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REAL TIME AIR QUALITY MONITORING SYSTEM USING INTERNET of THINGS

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Abstract

Internet of things (IoT) is a worldwide system of "smart devices" that can sense and connect with their surroundings and other systems. Global air pollution is one of the major concerns of our era. Existing monitoring systems have inferior precision, low sensitivity, and require laboratory analysis. Therefore, improved monitoring system s are needed. To overcome the problems of existing systems, we propose a three-phase air pollution monitoring system. An IoT kit was prepared using gas sensors, Arduino IDE (integrated Development Environment), and a Wi-Fi module. This kit can be physically placed in various cities to monitoring air pollution. The gas sensors gather data from air and forward the data to the Arduino IDE. The Arduion IDE transmits the data to the cloud via the Wi-Fi module. If a user is traveling to a destination, the pollution level of the entire route is predicted, and a warning is displayed if the pollution level is too high. The proposed system is analogous to Google Traffic or Navigation application of Google Maps. Furthermore, air quality data can be used to predict future air quality index(AQI) levels.

Keywords:

Air quality monitoring system;
Arduino;
sensor;
Wi-Fi module;
Integrated development;
environment.

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1. Introduction

1.1 General

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. Where as in EU number reaches to 300,000 and over 3,000,000 worldwide.

IoT based Air Pollution Monitoring system monitors the air quality over a web server using internet and will trigger an alarm when the air quality goes down beyond a certain threshold level, means when there are sufficient amount of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3, LPG and NOx.

1.2 Internet of Things

The internet of things is transforming the way enterprises manage assets and run operations. The enormous data that is harnessed is fueling innovation is every aspect from optimization in manufacturing process, service delivery mechanisms to creating newer business models.

Web NMS enterprise IoT platform enables your enterprise to harness the power of IoT to connect a diverse set of assets, operations, and systems to enable data driven decisions. Web NMS IoT platform is a sophisticated application enablement platform that comes pre-built with functionality such as data acquisition from edge, analytics and storage, escalations and remote action triggers, visualization and reporting, device management, user management and security. With complete support for energy management, remote asset management and logistics and fleet management, the platform addresses most enterprise IoT application needs and integrates seamlessly with 3rd party enterprise applications, enabling true digital transformation.

2. Literature Review

Air pollution in large urban areas has a drastic effect on humans and the environment. Ecological issues in India are growing quickly. Air contamination is mainly caused by vehicles and industries which cause various respiratory diseases.

An extensive number of projects have been described in the literature that utilize low cost air pollution sensing devices that can be carried by individuals or by versatile vehicles. In two studies, the authors demonstrated an environmental sensing approach that reinvigorate attention and sympathy of citizens towards pollution.

In another study the authors present a cloud based system that uses knowledge based discovery to find real time air quality data. This system uses mobile clients for monitoring purpose.

Air pollution is a challenge that threatens basic human welfare, damages natural and physical capital and constrains economic growth. We hope this study will translate the cost of premature deaths into an economic language that resonates with policy makers so that more resources will be devoted to improving air quality.

3. Proposed approach

We are make an IoT based Air Pollution Monitoring System in which will monitor the air quality over a web server using internet and will trigger a 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 well as on webpage so that we can monitor it very easily.

3.1 Internet of Things

Internet of Things (IoT) encompasses regular objects that have networks availability, permitting them to send and get information. “Things” include people, information, software agents, or any other virtual participating actors. There are four kinds of “Things” utilized in this paper: NodeMcU, gas sensor, Ubidots-cloud services, and Android.

Previously we have built the LPG detector using MQ6 sensor and smoke detector using MQ2 sensor, but this time we have used MQ135 sensor which is the best choice for monitoring air quality as it can detect most harmful gases and can measure their amount accurately. In this IoT project, you can monitor the pollution level from anywhere using your computer or mobile.

