IoT Air Pollution Monitoring System using Arduino

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Abstract – *Air pollution is a growing issue these days. It is necessary to monitor air quality and keep it under control for a better future and healthy living for all. Here we propose an air quality monitoring system that allows us to monitor and check live air quality in a particular area through IOT. System uses air sensors to sense presence of harmful gases/compounds in the air and constantly transmit this data to microcontroller. Also system keeps measuring sound level and reports it to the online server over IOT. The sensors interact with microcontroller which processes this data and transmits it over internet. This allows authorities to monitor air pollution in different areas and take action against it.*

***Key Words*: IOT, SENSORS**

1. INTRODUCTION

Air pollution is the biggest problem of every nation, whether it is developed or developing. Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants. Harmful 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. According to a survey, due to air pollution 50,000 to 100,000 premature deaths per year occur in the U.S. alone whereas in EU number reaches to 300,000 and over 3,000,000 worldwide. Various kinds of anthropogenic emissions named as primary pollutants are pumped into the atmosphere that undergoes chemical reaction and further leads to the formation of new pollutants normally called as secondary pollutants. For instance, according to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), nearly all climate-altering pollutants either directly or indirectly (by contributing to secondary pollutants in the atmosphere) are responsible for health problems. Almost every citizen spends 90% of their time in indoor air. Outdoor air quality of the cities of developed countries improved considerably in recent decades. In contrast to this, indoor air quality degraded during this same period because of many factors like reduced ventilation, energy conservation and the introduction to new sources and new materials that cause indoor pollution. The design of buildings for lower power consumption resulted in decrease of ventilation which further decreases the quality of air inside the building. This increases the need for indoor air quality (IAQ) monitoring Due to this fact and use of new building materials, IAQ often reaches to unacceptable levels.

Present innovations in technology mainly focus on controlling and monitoring of different activities. These are increasingly emerging to reach the human needs. Most of this technology is focused on efficient monitoring and controlling different activities. An efficient environmental monitoring system is required to monitor and assess the conditions in case of exceeding the prescribed level of parameters (e.g., noise, CO and radiation levels). By using embedded intelligence into the environment makes the environment interactive with other objectives, this is one of the application that smart environment targets.

1.1 MQ135 SENSOR

The Sensitive material used in MQ135 sensor is SnO_2. 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 CO_2. 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. MQ 135 gas sensor is widely used in industrial gas alarm, portable gas detector and domestic gas alarm as shown in Fig.1. MQ-135 is used for monitoring CO_2 in air.

Specifications of MQ-135 gas sensor

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life Simple drive circuit
- Used in air quality control equipment for buildings/offices, is suitable for detecting of NH_3, NOx, alcohol, Benzene, smoke, CO_2, etc.
- Size: 35mm x 22mm x 23mm (length x width x height)
- Working voltage: DC 5 V
- Signal output instruction.
- Dual signal output (analog output, and high/low digital output)
- 0 ~ 4.2V analog output voltage, the higher the concentration the higher the voltage.

Fig 1. MQ135 Sensor

1.2 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 as shown in Fig.2. 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.

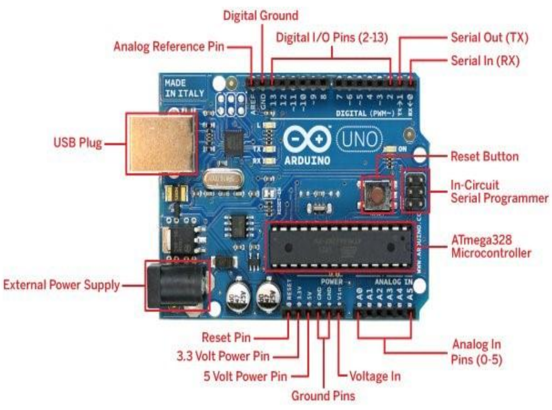

Fig 2. Arduino Microcontroller

1.3 ESP8266 Wi-Fi Module

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box). The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF part. There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support.

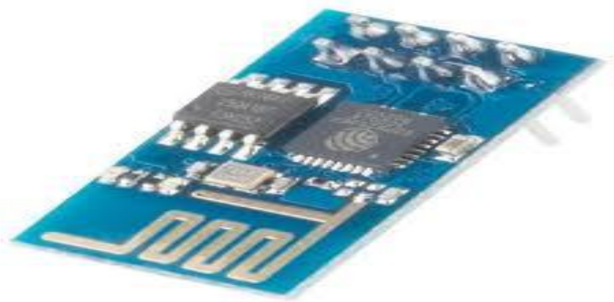

Fig 3 ESP8266 wifi module

1.4 LCD Display 16x2

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. The data register stores the data to be displayed on the LCD.

Fig 4: Liquid Crystal Display

1.5 ARDUINO COMPILER

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

2. LITERATURE REVIEW

Dias, M. J. et al proposed 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. The values of these parameters are transmitted by using Zigbee Pro (S-2) to a base station where they are being monitored. The value of temperature and humidity are transmitted over Bluetooth also so that every person in the range of the system can check it over their smart phones and laptops as these parameters hold importance to everyone. CO, a dangerous parameter is monitored with an extra precaution. A text message is sent to the base station through GSM module whenever its volume exceeds a particular safe limit intended for a particular application. [1].

