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Air Quality Monitoring over Internet using IOT

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Abstract *— The level of pollution has increased with times by 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. Objective of this paper is to design and implement a system for air quality monitoring using Internet of Things called as IoT. It will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient number of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3 and NOx. It will show the air quality in PPM on the LCD and as well as on webpage so that air pollution can be monitored very easily. This study measures real-time temperature, Air Quality Index. Monitored data is wirelessly transmitted to a server. When the sensor node reads pollutant gases composition, temperature and it will be displayed on the website.*

Keywords *— Air Pollution, Arduino Uno, IOT, MQ-135 Sensor, Smart City*

I. INTRODUCTION

Air is getting polluted because of release of toxic gases by industries, vehicle emissions and increased concentration of harmful gases and particulate matter in the atmosphere. The level of pollution is increasing rapidly due to factors like industries, urbanization, increasing in population, vehicle use which can affect human health. Particulate matter is one of the most important parameters having the significant contribution to the increase in air pollution. Air pollution has become major problem for every nation, whether it is developed country or developing country. Health issue have been growing rapidly especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of air pollutants. Adverse effects of pollution can cause allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma.

This creates a need for measurement and analysis of real-time air quality monitoring so that appropriate decisions can be taken in a timely period. Air Pollution Monitoring System monitors the Air quality over a web server using internet and will activate an alarm when the air quality goes down beyond a certain threshold level, means when there is sufficient number of toxic gases present in the air like CO2, smoke, alcohol, benzene, NH3, LPG and NOx, temperature using MQ 135, MQ 6 and LM35 sensors. It will show the air quality in PPM (Parts Per Million), and temperature (degree centigrade) on the LCD and as well as on web page so that it can monitor it very easily.

It is necessary to supervise air quality and keep it under control for a superior future and healthy living for all. Due to resilience and low-cost Internet of things (IoT) is getting popular day by day. With the Industrialization and with the increase in the vehicles on road the atmospheric conditions have considerably affected. Adverse effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. Monitoring gives measurements of air pollutant, which can then be resolved interpreted and presented. This information can then be applicable in many ways. Testing of monitoring data allows us to assess how bad air pollution is from day to day.

II. LITERATURE REVIEW

Some of the existing methodologies for the air pollution monitoring are described as below, in plug and sense device method, it Uses multiple sensors with location co-ordinate, AQI LED indicator is actuated as per pollution level and the Real time pollution level visualized using line graph [1].

In distributed sensor data computing, it uses distributed intelligence for the sensor nodes and uses spatial database for locations [2]

In Arduino based method it uses MQ series sensor devices for data, Uses GPRS GSM SIM module or WIFI module for connection to server, Uses Node.js and Node RED for displaying data on the server side [3].

In ZigBee technology, ZigBee transmitters and receivers are used, GPS module is used for locations for pollution level on map [4].

In order to monitor in this project, we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient number of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3. 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 [5].

The system will show the air quality in PPM and temperature in degree centigrade on the LCD and as well as on webpage so that it can be monitored very easily. LPG gas is detected using MQ6 sensor and MQ135 sensor is used for monitoring Air Quality as it detects most harmful gases, LM35 sensor is used for temperature monitoring and can measure their amount accurately [6].

III. METHODOLOGY

A. Components

1. MQ 135 Gas Sensor

The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2 and some other gases. It gives the output in form in voltage levels which are further converted into PPM (parts per million).

2. MQ 6 Gas Sensor

MQ-6 sensor is a simple-to-use liquefied petroleum gas (LPG) sensor, suitable for sensing LPG (composed of mostly propane and butane) concentrations in the air. The MQ-6 can detect gas concentrations anywhere from 200 to 10000ppm.

3. LM 35 Temperature Sensor

The LM35 is precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It can be used with single power supplies, or with plus and minus supplies.

4. Arduino UNO R3

Arduino Uno is a microcontroller board based on the ATmega328P It has 14 digital input/output pins 6 analog inputs, a 16 MHz quartz crystal, a USB Connection, power jack, an ICSP header and a reset button as shown.

5. SIM Module

Modulates and demodulates the signals from the Wireless Network and allows connection of circuit with internet so that air quality can be monitored on IOT web page website.

6. 16X2 LCD Display

This is a basic (16x2) 16 character by 2-line display. Black text on Green background. It is used to indicate the Air quality and temperature.

7. Breadboard

The purpose of the breadboard is to make quick electrical connections between components like resistors, LEDs, capacitors, etc. So that you can test your circuit before permanently soldering it together

8. Piezo Buzzer

A Buzzer or beeper is an audio signaling device. Whenever the air pollution or temperature goes above the threshold level the Buzzer starts beeping indicating Danger.

9. LED's

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. LED is used like buzzer for beeping light indicating danger.

