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IoT Based Air Quality Monitoring System

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Abstract : Air pollution has become a major environmental problem as air quality is deteriorating day by day. It causes serious harm to the human health and also to the other terrestrial organisms. Air is getting contaminated because of release of toxic gases by industries and particulate matter in the atmosphere. Therefore, it is quite necessary to constantly monitor the air quality. Internet of Things (IoT) is now a days considered to be a new technology finding profound use in each and every sector. With the help of this technology, we aim to propose and develop a real time air quality monitoring system which includes various parameters such as carbon monoxide, carbon dioxide, PM2.5, PM10, temperature and humidity by means of four sensors, respectively, MQ- 7, MQ-135, PMS5003 and DHT22. The system is equipped with the Arduino Uno microcontroller and Wi-Fi module that will allow data to be sent to a server in the cloud. The gathered data is accessible through an Android Application.

Keywords *– DHT22, ESP8266, Internet of Things, PMS5003, ThingSpeak.*

1. INTRODUCTION

Air pollution is increasing day by day. Various factors are responsible for air pollution such as poisonous gases from vehicles and industries and additionally particulate matter within the atmosphere. As the world's population is turning into more and more urban cities are struggling to stay liveable. Numerous health issues arising due to poor air quality like heart diseases, stroke, carcinoma, metabolism diseases as well as respiratory problems etc. According to the World Health Organization (WHO) every year nearly seven million deaths occurred due to the air pollution.

In recent years, air quality data is provided by government agencies in various forms like annual reports, surrounding reviews and subject specific analysis to aware the people. In India, on September 17, 2014, the National Air Quality Index (AQI) was launched in New Delhi.

AQI Category (Range)	PM_{10} (24hr)	$PM_{2.5}$ (24hr)	NO_2 (24hr)	O_3 (8hr)	CO (8hr)	SO_2 (24hr)	NH_3 (24hr)
Good (0–50)	0–50	0–30	0–40	0–50	0–1.0	0–40	0–200
Satisfactory (51–100)	51–100	31–60	41–80	51–100	1.1–2.0	41–80	201–400
Moderately polluted (101–200)	101–250	61–90	81–180	101–168	2.1–10	81–380	401–800
Poor (201–300)	251–350	91–120	181–280	169–208	10–17	381–800	801–1200
Very poor (301–400)	351–430	121–250	281–400	209–748	17–34	801–1600	1200–1800
Severe (401–500)	430+	250+	400+	748+	34+	1600+	1800+

Fig 1. Air Quality Index

In the current scenario, IoT is profoundly used in the pollution monitoring system, smart cities, e-health and so on. Internet of Things creates a global network of machines and devices that are capable of communicating and exchanging data with each other through the internet. IoT and Cloud computing are the most emerging technologies and IoT becomes very powerful when converges with cloud computing. The data stored at the cloud can be retrieved any time and scenarios can be analyzed in a better way.

Considering the complexities, operational difficulties and cost-efficiency this paper proposes an IoT based air quality monitoring system with a developed android app. The main contribution of this research is to develop a cost-efficient monitoring system that senses the real time data of surrounding various parameters such as temperature, humidity, carbon monoxide, carbon dioxide and PM level and alerts the people when the quantity of these parameters goes beyond a certain limit. It can be installed in homes, schools, hospitals, companies etc.

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2. SYSTEM ARCHITECTURE

2.1 Hardware Description

2.1.1 Arduino UNO

The Arduino is an open source microcontroller board which based on the microchip ATmega328P. The IDE Arduino is used to program the microcontroller. It allows to read data coming from sensors and Arduino IDE uses a simplified version of C++. In this research the Arduino platform has been used for building the hardware interface that interacts with web system.

2.1.2 ESP8266

The ESP8266 is a low cost Wi-Fi module. This Wi-Fi module is a self contained SOC with integrated TCP/IP protocal. ESP8266 allow any microcontroller to connect to the internet through a Wi - Fi connection. Moreover it has a powerful enough on board processing and storage capability.

