Air quality monitoring and assessment using IoT

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Abstract

Air pollution is both an environmental and a social problem, which affects human health, the ecosystem, and the climate. Air pollution is one of the largest environmental health risks. Quality of the air is the most important factor that directly causes diseases and decreases the quality of life. The development of air quality monitoring system will capture the amount of major pollutant and corresponding sources at appropriate level. These monitoring systems are important components for monitoring the quality of air and for controlling the concentration of main pollutant in the urban areas. The internet of things is referred as the system of interrelated and internet connected objects, which is used to collect and transfer data. In order to monitor the pollution MQ135 sensor, GSM module is used for carrying out the research study in Sona College of Technology, Salem. The fundamental aspects of the proposed project are to reduce the cost of the infrastructure and enhance the data collection and dissemination to all stockholders.

Keywords: Air pollution, IoT, wireless sensors, Arduino Uno, pollutant classification.

1. Introduction:

IoT reveals that people are a source of data and in its second version, things or objects are creating data. It influences the computing and communication technology in the future. The vision of IoT makes the objects smarter for a better and easy world. The environmental data
sampled and transmitted in time to the data center by air quality monitoring [1]. Internet acts as a backbone to IoT to connect with heterogeneous elements. IoT has many applications in various domains like Smart Cities, Smart Homes, IoT in transportation, IoT in Industries, Public Safety etc. This system will show the gases present in the atmospheric air and their purity there off. The system can be implemented in any kind of places like industries and houses, where the gases are mostly to be found across the threshold limit, the system gives an alert message. An alteration of air quality, which is characterized by the contents of chemical, biological or physical pollutants in the air, is called air pollution. The quality of air is indicated by air quality index[5]. Air pollution is mainly impacting the process of plant evolution by preventing photosynthesis, which leads to serious consequences in the purification of the air we are breathing in. 'Criteria air pollutants' is one of the terms used to describe air pollutants, which are the indicators of air quality. The regulations are based on criteria, which are related to health and environmental effects.

| Name of the gas     | Safe level     | Unsafe level               |
|---------------------|----------------|----------------------------|
| Carbon dioxide      | 250 to 350 ppm | Greater than 1000-2000 ppm |
| Carbon monoxide     | 50 ppm         | Greater than 101 ppm       |
| Nitrogen dioxide    | Less than 5 ppm| Greater than 5 ppm         |

Table 1: Air quality standards

In this paper, authors have made a study on survey of controlling the pollution, quality of air, the reminder of paper: In section 2, an overview of system requirement like Arduino UNO, sensors. In section 3, explanation has been given for the result obtained from experiment. At the end of the document, a brief conclusion about this paper is given in section 4.
2. Components of system

Hardware requirement

2.1 Arduino Uno
Arduino UNO is developed by Arduino.cc which is an open source microcontroller board which is completely based on the microchip ATmega328P. It can detect the surroundings of the input.

Features
Its needs an operating voltage of 5v. The flash memory of the Arduino is 32 KB. It has an analog i/p pins that are 6.

2.2 Breadboard
A breadboard is a construction base, which is used for the prototyping of electronics. It is easy to create temporary prototypes and experimenting with circuit design.

Features
Breadboard dimensions are 6.5*4.4*0.3 inch. It has a withstanding voltage of 1,000V AC / 1 minute.

2.3 Light-emitting diode(LED)
When current flow through the semiconductor light source, it emits light. The energy required for electrons to cross the band gap of the semiconductor determines the colour of the light.
Features

The LEDs are durable against impact and vibration. They are extremely efficient low energy light sources.

2.4 LCD (liquid crystal display)
This is a basic (16x2) 16 character by a 2-line display, which has green text on black background. It is used to indicate the Air and its quality in PPM.

Features

Every character can be build with a 5×8-pixel box. These are obtained in Blue & Green Backlight.

2.5 MQ135 gas sensor
The MQ135 sensor is used in the air quality monitoring system. It can sense NH3, NOx, alcohol, Benzene, smoke, CO2, and some other gases. It gives the output in the form of voltage levels.

Features

Wide detecting scope. It can be used as a digital or analog sensor.

2.6 Sim 900a gsm module
GSM modem is otherwise said as GSM module, which gives different type of output with the help of PCB, connected to the module. The SIM900 is a complete Quad-band GSM or GRPS solution in a SMT module.

Features

Single supply voltage: 3.4V – 4.5V. It sends a Short message service (SMS)

![Figure 2: Air quality monitoring system](image-url)
Software requirement

2.7 Arduino 1.6.13 software
It is a software which makes easy to write codes on board and upload it. It runs in windows, mac OS X, Linux.

2.8 Embedded C language
It is a generic term associated with the hardware architecture. It is an extension to C language.

