delivered as the consequence of non-renewable energy sources consuming. Typically, NO tossed to the environment is changed over in NO2 by compound forms. In high fixations, NO2 may prompt respiratory issues. Like SO2, it adds to corrosive downpours.

5. AIR POLLUTION MONITORING EQUIPMENT

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

5.1 Arduino Uno R3 microcontroller: It is the most flexible hardware platform used based on ATmega328P which can be programmed according to the function where it is to be used. It has 6 analog inputs, 14 digital input/output pins (6 pins of these can be used as
PWM outputs), a USB Connection, a 16 MHz quartz crystal, SPI, serial interface, a reset button, a power jack and an ICSP header. The Arduino microcontroller is not only for technical audience but is intended for designers and artists as well because of its focus to usability based on its design which helps to achieve the intended goal. It is the primary

component of the framework. In addition, it is an open source microcontroller device with easily accessible software/hardware Platform and is compatible with many sensors available.

Everything needed for its working is present on the board; we only require a USB cable to directly connect it to the computer or give power using battery source or AC to DC adapter to get started.

5.2 ESP8266 Wi-Fi Module:

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated IP protocol stack that can give any microcontroller access to your Wi-Fi network. Wi-Fi module is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Every ESP8266 module comes pre-programmed with an AT command set firmware, meaning, we can simply connect to the Arduino device. The ESP8266 module is an extremely cost effective board.

5.3 MQ135 Gas Sensor: The Sensitive material used in MQ135 gas sensor is SnO2. The conductivity of this material is lower in clean air. The sensor conductivity increases with the increasing concentration of target pollution gas. MQ135 can monitor different kinds of toxic gases such as sulphide, ammonia gas, benzene series steam and CO2. The detection range is 10-10,000 ppm with the voltage rate of about 5.0V±0.1V AC or DC.

5.4 MQ2 Gas Sensor: The Grove - Gas Sensor(MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting LPG, CH4, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer.

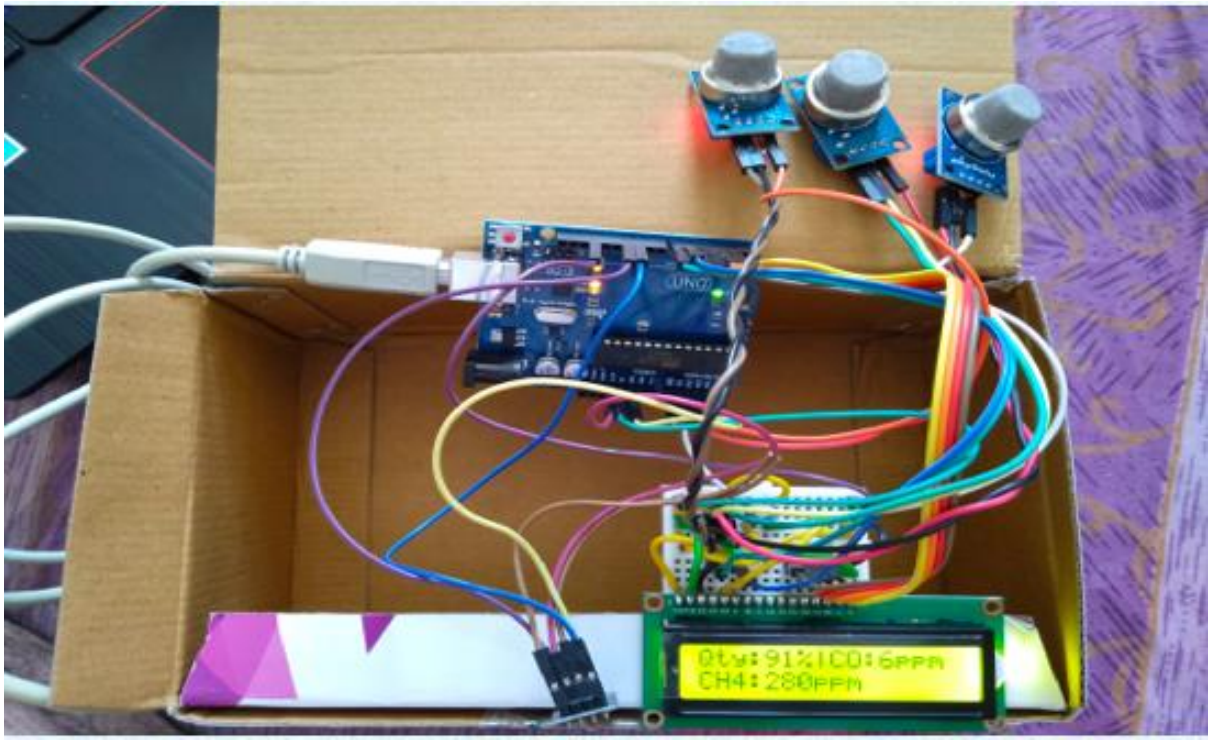
5.5 MQ9 Gas Sensor: The Grove - Gas Sensor(MQ9) module is useful for gas leakage detection (in home and industry). It is suitable for detecting LPG, mainly CO. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible.
The sensitivity of the sensor can be adjusted by using the potentiometer.