2.1.3 MQ-7 Gas Sensor

The MQ-7 is a carbon monoxide coal gas sensor module which detects the concentration of CO in the atmosphere and gives analog output. This sensor can measure the concentration from 10 ppm to 1000 ppm. Also it provides both digital and analog outputs. Moreover, the threshold level for digital output can be easily adjusted using the present button on the board. MQ-7 sensor can operate in temperature between -10 to 50 degrees celsius and consumes less than 150 mA at 5 V.

2.1.4 MQ-135 Gas Sensor

The MQ-135 Gas Sensor can detect the concentration of various gases like Ammonia (NH3), Benzene (C6H6), Sulphur (S), Carbon dioxide (CO2), other harmful gases and smoke. This sensor has been used in this work to detect the concentration level of CO2 in the surrounding. It has a digital and analog output pin. The MQ-135 sensor module operates at 5V and consumes around 150 mA. It requires some preheating and it is quite inexpensive and stable.

2.1.5 DHT22 Sensor

DHT22 is used to measure the concentration of temperature and humidity. It has a moisture holding component sandwiched between two electrodes. The temperature is measured by a thermistor that work as a temperature dependent variable resistor. The operating voltage of DHT22 is 3-5 V. It can measure the temperature from -40 to 80 degree celcius and humidity from 0-100%.

2.1.6 PMS5003 Sensor

In this work, the PMS5003 sensor has been used for PM2.5 and PM10 measurements. The sensor uses laser light scattering principle to measure value of dust particles suspended in the air. Other characteristics of PMS5003 include the real time responses, high anti-interface performance etc.

2.2 Software Description

2.2.1 ThingSpeak

One of main goal of this research is to make real time data widely available to authenticated users. This is possible through the use of ThingSpeak, a web platform that enables users to store and analyze live data in the cloud. It works seamlessly with apps and interfaces.

2.2.2 Android Application

The app created is designed to fetch the data in real time form the ThingSpeak platform with the help of an API. The app displays the measured readings of various parameters in a chart format. User can easily sign in with an email or with google to see the real time concentration of parameter.

3. METHODOLOGY

The schematic block diagram of proposed system is shown in fig 2. The sensors are used for detecting different environmental parameters. The prototype is established using the Arduino Uno microcontroller. In this prototype we considered sensor MQ-7 which detect Carbon Monoxide (CO), sensor MQ-135 which measure the concentration of carbon Dioxide (CO2) in air, DHT22 sensor senses the temperature and humidity and PMS5003 is a PM sensor used for measuring the particulate matter i.e. PM2.5 and PM10 in our surrounding.

The output data from the sensors is then transmitted as input to Arduino Uno as processing unit and then dispatch this data to ThingSpeak cloud through ESP8266 Wi-Fi module.

ThingSpeak cloud is an open cloud platform on which data stored and recover via HTTP over the internet. The designed system display the status of concentration of pollutants of air quality through TFT LCD display. This data can also be obtained through a Android Application. The app is designed in such a manner that it get the data in real time from the ThingSpeak platform with the help of Application Programming Interface (API).When the concentration of parameters raises above the certain limit then the buzzer will start beeping and it will aware the people.

