Air Quality Index Monitoring Board

Mr.A.Bala Raja Ram[1], Dr.R.S.R.Krishnam Naidu[2], S.Jaya Krishna[3] D.Pujitha Lakshmi[4]K.Pavan Kalyan[5]P.Venkat Teja[6] S.Jayashree[7]Ritik Ranjan[8] S.Jagadeesh[9]
[1]*Assistant professor, Electrical & Electronics Engineering, NSRIT, Visakhapatnam, India*
[2]*Associate professor, Electrical& Electronics Engineering, NSRIT, Visakhapatnam, India*
[3,4,5,6,7,8,9] *Students of Department of Electrical & Electronics Engineering, NSRIT, Visakhapatnam, India*

***Abstract*— Air pollution is one of the governing factor for the public health and it is the concerning part for the environment. The main objective of this paper is to provide the details about our project which is based on monitoring the air quality index of area where we live. This will help us to know in what situation we are living and what are the environmental changes that need to be made to make our live more healthy. In this paper we will show how our project compares the actual data with the predefined data. The predefined data is based on the National Air Quality Index (NQAI). In this paper concentration of various pollutants along with various harmful gases for various cities of India are also analyzed based on NAQI data and it will be easy to compare the actual data with it. This paper includes the comparison data of many Indian cities with grown alarming due to severe unsafe web of particulate matter (PM) and harmful gases present in air.**

Index Terms: **Air Quality Monitoring, National Air Quality Index, Particulate Matter, Sensors, LED Board.**

1.INTRODUCTION

The Air Excellence Guide (AEG) may be a common indicator of air quality. The Air Quality Indicator (AQI) is calculated and supported on air pollutants like CO and NO2 compounds that consume opposing possessions happening the atmosphere and human health. The Air Quality Indicator may be a range that represents the very finest meditation of a specific air unused matter at a particular time. I propose an air quality as well as air pollution monitoring system that allows us to monitor and check live air quality as well as air pollution in an area through Internet of Things (IoT). It uses air sensors (Gas Sensor SENSOR NETWORK) to sense presence of harmful gases/compounds in the air and constantly transmit this data. In addition, system keeps measuring air level and reports it. The sensors interact with Arduino Uno (Microcontroller) which processes this data and transmits it over the application. This allows authorities to monitor air pollution in different areas and act against it [1]. In addition, authorities can keep a watch on the air pollution near schools, and hospitals areas. Normally, little concentrations area unit measured exploitation ppb (parts per billion), that represents units of mass of a material per one billion units of total mass. Parts per million (ppm) may be similar and unremarkable used unit to measure concentrations of pollutants. It determines the requirements of a new system and analyze on product and resource requirement, which is required for the successful system. The product requirement contains input and output requirements it gives the wants in term of input to produce the required productivity. The resource requirements define in brief about the hardware that are needed to achieve the required functionality. In this project I am going to make an IoT based Air Pollution Detection Monitoring System in which I monitor the Air Quality over a web server using ESP8266 Wi-Fi device and a trigger alarm when the air quality goes down a certain level means when there is amount of harmful gases is present in the air like CO2. It shows the air quality in PPM (Parts per Million) on LED BOARD and webpage so that I monitor it very easily.

2. LITERATURE SURVEY

2.1 A Comparative Study of Air Quality Index Based on Factor Analysis and US-EPA Methods for an Urban Environment:

Bishoi et al posited the EPA method for the computation of AQI (EPAQI). This technique involved the calculation other index value for each pollutant (SO2, NO2, carbon monoxide, Ozone, Particulate Matter). The EPAQI was then evaluated by determining the maximum index value of the

single pollutant which provided a rough estimate of the impact on the quality of air on human health. Furthermore, the research involved the Factor Analysis method to calculate the New AQI (NAQI) encompassing the Principal Component Analysis (PCA) [3], which was used to ascertain whether their quality has worsened or improved over the months.

