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Iot Based Air Pollution Monitoring System

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Abstract

Air pollution is one of the biggest threats to the present-day environment. Everyone is being affected by air pollution day by day including humans, animals, crops, cities, forests and aquatic ecosystems. Besides that, it should be controlled at a certain level to prevent the increasing rate of global warming. This project aims to design an IOT-based air pollution monitoring system using the internet from anywhere using a computer or mobile to monitor the air quality of the surroundings and environment. The IOT-based air pollution monitoring system would not only help us to monitor the air quality but also be able to send alert signals whenever the air quality deteriorates and goes down beyond a certain level.

Keywords— NodeMCU V3 , DHT11 Sensor Module , MQ 135Gas Sensor Module,LED,ThinkSpeak Cloud , ArduinoIDE.

I. Introduction

Air is getting polluted because of the release of toxic gases by industries, vehicle emissions and increased concentration of harmful gases and particulate matter in the atmosphere. A lot of air pollutants have been studied to pose deleterious consequences to the human health. 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. This paper presents real-time standalone air quality monitoring. Internet of Things (IOT)is nowadays finding profound use in each and every sector, plays a key role in our air quality monitoring system too. The setup will show the air quality in PPM so that we can monitor it very easily. In this IOT project, we can monitor the pollution level from anywhere using your computer or mobile.

A .Drawbacks in existing monitoring systems:

The drawbacks of the conventional monitoring system are their large size, heavy weight and extraordinary expensiveness. In order to be effective, the locations of the monitoring stations need careful placement because the air pollution situation in urban areas is highly related to human activities. There are some possibilities that the data stored can be tracked by malicious users which can be a big threat to the environment.

Ii. Objectives:

The aim is to monitor the quality of the air on which our life is based on.

A .Acronyms We Used In Our Project:

DHT - Digital Humidity and Temperature

IOT - Internet of Things

PPM - Parts Per Molecule

PM - Particulate Matter

CO - Carbon Monoxide

CO2 - Carbon Dioxide

LED - Light Emitting Diode

LPG - Liquid Petroleum Gas

IDE - Integrated Development Environment

B .Components Used In Air Monitoring System:

Hardware Components:

- NodeMCU V3
- DHT11 Sensor Module
- MQ-135 Gas Sensor Module
- Veroboard(KS100) Breadboard
- Connecting Wires
- AC-DC Adapters
- LEDs emitting green, yellow and red colours
- Resistors

Software Components:

- ThinkSpeak Cloud
- Arduino IDE

C .Usage of tools involved in system:

"NodeMCU V3" is an open-source ESP8266 development kit, armed with the" CH340G USBTTL "Serial chip. It has firmware that runs on ESP8266 Wi-Fi SoC from Espressif Systems. Whilst cheaper "CH340 "is super reliable even in industrial applications. The "DHT11" is a temperature and humidity sensor that gives digital output in terms of voltage. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air. The material of "MQ135" is SnO2, it is a special material: when exposed to clean air, it is hardly being conduct.

"Veroboard" is the original prototyping board. Sometimes referred to as 'stripboard' or 'matrix board' these offer total flexibility for hard wiring discrete components. Manufactured from a copper clad laminate board or Epoxy based substrate. An "AC-DC" power supply or adapter is an electrical device that obtains electricity from a grid-based power supply and converts it into a different current, frequency, and voltage. The "Arduino IDE" is open-source software, which is used to write and upload code to the Arduino boards.

Iii. Working Principles:

A .Process involved in the System:

NodeMCU plays the main controlling role in this project. It has been programmed in a manner, such that, it senses the sensory signals from the sensors and shows the quality level via led indicators. The DHT11 sensor module is used to measure the temperature and the humidity of the surroundings .With the help of the MQ-135 gas sensor module, air quality is measured in ppm. These data are fed to the ThinkSpeak cloud over the internet. We have also provided LED indicators to indicate the safety level.

Firstly, the calibration of the MQ-135 gas sensor module is done. The sensor is set to preheat for 24 minutes. Then the software code is uploaded to the NodeMCU followed by the hardware circuit to calibrate the sensor has been performed. Then, the DHT11 sensor is set to preheat for 10 minutes. The result of calibration found in STEP 1 is used to configure the final working code.The final working code is then uploaded to the NodeMCU. Finally, the complete hardware circuit is implemented.