10. Software Requirements

Arduino 1.6.13 Software

Embedded C Language

B. Block Diagram

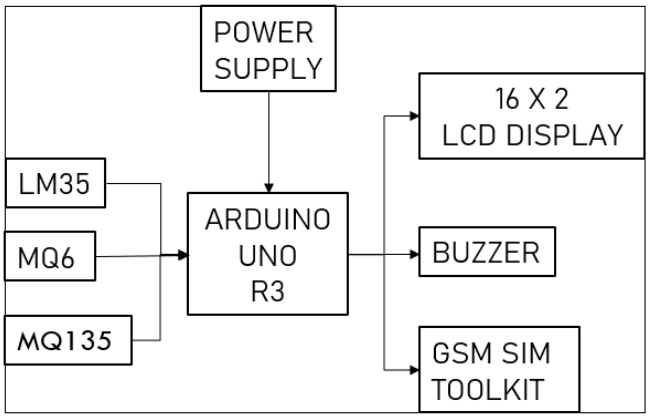

Fig. 1. Block Diagram

C. Working

Proposed Air Pollution Monitoring System is based on the block diagram as shown in Fig.1. The data of air is recognized by MQ135 gas sensor and MQ6 LPG gas sensor. The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2. So, it is dynamic gas sensor for our Air pollution Monitoring system. Temperature is sensed using LM35 sensor When it will be connected to Arduino then it will sense all gases, and it will give the Pollution level in PPM (parts per million). MQ135 gas sensor will give the output in form of voltage levels and we have to convert it into PPM. So, for converting the output in PPM, we have used a library for MQ135 gas sensor and MQ6 sensor and this data will be displayed on LCD display and on website. The ionized constituents are detected by the sensing element, which creates a potential difference thus giving output in the form of current. The concentration of the gas detected is then send to the IOT web page. Arduino is an open-source micro-controller which is used with other communication and sensing technologies. This single-board development environment allows user to read uploaded data from sensors and allows to control different devices. Sensor is giving us value of 85 when there is no gas near it and the air quality safe level is 100 PPM and it should not exceed 150 PPM. When it will exceed the limit of 150 PPM, it will cause Headaches, sleepiness and stagnant, stuffy air. When the value will be less than 100 PPM, then the LCD and webpage will display "Fresh Air". When the value will increase from 150 PPM, then the buzzer will start beeping and the LCD and webpage will display "Poor Air". And when

it will increase above 200, system will give an alert message and the LCD and webpage will display "Danger". AQI (Air Quality) Index is shown in Fig. 2.

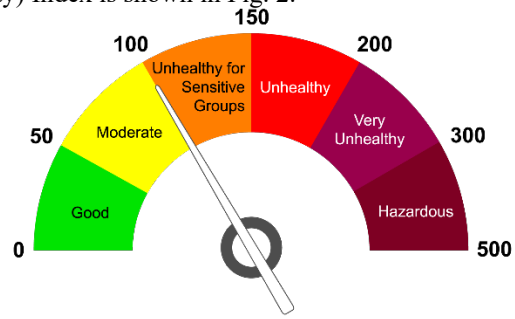

Fig. 2 Air Quality Index.

IV. Results and Discussions

The system to monitor the air of environment using Arduino microcontroller, IOT Technology is proposed to monitor quality of air. In factories or high traffic area where the emission is higher and affect many people, in developing countries and in places where the air quality is very poor an can be a health hazard by alerting the people to threatening levels of these realized pollutants. Here, we are using the MQ135 and MQ6 gas sensors giving the sense of different type of dangerous gas and Arduino is the heart of this project, which control the entire process. Results from project are shown in Fig. 3.1, 3.2, 3.3.

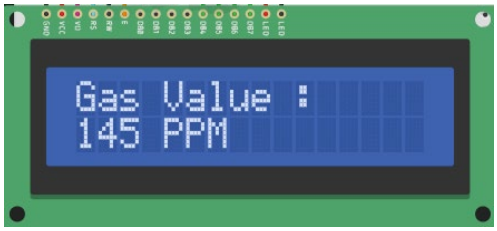

Fig. 3.1 Screenshot of LCD display from our Project displaying Air Quality value.

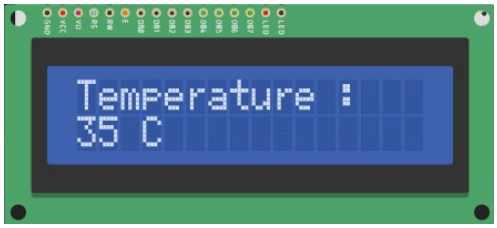

Fig. 3.2 Screenshot of LCD display from our Project displaying Temperature value.

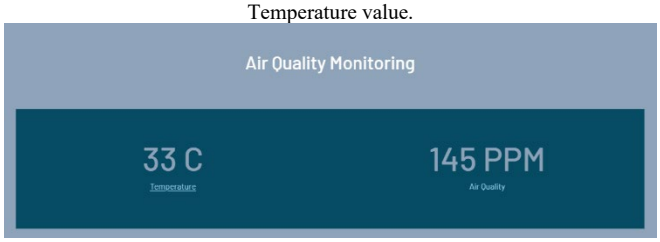

Fig. 3.3 Screenshot of Web Page from our Project displaying Temperature and Air Quality value.