2.2Air Quality Index A Comparative Study for Assessing the Status of Air Quality:
Shivam et al carried out a comparative study, wherein the various formulas and methodologies used in the computation of AQI were assessed. The study included an analysis of five different techniques to determine the most precise calculation methodology to provide accurate results for further scrutinization.

2.3Forecasting of Air Quality in Delhi Using Principal Component Regression Technique:
Anikender et al proposed a forecasting model to predict the AQI value which implemented the technique of Multiple Linear Regression and Principal Component Regression model. This research model included the usage of the past days' AQI values. These values were computed using the EPA, 1999 formula.

2.4 A Review on Air Quality Indexing System:
Kanchan et al calculated and compared AQI values. TheAQI value is defined with respect to five main airpollutants: carbon monoxide (CO), ozone (O3), Sulphurdioxide (SO2), nitrogen dioxide (NO2), and particulate matter (PM10 and PM2.5)[6]. The major differences among these indices were aggregation function, type of pollutants, number of index classes (and their associated colors) and related descriptive terms.

2.5 Impact Analysis of Air Pollutants on the Air Quality Index in Jinan Winter:
Song studied the effect of air pollutants on the Air Quality Index by using correlation analysis and path analysis. The correlation values revealed the direct effect of pollutants on AQI with a positive value indicating adirect proportionality and a negative value representingan indirect proportionality. The path analysis revealed a more in-depth dependency of AQI on the pollutants by giving both the direct and the indirect dependency (ie; changes in concentration due to other pollutants' concentration)

3. DESIGN

Components
To monitor the air quality in the area living we have made a board which shows the current air quality index with the reference to NQAI. For this we have used the following components.

3.1 LED Display Board:
LED BOARD screen is an electronic display module and it has wide range of applications. Here we are using a 16 x 2 LED BOARD display for AQI monitoring. This LED BOARD is preferred as these are more economical, easily programmable compared to multi segment.

3.2 Arduino UNO:
It's the core of our model. Arduino is an open source devices stage in light of simple to operate equipment and programming. Arduino comprise of both physical programmable circuit board (microcontroller) and bit of programming or integrated development programme (IDE) that keeps running on our PC, used to compose and transfer PC code to the physical board. Arduino Uno is a microcontroller board based on the Atmega328P, an 8-bit microcontroller with 32KB of flash memory and 2KB of RAM. It comprehends everything needed to support the microcontroller; basically connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to become started. The UNO panel is the first in a series of USB boards and it is orientation model for the Arduino stage 3 MQ-135 gas sensor.
MQ-135 gas sensor can be implementation to detect the smoke and other harmful gases including NH3, NOx, and alcohol.

Fig.1.Arduino UNO

3.3 Gas Sensor:

MQ-135 gas sensor is implemented to detect the smoke and other harmful gases. It has potential to detect different harmful gases including NH3, NOx, smoke and CO2. It has high sensitivity to Ammonia, Sulfide and Benzene steam. Other circuit components like LM393 analog comparator chip is used in this project. The MQ-135 uses a heating element. . The sensor conductivity increases with the increasing concentration of target pollution gas. MQ-135 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 The important features are long life span, low cost, simple driver circuit and good sensitivity to toxic gases. We use it to

Fig.2.Gas Sensor

3.4MLX90614ELF:

Infrared (IR) Temperature Sensor Module, the MLX90614ESF is an Infra-Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASIC are integrated in the same TO-39 can. Integrated MLX90614 is a low noise amplifier, 17-bit ADC and powerful DSP unit thus achieving high accuracy and resolution of the thermometer...The user can configure the digital output to be PWM. As a standard, the 10-bit PWM is configured to continuously transmit the measured temperature in the range of -20 to 120 °C, with an output resolution of 0.14.