2.9 Working principle
The quality of the air is recognized by the MQ135 gas sensor. It can sense NH3, NOx, alcohol, benzene, smoke, CO2 and is effectively used in air pollution monitoring system. Once the MQ135 sensor is connected with the Arduino, it will sense all the gases and pollution level in ppm (parts per million). The sensor MQ135 will give us the output in the form of voltage V/m which is converted into ppm. That conversion will be made only if the library for MQ135 gas sensor is installed. In the absence of gas, the area will show us the value 90, whereas the air quality safe level is 1000 ppm, once it exceeds the level of 1000 ppm, the gas will cause headache, sleepiness, stuffy air, etc.

If the gas level exceeds 2000 ppm, it will cause increased heart rate and many other diseases. When the gas level is less than 1000 ppm, the OLED which is connected with the system will display as “Fresh Air” and the LED lights which is connected will be in “off” position. In the meantime, an alert message will be sent to the mobile phone as “Fresh Air” with the help of a GSM module installed in the system. When the gas level exceeds 1000 ppm, the LED starts glowing and the OLED display as “Poor Air”. When the level exceeds beyond 2000 ppm, the LED keeps glowing and an alert message with the content “Poor Air” and the quality of the polluted air in ppm will be sent to the mobile. OLED and LED are the output devices. OLED shows the data of the gas level in ppm and LED glows when the ppm exceeds the threshold limit. This is the working principle of this type of air quality monitoring.

2.10 Applications and advantages
The applications of air quality monitoring system includes Indoor air quality monitoring, which is used to check the quality of air present indoor and outdoor quality monitoring which also helps in controlling the pollution for the quality of air. It can be used safety monitoring system in the indoor spaces[4]. The Roadside pollution monitoring which helps to control pollution in roads. Industrial perimeter monitoring which is been used in industries where most of the gases are to be found and controlled. And this makes the data visible even to the common man who are in need of it. Air quality monitoring is basically in expensive to operate and easy to use based on passive samplers [2]. This kind of Sensors are easily available. Low cost air quality sensors cannot be used for regulatory purposes even though there are many number of useful applications are there for this low cost tools[7][9]. These have a long lifetime and are less in cost. It gives out visual outputs and Continuous update of change in percentage of quality.
3. Results

Air quality monitoring is a device that is operated with the help of MQ135 gas sensor and a software called Arduino. Arduino UNO is kind of a CPU and it has a microcontroller in which the Arduino program which is feed is getting stored. Voltage applied to the Arduino board is 5v and the voltage is supplied to Arduino with the USB connecter present in it. To the Arduino MQ135 sensor is connected to verify the purity of the air. The sensor has a copper inside it and so it sense restlessly since it does not have a on and off keys. The sensor gives the value continuously but as the program that is given to Arduino displays the reading in the LCD and mobile only after storing five values to itself and display us the average of the five readings. The values displayed is visible in LCD since we have connected the LCD to the Arduino UNO with the help of breadboard. Just getting the values in ppm in LCD is the first step that we have done. It shows the quality of air around us and the measurement of the quality in ppm.

Using this we have checked the quality of air in the college campus of different blocks. We used to take the device to the certain place and we get the reading. But this type of monitoring system helps us get the information without our presence which results in sending text messages to our mobile phone when needed to know the status of air in a particular place. For this we have used GSM module. In that we have sim plate, the sim is placed there and when the we need to know the range of air, we have to send a text message to the sim inserted to the sim plate and we get the result message when the requested message is collected by the antenna. This GSM module gets the data from the microcontroller that is present in the Arduino and sends it to our mobile as a text message. Result obtained in the end of the experiment is the amount of polluted air in our environment which is displayed in ppm. We get a text message from the GSM module which is connected to the device. The text message not only gives us the amount or the quality of the air it also says the status of air whether it is fresh or poor in quality. We can also get to know the reading or the quality of air through the LCD.
4. Conclusions

This paper is about a Wired Sensor Network (WSN) based air quality monitoring system using IoT and gas sensors MQ135. It is a very simple system as compared to other existing air quality monitoring systems. Usually Changes in pollutant level are responded in a very slow process by sensor, causing pollutant strikes[6]. The systems is low in cost with low consumption of power, compact, and result in a high level of accuracy. It will be used to monitor the environment with remote-friendly sensors. Basically indoor air quality is two to five times higher than that of outdoor air quality. Usage of more chemical households and fresheners for air results in degrading the quality of indoor air[3]. Many solution have been proposed to find out the pollutant with the use of mobile which has sensors of low cost[8][MAQS][10]. This project can also be used for pollution monitoring purposes in all the places. In future, this kind of prototypes can extend to real-time implementations in urban cities and Furthermore air pollutants can be found.

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