6. CIRCUIT DIAGRAM AND EQUIPMENT

6.1 COMPONENTS NEEDED

- MQ135 Gas sensor
- Arduino Uno
- Wi-Fi module ESP8266
- 16X2 LCD
- Breadboard
- 1K ohm resistors
- 220ohm resistor
- Buzzer
- MQ2 Gas Sensor
- MQ9 Gas Sensor

6.2 CIRCUIT DIAGRAM

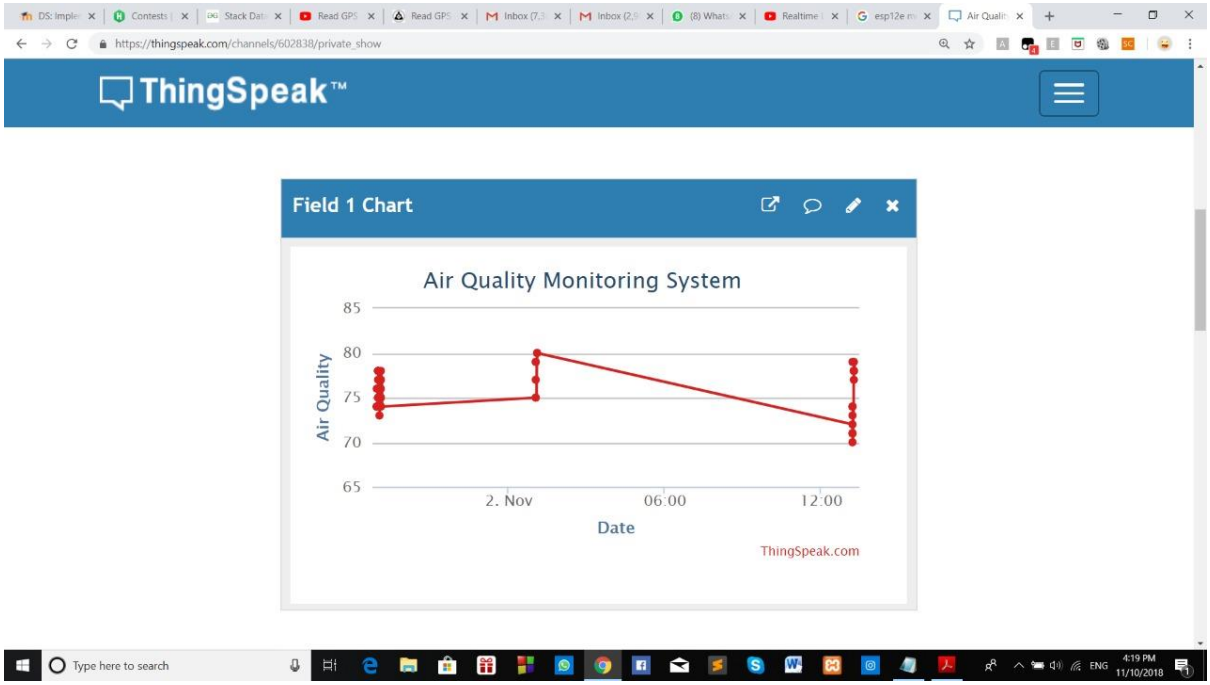


6.3 WORKING

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 won't work properly and it may get damage. Connect the VCC and the CH_PD 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. So, we will have to make a voltage divider for it which will convert the 5V into 3.3V. This can be done by connecting three resistors in series like we did in the circuit. Connect the TX pin of the ESP8266 to the pin 10 of the Arduino and the RX pin of the esp8266 to the pin 9 of Arduino through the resistors. ESP8266 Wi-Fi module gives your projects access to Wi-Fi or internet. It is a very cheap device and makes your projects very powerful. It can communicate with any microcontroller and it is the most leading devices in the IOT platform. Learn more about here. Then we will connect the MQ135 sensor with the Arduino. 