3.2 Block diagram

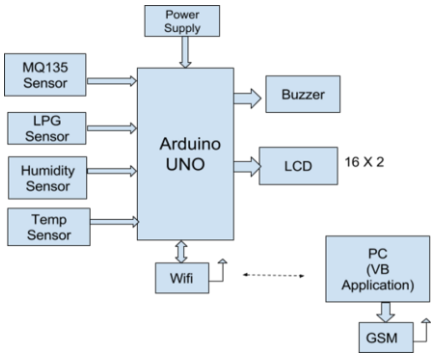

Figure 1:The system architecture of IoT testbed

3.2.1 Working

We have used a library for MQ135 gas sensor. Sensor is giving us value of 90 PPM, when there is no gas near it and the air quality

safe level is 350PPM and it should not exceed 1000 PPM. When it will exceed the limit of 1000 PPM, it will cause headaches, sleepiness and stagnant, stuffy air. If it exceeds beyond 2000 PPM then it will cause increased heart rate and many different diseases. When the value will be less than the 1000 PPM, then the LCD and web page will display “Fresh Air”. When the value increased from 1000 PPM, then the buzzer will start beeping and the LCD and webpage will display “Poor Air, Open Windows”, and when it will increase 2000 PPM, the buzzer will keep beeping, LCD and webpage will display “Danger! Move to fresh Air”. LCD and Buzzer are the output devices. I2C is use to the synchronous processing. LCD shows the data of the gases in PPM (parts per million) and buzzer is used when PPM crosses above threshold limit.

3.3 Components

3.3.1 ArduinoUno

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 inFigure2.

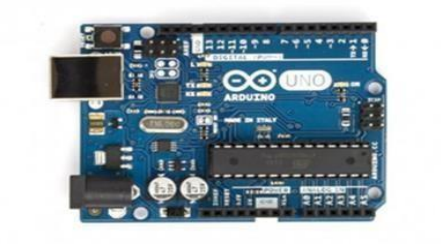

Figure 2: Arduino UNO

The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

The word "uno" means "one" in Italian and was chosen to mark the initial release of the Arduino Software. While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to- serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

3.3.2 MQ135sensor

TheMQ135sensorcansenseNH3,NOx,alcohol,Benzene,smoke,CO2andsome other gases. It gives

the output in form of voltagelevels.

Figure 3: MQ135 sensor

MQ135 sensor use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benze steam, also sensitive to smoke and other harmful gases. It is with low cost and particularly suitable for Air quality monitoring application.

The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. If you need to measure the gases in PPM the analog pinneedtobeused.TheanalogpinisTTLdrivenandworkson5Vandsocanbeused with most commonmicrocontrollers.

3.3.3 WIFI module(ESP8266)

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability. It runs on 3.3V and gives our system accessto Wi-Fi or internet. Figure 4 shows Wi-Fi Module(ESP8266).

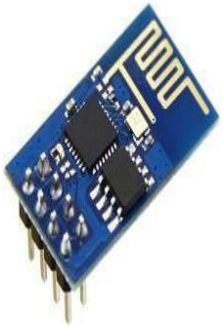

Figure 4: WIFI Module

This is a serial module with a built-in TCP/IP stack, so you can use it standalone but you will be likely limited. You need a FTDI to connect this module to your computer, and start communicating with it.

3.3.4 Buzzer

A Buzzer or beeper is an audio signaling device. Whenever the air pollution goes above the threshold level the Buzzer starts beeping indicating Danger. Figure.5 shows Buzzer.

Figure 5:Buzzer

which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmationof user input such as a mouse click or keystroke.

It most commonly consists of a number of switches or sensors connected to a controlunitthatdeterminesifandwhichbuttonwaspushedorapresettimehaslapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on anelectromechanicalsystemwhichwasidenticaltoanelectric bell without the metal gong. The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices, operated fromstepped-down AC line voltage at 50 or 60 cycles. Other sounds commonly used to indicate that a button has been pressed are a ring or a beep. Some systems, such as the one used on Jeopardy!, make no noise at all, instead usinglight.

3.3.5 LCD (Liquid CrystalDisplay)

This is a basic (16x2) 16 character by 2line display. Black text on Green background.ItisusedtoindicatetheAirandHumidityinPPM.Figure.6 showsLCD (16x2).

Figure 6: LCD

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystalsinitsprimaryformofoperation.LEDshavealargeandvaryingsetofusecases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrumentpanels.

LCDs were a big leap in terms of the technology they replaced, which include light-emitting diode and gas-plasma displays. LCDs allowed displays to be much thinner than cathode ray tube technology. A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels.

3.3.6 GSMmodule

GSM Module is used to establish communication between a computer and a GSMsystem.GlobalSystemforMobilecommunication(GSM)isanarchitectureused for mobile communication.

Figure 7: GSM Module

GSM system was developed as a digital system using time division multipleaccess technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its ownparticulartimeslot.Thedigitalsystemhasanabilitytocarry64kbpsto120Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementationdomain.