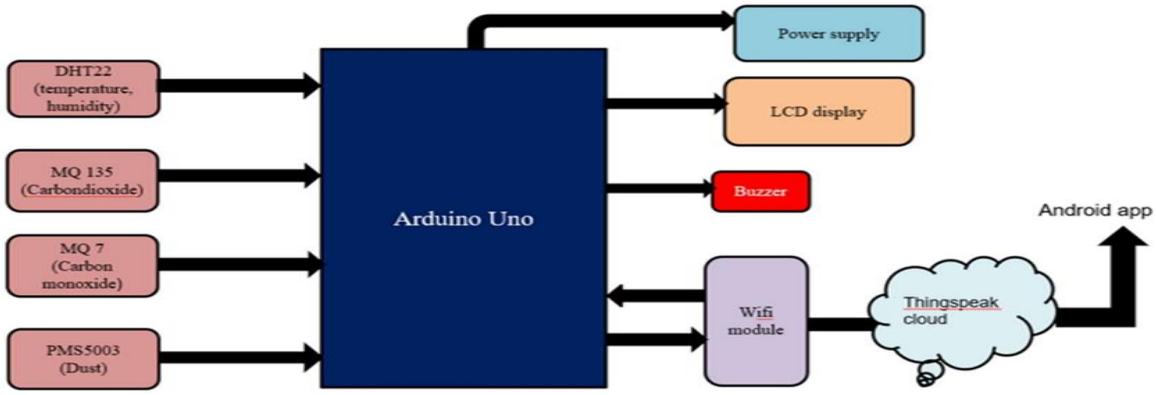

Fig 2. Schematic block diagram of proposed system

4. FLOWCHART

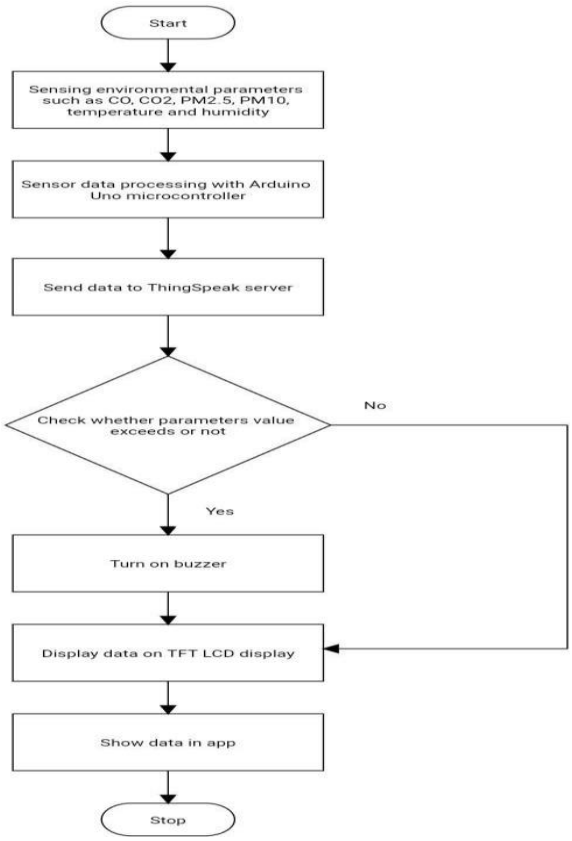

Fig 3. Flowchart

5. ALGORITHM

1) Start the operation
2) Sensor senses the environmental parameters
3) Sensor data processing with Arduino Uno Microcontroller
4) Transmit data to ThingSpeak using Wi-Fi module
5) If parameters value exceeds turn on buzzer and display values on the TFT LCD
6) If parameters value does not exceeds the data only show on the TFT LCD
7) User side android application display current status of environmental parameters
8) Stop