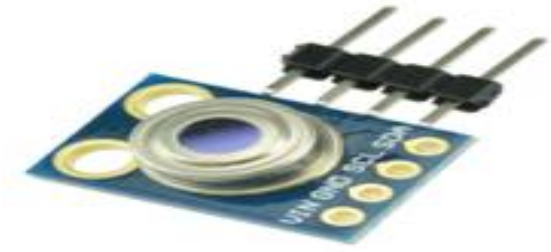


Fig.3.MLX9061ELF

3.5 DHT11 Humidity Sensor:

The DHT-11 Digital Temperature And Humidity Sensor is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed)..It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so in your code please use sensor reading interval at 2 seconds or more. Compared to the DHT22, this sensor is less precise, less accurate, and works in a smaller range of temperature humidity. But despite its disadvantages over DHT22, these humidity sensors will help us to measure the humidity around us. To know the humidity of the nature we are using the humidity sensor which also compares the actual input with the standard values (which are prescribed by the NQAI).

Fig.4.DHT11 Humidity Sensor

3.6Arduino A-B Cable (0.5m):

Standard USB 2.0 cable is used to connect ArduinoUno, Genuino Uno, Genuino Mega 2560, Genuino 101 or any board with the USB female A port of our computer. Cable length is approximately 50cm.

3.7 Jumper wire:

A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering These jumper wires are used as connection between the arduino board and the different sensors that are being used in this project.

3.8Alarm:

This will acts as feed back to the system, whenever the sensor senses the value which is greater than the prescribed value it immediately send an alarm signal,

thus helping the people to understand the consequences.

4.CIRCUIT DIAGRAM

I connect the ESP8266 with the Arduino. ESP8266 runs on 3.3V and connect the VCC and the CH_EN to the 3.3V pin of Arduino. The RX pin of ESP8266 works on 3.3V and it communicate with the Arduino when I connect it directly to the Arduino. So, I have to make a voltage divider for it which convert the 5V into 3.3V. This can be done by connecting three resistors in series like I did in the circuit. Connect the TX pin of the ESP8266 to the pin 8 of the Arduino and the RX pin of the esp8266 to the pin 9 of Arduino. ESP8266 Wi-Fi module gives my projects access to Wi-Fi or internet. Then I connect the SENSOR NETWORK 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 7 of the Arduino which start to beep when the condition becomes true. In last, I connect LED BOARD with the Arduino. The connections of the LED BOARD are as follow Connect pin VCC to the 5V of the Arduino; Connect pin GND to the GND of the Arduino; Connect pin RS to the pin 12 of the Arduino; Connect pin RW & GND (Read/Write) to used Jumper pin; Connect pin E to the pin 11 of the Arduino; The following four pins are data pins which are used to communicate with the Arduino; Connect pin D4 to pin 5 of Arduino; Connect pin D5 to pin 4 of Arduino; Connect pin D6 to pin 3 of Arduino; Connect pin D7 to pin 2 of Arduino.

5. OBJECTIVES

The air quality monitoring program design dependent upon the monitoring specific objectives specified for the air quality management in the selected area of interest. Defining the output influence, the design of the network and optimize the resources used for monitoring. It also ensures that the network is specially designed to optimize the information on the problems at hand. There might be different objectives for the development of the environmental monitoring and surveillance system. Normally, the system has to provide on-line data and information transfer with a direct automatically on-line quality control of the collected data. Several monitors, sensors and data collection systems need to be applied to make on-line data handover and control. The main objectives stated for the development of an air quality measurement and surveillance program might be to facilitate the background concentration(s) measurements, monitor current levels as a baseline for assessment, check the air quality relative to standards or limit values, detect the importance of individual sources, enable comparison of the air quality data from different areas and countries, collect data for the air quality management, traffic and land-use planning purposes, observe trends (related to emissions).