3.3.7 LPGsensor

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. Figure.8 shows LPG sensor (MQ6).

Figure 8:MQ6

This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

This sensor comes in a package similar to our MQ-3 alcohol sensor, and can be used with the breakout board. Using a MQ sensor it detect a gas is very easy. You can either use the digital pin or the analog pin to accomplish this. Simply power the module with 5V and you should notice the power LED on the module to glow and when no gas it detected the output LED will remain turned off meaning the digital output pin will be 0V.

3.3.8 Temperaturesensor(LM35**)**

The LM35 is precision integrated-circuit temperature sensor, whose output voltageislinearlyproportionaltotheCelsius(Centigrade)temperature.Itcanbeused with single power supplies, or with plus and minus supplies. Figure 9.shows LM35 sensor forTemperature.

Figure 9: LM35

TheLM35devicehasanadvantageoverlineartemperaturesensorscalibratedin Kelvin, as the user is not required to subtract a large constant voltage from the output toobtainconvenientCentigradescaling.TheLM35devicedoesnotrequireanyexternal calibration or trimming to provide typical accuracies of ±¼°C at room temperatureand

±¾°Coverafull−55°Cto150°Ctemperaturerange.Lowercostisassuredbytrimming andcalibrationatthewaferlevel.Thelow-outputimpedance,linearoutput,andprecise inherentcalibrationoftheLM35devicemakesinterfacingtoreadoutorcontrolcircuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heatingoflessthan0.1°Cinstillair.TheLM35deviceisratedtooperateovera−55°C to 150°C temperaturerange**.**

3.3.9 Humiditysensor(sy-h-220)

The humidity sensor is of capacitive type, comprising on chip signal conditioner.However, it is mounted on the PCB, which also consists of other stages employed to make sensor rather smarter. The PCB consists of CMOS timers to pulse the sensor to provide output voltage. Figure.10 shows SY- HS-220 sensor for Humidity.

Figure 10:SY-HS-220

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture ataparticularairtemperatureiscalledrelativehumidity.Relativehumiditybecomesan important factor when looking forcomfort.

3.4 Applications

1. Industrial perimeter monitoring
2. Indoor air quality monitoring
3. Site selection for reference monitoring stations.
4. Making data available to users

3.5Advantages

It has been stated numerous times that Air is one of the most essential elements for survival of living organisms. We not only don't require air, but also we require clean pollution free air for our survival.

1. Easy to install and low cost
2. Updates on mobile phone directly
3. Accurate pollution monitoring
4. Remote location monitoring
5. The data collected from air quality monitoring helps us assess impacts caused by air quality on public health

4. Result and discussion

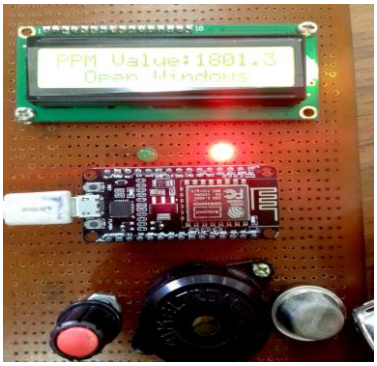

Figure 11: Proto type model

MQ135 gas sensor gives the output in form of voltage levels and we need to convert it into PPM, so for converting the output in PPM, here we have used a library for MQ135 sensor.

In the project the GSM module act as android smart phone which Move to one destination to another destination to support the google map identify the air quality.

We complain to the Wi-Fi module and android board in to nodeMcU. NodeMcU is an open source IoT platform. It includes firmware which runs on the ESP8266Wi-Fi SoC from Espressif system, and hardware which is based on the ESP-12 module.

It is also used to the I2C protocol. I2C is a serial protocol for two wire interface to connect low speed device like microcontrollers, EEPROMS, A/D and D/A converters, I/O interfaces and other similar peripherals in embedded systems. It may also use to the synchronous data transfer. There are two LEDs used here,on which green color indicates fresh air, red color indicates danger and indicate move to "Fresh Air".

5. Conclusion

The system to monitor the air of environment using NodeMcU, IoTtechnonogy was proposed to improve quality of air. With the use of IoT technology which enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this paper. Here, using the MQ135

gas sensors gives the sence of different type of dangerous gas and NodeMcU is the heart of this project,Which control the entire process. Wi-Fi module connects the whole process to internet and LCD is used for the visual output.

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