V. Apendix

A. Figures and Tables

Fig 12 and 14 show (Rs/Ro) Vs PPM graphs for MQ 6 and MQ 135 sensors respectively, where Ro is sensor resistance 100 PPM of NH_3 in clean air and Rs is sensor resistance at various concentration of gases. First, we need to calibrate the sensors by finding the values of Ro in fresh air and then use that value to find Rs using formula:

$$Rs = (V_C/V_{RL}-1) * R_L \text{ [7]}$$

LM35 sensor can measure temperature from -55^{0}C to 150^{0}C, Output voltage is directly proportional to temperature (i.e.) there will be rise of 10mV (0.01V) for every 1^{0}C rise in temperature [8].

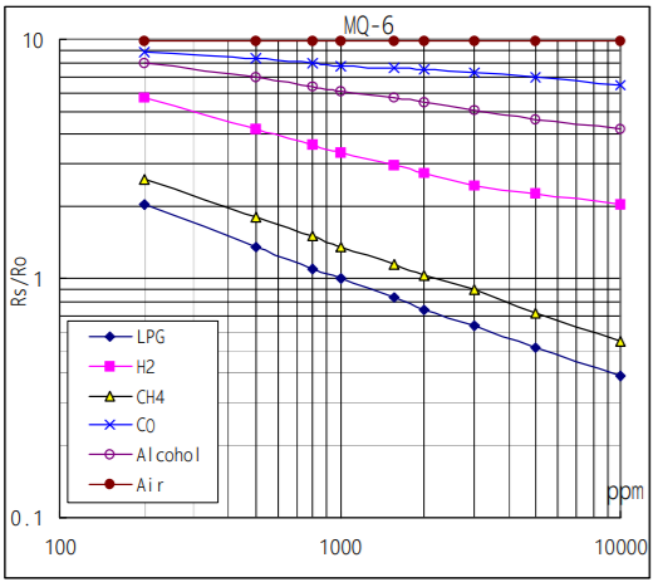

Fig. 4 Sensitivity Characteristics of MQ6 Sensor.

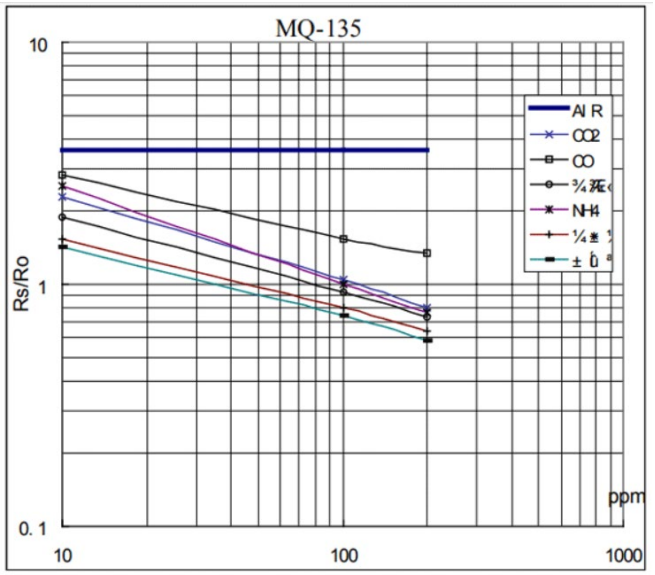

Fig. 5 Sensitivity Characteristics of MQ135 Sensor.

VI. LIMITATIONS

However, there are not many limitations to our project but few limitations to our project are:

1. Accurate measure of contaminating gases cannot be detected in PPM.
2. Humidity should be less than 95%.
3. 3 sensors are used.

VII. FUTURE SCOPE

1. Interface a greater number of sensors to know details content of all gases present in air.
2. Interface memory card to store data.
3. Interface GPS Module to monitor the pollution at exact location and upload on the webpage.
4. Design server using IOT and upload data on that server with data and time.
5. To set a danger limit on that server and inform the concerned authorities to take further actions.
6. To make this data available for everyone.
7. This model can be further expanded to monitor the developing cities and industrial zones for pollution monitoring.

VIII. CONCLUSION

Air quality is a basic issue that clearly impacts human prosperity. Air quality data are accumulated remotely from sensors. The smart way to monitor environment and an efficient, low-cost embedded system is presented in this paper. In the proposed architecture functions of different sensors and components are discussed. The proposed system is developed for indoor air quality monitoring remotely.

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[7] MQ6 and MQ135 Sensor Datasheets.

[8] LM35 Sensor Datasheet.

[9] Fig. 4 – MQ 6 Sensor Datasheet

[10] Fig. 5 – MQ135 Sensor Datasheet