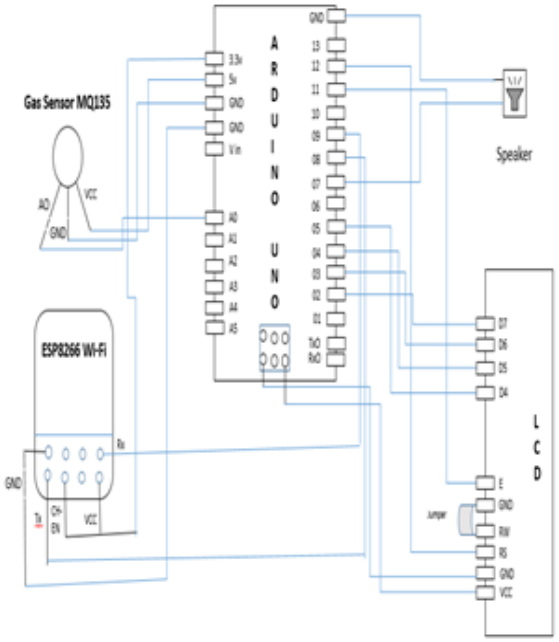
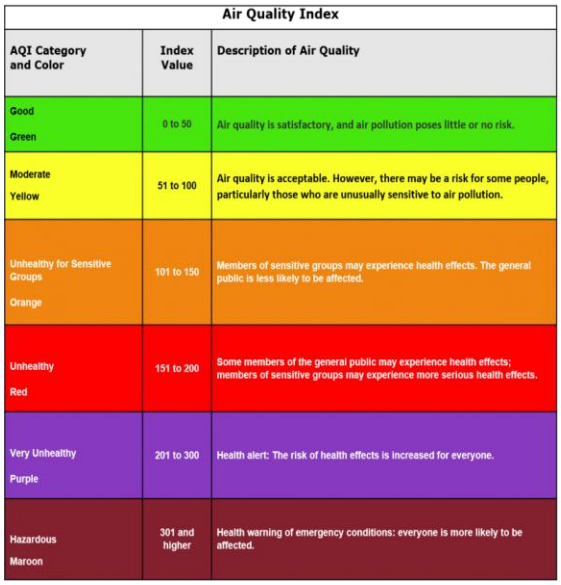


Fig.3 Circuit Diagram

4. NECESSITY OF AIR MONITORING

Depending on where you live, your age, sensitivity to airborne constituents and other factors, the air quality index (AQI) could be something that you monitor frequently. It is important to note that allergy levels are measured and reported separately from the AQI. For allergies, airborne biological particles are usually monitored by particle impaction (surface collection) and microscopic examination. In this case, different monitoring stations provide regional-scale measurements for aeroallergen (airborne substances that cause allergy level.



Air Quality Index		
AQI Category and Color	Index Value	Description of Air Quality
Good Green	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Moderate Yellow	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups Orange	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Unhealthy Red	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy Purple	201 to 300	Health alert: The risk of health effects is increased for everyone.
Hazardous Maroon	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Fig.4 Air Quality Index

7. ALGORITHM & WORKING PROCESS

I have connected the SENSOR NETWORK gas sensor and ESP8266 Wi-Fi device 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. We connected a buzzer to the pin 7 of the Arduino which start to beep when the condition becomes true. The SENSOR NETWORK sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2 and some other gases, so it is faultless gas sensor for our Air Quality Observing Detection Project. When connected it to Arduinoit senses the gases, and I get the Pollution level in PPM (parts per million). SENSOR NETWORK gas sensor gives the output in form of voltage levels and I need to convert it into PPM. Sensor is giving us value of when there is no gas near it and the safe level of air quality is 0.5 PPM and it is not exceeding 0.5 PPM. When it exceeds the limit of 0.5 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air and if exceeds beyond 1 PPM then it can cause increased heart rate and many other diseases. When the value is being less than 0.5 PPM, then the LED BOARD and serial monitor is displayed “Fresh Air”. Whenever the value is increased PPM, then serial monitor is displayed “Poor Air, Open Windows”. If it is increased 1 PPM, then the buzzer is kept beeping and the LED BOARD is displayed “Danger! Move to fresh Air”. After uploading the code, I am connected to the Wi-Fi of my ESP8266 device, the serial monitor has opened. If I have typed mentioned IP address in my browser, it is shown the output as below. I have to refresh the page again if I want to see the current Air Quality Value in PPM. After uploading code, the value is being less than 0.5 PPM, then the LED BOARD and Web Browser is displayed “Fresh Air”. After uploading code, the value is increased 0.5 PPM, then the LED BOARD and web browser are displayed “Poor Air, Open Windows”. After uploading code, When the value is increased 1.00 PPM then the buzzer is kept beeping and the LED BOARD and Web Browser are displayed “Danger! Move to fresh Air”.