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 A0 of the Arduino. Connect a buzzer to the pin 8 of the Arduino which will start to beep when the condition becomes true. The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2 and some other gases, so it is perfect gas sensor for our Air Quality Monitoring Project. When we will connect it to Arduino then it will sense the gases, and we will get the Pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and we need to convert it into PPM. So for converting the output in PPM, here we have used a library for MQ135 sensor, it is explained in detail in "Code Explanation" section below. Sensor was giving us value of 90 when there was no gas near it and the safe level of air quality is 350 PPM and it should not exceed 1000 PPM. When it exceeds the limit of 1000 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air and if exceeds beyond 2000 PPM then it can cause increased heart rate and many other diseases. When the value will be less than 1000 PPM, then the LCD and webpage will display "Fresh Air". Whenever the value will increase 1000 PPM, then the buzzer will start beeping and the LCD and webpage will display "Poor Air, Open Windows". If it will increase 2000 then the buzzer will keep beeping and the LCD and webpage will display "Danger! Move to fresh Air".

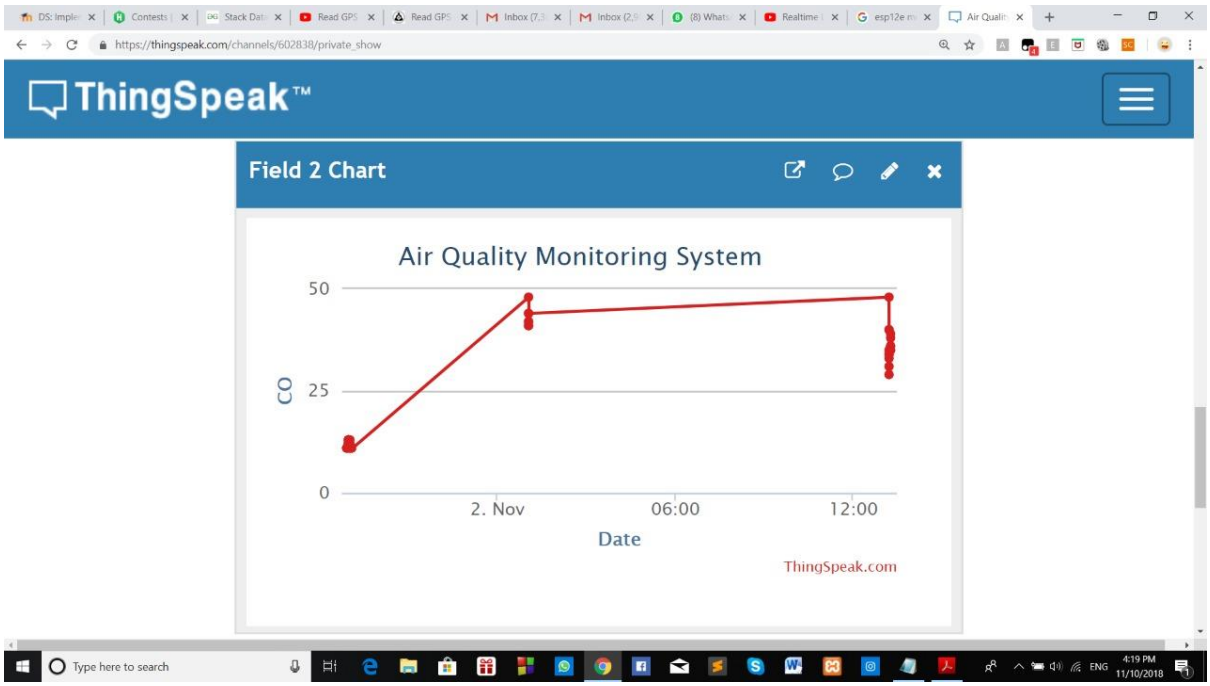
7.RESULTS AND DISCUSSION

7.1MQI35 sensor graph.