6. RESULT

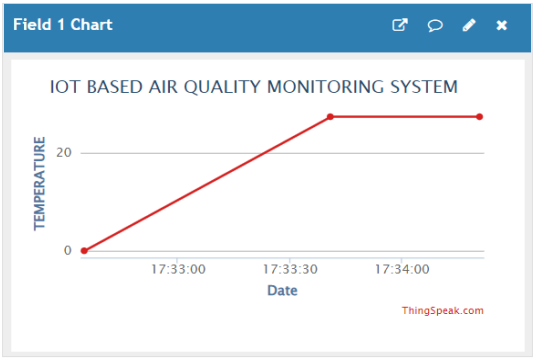

Fig 4. Temperature Graph

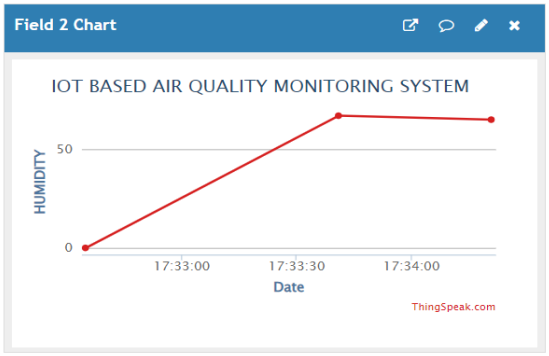

Fig 5. Humidity Graph

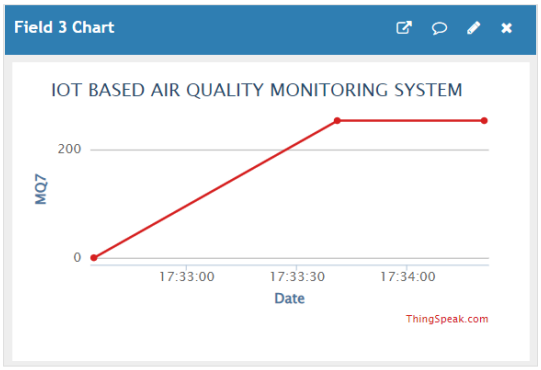

Fig 6. Carbon Monoxide Level Graph

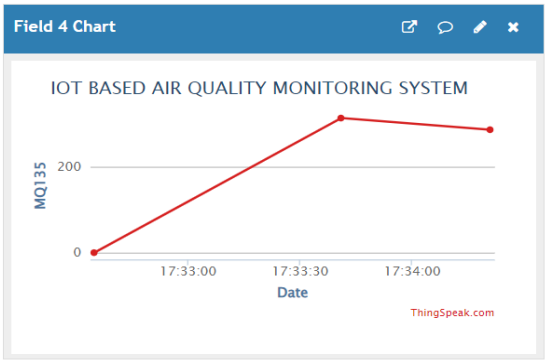

Fig 7. Carbon dioxide Level Graph

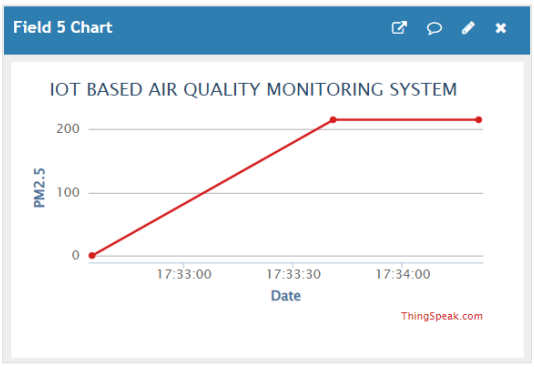

Fig 8. PM2.5 Level Graph

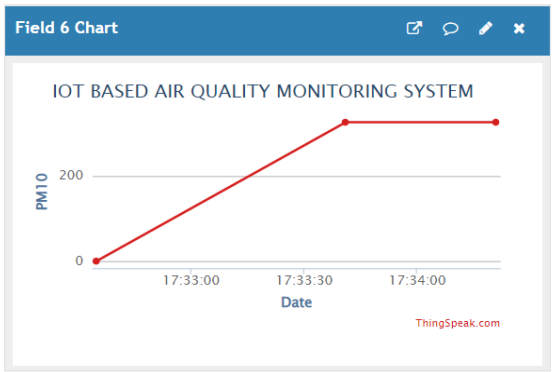

Fig 9. PM10 Level Graph

7. CONCLUSION

Air pollution contains adverse impact on people and our scheme. Thus we have proposed air quality observance system with the help of IoT. The system perpetually monitor the real-time data of surrounding numerous parameters like carbon monoxide, carbon dioxide, PM level, temperature and humidity and alerts the individuals once the amount of those parameters goes on the far side a definite limit. The key advantage of this system is that it is portable, small and cost-effective and consumes less power and it can be installed in hospitals, schools, companies, homes etc.

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