8. RESULT

Our LED will represent the real time readings of Humidity, temperature, Ch4, PM10,O3 and help us to know the present air quality of the surrounding and will warn us if the air quality is lesser than the prescribed value.The below table shows the Air Quality Index and related health problems. The same is reflected in our LED Board with the predefined standards. Here the live data is compared with the predefined data which will further analyzed by the system. Further the system checks on which category the Air quality range falls and corresponding result is printed on the LED board as follows.

Air quality indicator range	Result	Health Impacts
0-0.5	Fresh Air	Minimal impact.
0.6-0.9	Poor Air	May cause minor breathing discomfort to few people.
1 to above	Danger Air	May cause breathing discomfort to those people with lung diseases such as asthma and discomfort to people with heart disease, children and older people

Table.6.Result Analysis

9. CONCLUSION

We have developed an Arduino based air pollution detector which is a very effective air pollution monitoring system. Based on the performance we can say that it is easy to use, and functionality is

comparable to the expensive existing air pollution detectors. It is a microcontroller based portable system. It is efficient and user friendly air quality detection system.With the use of sensors technology enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this paper. Here, using the SENSOR NETWORK gives the sense of different type of dangerous gas and Arduino is the heart of this project. Which control the entire process, Arduino module connects the whole process to LED BOARD and serial monitor is used for the visual Output.

10. FUTURE SCOPE

The future scope is that device which we are having can be done in a compact way by reducing the size of the device for further implementation or the modifications which can be is thatdetecting the vehicles amount of pollution which can be determined. In future the range can be made increased according to the bandwidth for the high range frequencies. Further research can be made by making the people in the right direction for their welfare. Therefore, there is another beneficiary by using this device in an app so the all can be used in an GSM mobile phone for their daily updates by increasing their range.

REFERENCE

[1] Ch.V.Saikumar, M.Reji, P.C.Kishoreraja, “IOT Based Air Quality Monitoring System”, International Journal on Information Theory (IJIT), Vol-117, No.-9, 2017;

[2] RiteekaNayak, Malaya RanjanPanigrahy , Vivek Kumar Rai and T AppaRao “IOT based air pollution monitoring system”, International Journal on Information Theory (IJIT) Vol-3, Issue-4, 2017;

[3] Poonam Pal, Ritik Gupta, SanjanaTiwari, Ashutosh Sharma, “Air Pollution System Using Arduino”, International Journal on Information Theory (IJIT), Vol-04, Issue-10, 2017;

[4] D.Arunkumar, K.Ajaykanth, M.Ajithkannan, M.Sivasubramanian, “Smart Air Pollution Detection And Monitoring Using IoT”, International Journal on Information Theory (IJIT) Vol-119, No.-15, 2018;

[5] Shanzhi Chen, HuiXu, Dake Liu, Bo Hu, and Hucheng Wang, “A Vision of IoT: Applications, Challenges, and Opportunities with China Perspective”, IEEE INTERNET OF THINGS JOURNAL, VOL.-1, NO.-4, August 2014;

[6] S. Chen, H. Xu, D. Liu, B. Hu and H. Wang, "A Vision of IoT: Applications, Challenges, and Opportunities with China Perspective," in IEEE Internet of Things Journal, Vol-1, No.-4, 2014;

[7] Ms. SarikaDeshmukh, Mr.Saurabhsurendran and Prof.M.P. Sardey, “Air and Sound Pollution Monitoring System using IoT” International Journal on Information Theory (IJIT), Vol-5, Issue-6, 2017;

[8] NavreetinderKaur,RitaMahajan and Deepak Bagai, “Air Quality Monitoring System based on Arduino Microcontroller”, International Journal on Information Theory (IJIT), Vol.-5, Issue-6, June 2016;