In the research study proposed by Al-Haija, Q. A., Al-Qadeeb, H., & Al-Lwaimi, A,we have used an innovative approach to using CanSat to test the air quality, specifically, the presence of poisonous CO gas, at various urban locations across the city of Sharjah. A CanSat is a simulation of a real satellite, integrated within the volume and shape of a soft drink can. The payload of the CanSat used in this project consists of a GPS sensor, an Ardusat space board (which includes sensors for temperature, infrared, luminosity, magnetometer, accelerometer, and a gyroscope), an air quality sensor detection module and a carbon monoxide gas sensor module. The data collection has been performed in different areas considering the type of road vehicles associated with that particular area such as large trucks/trailers in an industrial area, school buses in schools' area, etc. Data collection may also vary from rush hours to regular traffic hours. Results show that the concentration of CO_2/CO is significantly higher in rush hours. In general, the measured air quality near congested roads is much worse compared to an area away from main traffic roads. Also, the altitude-based presence of CO_2/CO, after their release from the road vehicles, has also been recorded and analyzed.[2]

3. METHODOLOGY

In this section we discuss about the interfacing of components and working of the whole system.

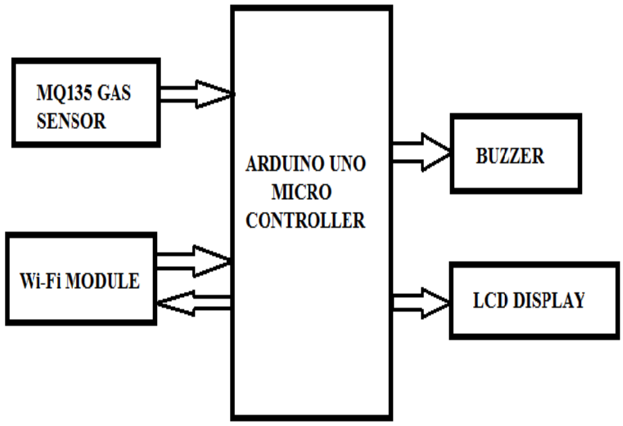

Fig 5. Block diagram

An **IOT Based Air Pollution Monitoring System** will monitor the Air Quality over a webserver using internet and will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient amount 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. The procedure for successful monitoring of air pollution is as follows:

- Firstly, MQ135 gas sensor is calibrated for the RZero value of the sensor. This is used in the header file of the MQ135 gas sensor for coding the sensor to give the PPM values.
- The appropriate Arduino code is uploaded to Arduino to initialize Wi-Fi module in order to communicate with Arduino so the transmission and receiving is accomplished.
- IP address of the webpage created using HTML programming is given as an input to Arduino code.
- The interfacing with Arduino is as shown in fig 6
- After interfacing the buzzer, MQ135 gas sensor and Wi-Fi module to Arduino, Run the Code on Arduino for verification and upload the same.

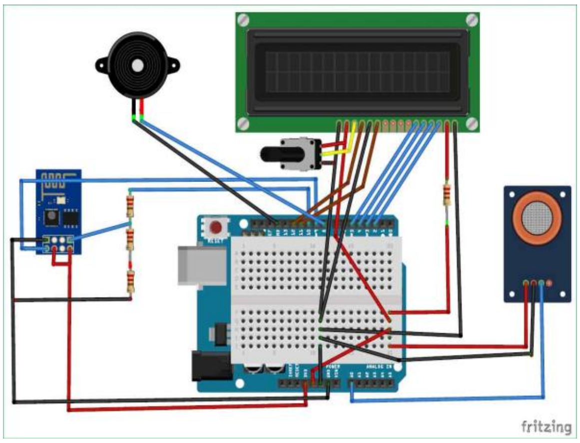

Fig 6: Connections of the Air Pollution Monitoring System

When the value is less than 1000 PPM, then the LCD and webpage will display "Fresh Air". Whenever the value increases to 1000 PPM, then the buzzer will start beeping and the LCD and webpage will display "Poor Air, Open Windows". If it increases to 2000 then the buzzer keeps beeping and the LCD and webpage will display "Danger! Move to fresh Air".

4. ADVANTAGES

- The measurements of pollution concentrations are the best characterization of the concentration of a given pollutant at a given time and location
- The data are supported by a comprehensive quality assurance program, ensuring good data of known quality

5. DISADVANTAGES

- For both gases and particulate matter, if several identical low cost systems are co-located, the user should expect a high level of repeatability ($R2 > 0.9$) and should expect to be able to adjust accuracy by 'calibrating' – adjusting slope and offset – against a co-located reference/equivalent station.

- Ozone is monitored daily, but mostly during the ozone season (the warmer months, approximately April through October)

6. CONCLUSION

This system includes the sensors that detect the parameters causing pollution. The sensors are carbon dioxide sensor. Whenever there is an increase in the level of these parameters the sensor senses the situation and an alarm or indication is given. The message is displayed in the LCD display. If the authority of the industry does not take any actions to minimize the emissions then the system takes certain actions to this. If carbon-dioxide rises above the threshold value then machines are terminated from working. Similarly if fire is detected then exhaust fans are turned on, if LPG and color change in liquids is detected the suitable actions are taken to overcome them. The system is operated through wireless system using the concept of IOT. The status of sensors of particular industry can be accessed anywhere from anyplace.

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