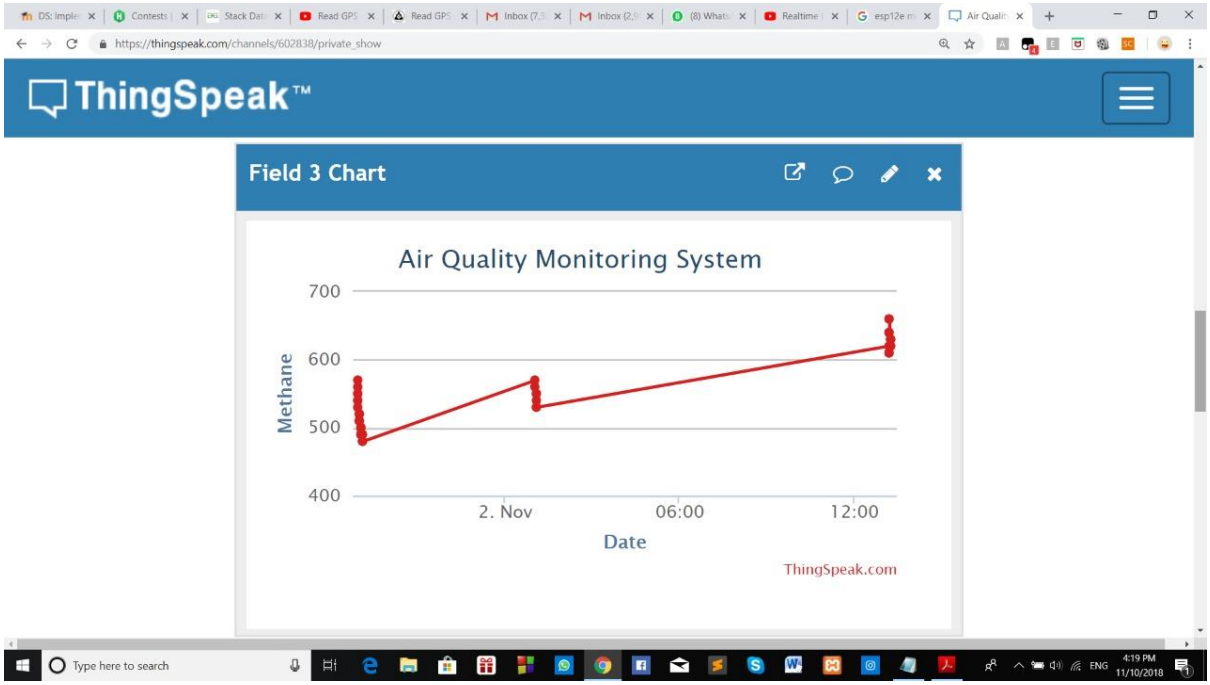
This graph is showing the air quality of the atmospheric air in ppm considering various gases with respect to time.

7.2 MQ9 sensor graph.



This graph is showing the concentration of carbon monoxide with respect to the time using the MQ9 sensor.

7.3 MQ2 sensor graph.



This graph is showing the concentration of methane with respect to the time by using the MQ2 sensor.

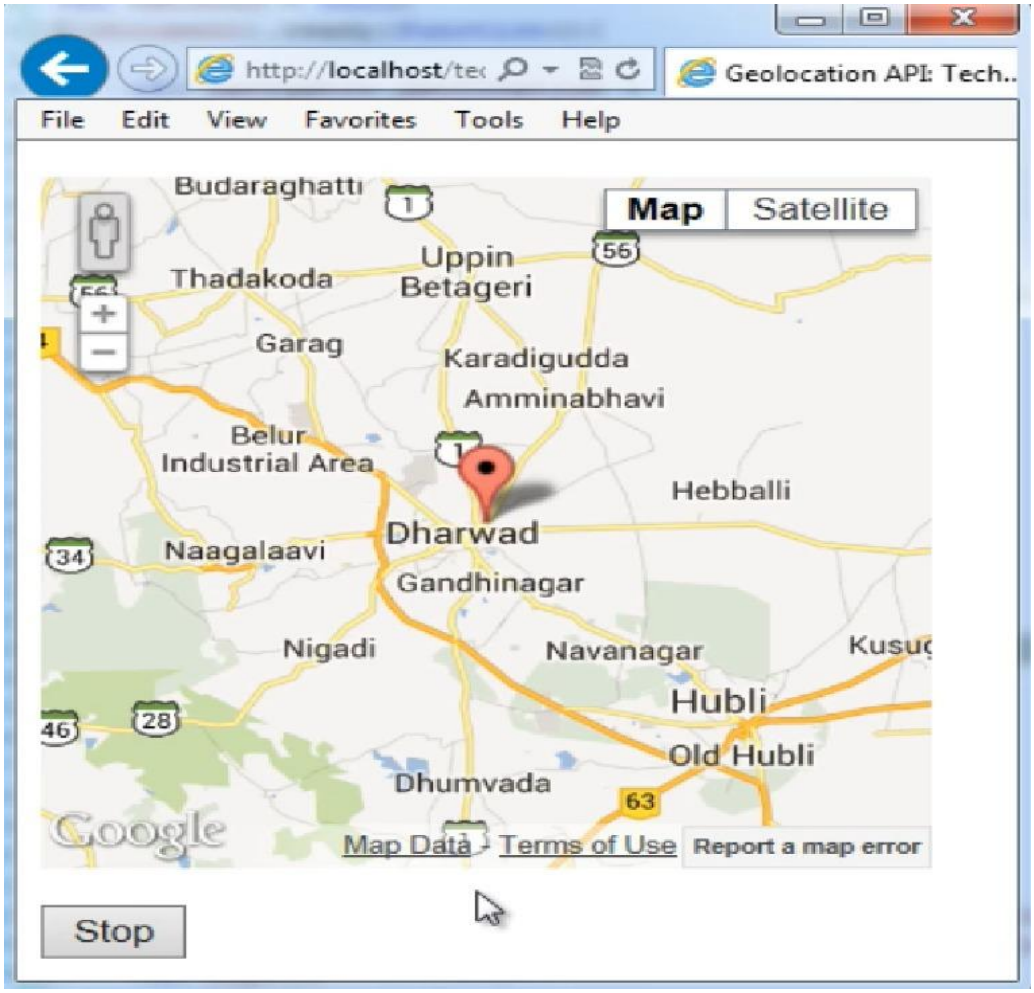
7.4 ESP12E-ESP8266 WiFi Module

Esp-12E Esp8266 Wifi Module is a low power consumption of the UART-Wifi module and ultra low power consumption technology, designed especially for mobile devices and IoT applications,user's physical device can be connected to a Wifi wireless network, internet or intranet communication and networking capabilities. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller.

Features of Esp-12E Esp8266 Wifi Module

- 802.11 b/g/n
- Integrated low power 32bit MCU
- Integrated 10bit ADC
- Integrated TCP/IP protocol stack
- Operating temperature range : -40 ° C ~ 125 ° C
- Frequency range : 2.4GHz - 2.5GHZ

- Operating voltage : 3.0v~3.6v
- Operating current: Average value 80mA
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- Supports antenna diversity
- WiFi 2.4 GHz, support WPA/WPA2 Security
- Network protocaol : IPv4, TCP/UDP/HTTP/FTP
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IRDA, PWM, GPIO
- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation and 0.4s guard interval
- Deep sleep power <10uA, Power down leakage current < 5uA
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- +20dBm output power in 802.11b mode



This is the map generated by the data collected by the ESP12E sensor which is being sent to the thing speak for locating the position of the sensor.

Code:

```
#include <LiquidCrystal.h>
#include "ESP8266.h"

#define SSID "Utkarsh's iPhone"     // "SSID-WiFiname"
#define PASS "12345678"       // "password"

#define IP "184.106.153.149"// thingspeak.com ip
String msg = "GET /update?key=Z4W7Y091E1GQSNWG"; //change it with your api key like "GET /update?key=Your Api Key"

#define QUALITY_PIN A0 //AIR QUALITY
#define METHANE_PIN A1 //MQ2 Methane
#define CO_PIN A2 //MQ9 Carbon Monoxide

ESP8266 ESP;
LiquidCrystal lcd(7, 6, 5, 4, 3, 2);

int qualityLevel;
int coLevel;
int methaneLevel;

void updateLevel(){
  String cmd = msg ;
  cmd += "&field1=";
  cmd += qualityLevel;
  cmd += "&field2=";
  cmd += coLevel;
  cmd += "&field3=";
  cmd += methaneLevel;

  cmd += "\r\n";
  if(ESP.get(IP, 80, cmd)){
//    ESP.serialDebug();
  }
}
void setup() {
  Serial.begin(115200);
  lcd.begin(16, 2);
  lcd.print("Initializing!");

  ESP.preInit();
  while(ESP.connectWiFi(SSID, PASS)){
```

```
Serial.print("Trying..");
    delay(500);
  }
  lcd.setCursor(0, 1);


  lcd.print("* ALL OK *");
  delay(2000);
}

void loop() {
  qualityLevel = analogRead(QUALITY_PIN);
  qualityLevel = map(qualityLevel, 0, 1023, 0, 100);
  qualityLevel=100-qualityLevel;

  coLevel = analogRead(CO_PIN);
  coLevel = (100-map(coLevel, 0, 1023, 0, 100));

//
//  float sensor_volt = coLevel / 1024 * 5.0;
//  sensor_volt = (5.0-sensor_volt)/sensor_volt; // omit * RL
//  coLevel = sensor_volt / 9.8; // The ratio of RS/R0 is 9.8 in a clear air from Graph (Found
using WebPlotDigitizer)

  methaneLevel = analogRead(METHANE_PIN);
  methaneLevel = map(methaneLevel, 0, 1023, 0, 100)*10;

  Serial.println("Read sensor: ");
  Serial.print("Quality : ");
  Serial.print(qualityLevel);
  Serial.print("% CO : ");
  Serial.print(coLevel);
  Serial.print("% CH4 : ");
  Serial.print(methaneLevel);
  Serial.println("%");

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Qty:");
  lcd.print(qualityLevel);
  lcd.print("%|CO:");
  lcd.print(coLevel);
  lcd.print("ppm");
  lcd.setCursor(0, 1);
  lcd.print("CH4:");
  lcd.print(methaneLevel);
  lcd.print("ppm");
  if(coLevel>150 || methaneLevel>1000){
     lcd.print("Danger");
  }
  updateLevel();

  delay(2000);
```

8. CONCLUSION

The system to monitor the air of environment using Arduino microcontroller, IOT Technology is proposed to improve quality of air. With the use of IOT technology enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this paper. Here the using of MQ135, MQ2 and MW9 gas sensor gives the sense of different type of dangerous gas and Arduino is the heart of this project which controls the entire process. Wi-Fi module connects the whole process to internet and LCD is used for the visual Output. The Automatic Air & Sound management system is a step forward to contribute a solution to the biggest threat. The air & sound monitoring system overcomes the problem of the highly-polluted areas which is a major issue. It supports the new technology and effectively supports the healthy life concept. This system has features for the people to monitor the amount of pollution on their mobile phones using the application.

Since India is lagging far behind in gas monitoring technologies, providing such a device at affordable prices help factories, municipals, researchers etc to have access to certain data of the interest. In future it can also be developed for monitoring of Landfill Gas Monitoring with a very little advancement. Similarly, we can Interface GPS module to monitor the pollution at exact location and upload on webpage. The Application includes:

- Roadside pollution monitoring.
- Industrial perimeter monitoring.
- Indoor Air Quality monitoring.
- Site selection for reference monitoring stations.

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