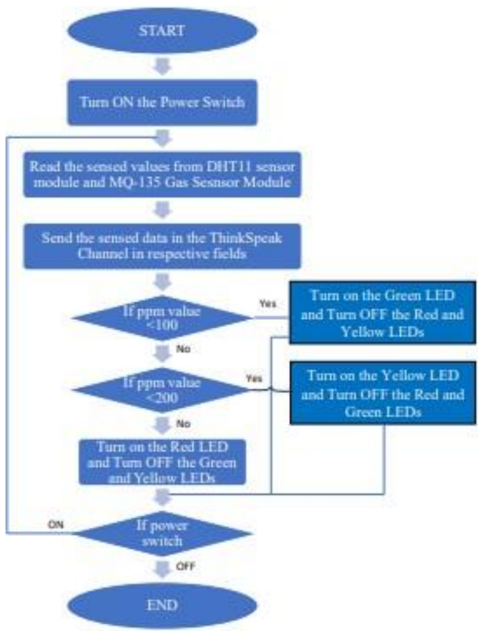
B .Main Specification Of Our Model:

In our model we worked on to get rid of all those drawbacks of existing model which make our model more eligible to solve pollution in air. We designed our model using asymmetric encryption which secures the data from being hacked. This model implements the way which does not require a lot of space. It also mainly concentrate on monitoring and transmitting the current day immediately to the webpage which can help to provide the solution timely.

Iv. Implementation:

A .Data Flow of system:

Through executing these step by step process we can achieve our main goal of our air quality monitoring system by obtaining the PPM value .



by initiating this process we can obtain accurate PPM value which gives us the exact data to control the air pollution occurs in our environment.

V. Calculation:

A. Equations used in Calibration of MQ-135 gas sensor:

From Ohm's Law, at a constant temperature, we can derive,

$$I=V/R \quad (1)$$

eqn. 1 is equivalent to

$$I=VC/RS+RI \quad (2)$$

we can obtain the output voltage at the load resistor using the value obtained for I and Ohm's Law at a t a constant temperature, V = I x R.

$$VRL=[VC/(RS+RL)] \times R \quad (3)$$

$$VRL = [(VC* RL)/(RS + RL)] \quad (4)$$

So now we solve for RS:

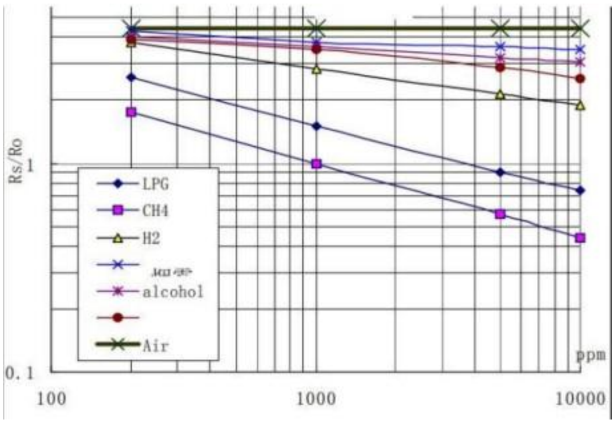
$$VRL \times (RS + RL) = VC \times RL \quad (5)$$

$$(VRL \times RS) + (VRL \times RL) = VC \times RL. \quad (6)$$

$$VRL \times RS = (VC* RL) - (VRL*RL) \quad (7)$$

$$RS = \{(VC* RL - (VRL* RL)\} / VRL \quad (8)$$

$$RS = \{(VC* RL)\ VRL\} - RL \quad (9)$$



(graph representing ratio vs ppm variation)

The resistance ratio in fresh air is a constant:

$$RS \;/\; R0 = 3.6 \quad (10)$$

To calculate R0, we will need to find the value of the RS in the fresh air. This will be done by taking the analog average readings from the sensor and converting them to voltage. Then we will use the RS formula to find R0. First of all, we will treat the lines as if they were linear. This way we can use one formula that linearly relates the ratio and the concentration. By doing so, we can find the concentration of a gas at any ratio value even outside of the graph's boundaries. The formula we will be using is the equation for a line, but for a log-log scale. We try to derive the following calculations.

$$y = mx + b \quad (11)$$

For a log-log scale, the formula looks like this:

$$\log10y = m * \log10x + b \quad (12)$$

Let's find the slope. To do so, we need to choose 2 points from the graph. In our case, we chose the points (200,2.6) and (10000,0.75). The formula to calculate slope m(here) is the following:

$$m = \{\log y - \log(y0)\} \;/\; \{ \log x - \log(x0)\} \quad (13)$$

If we apply the logarithmic quotient rule, we get the following:

$$M=\log(y/y0)/(x/x0) \quad (14)$$

Now we substitute the values for x, x0, y, and y0:

$$m = \log(0.75/2.6) \;/\; \log(10000/200) \quad (15)$$

$$m = -0.318 \quad (16)$$

Now that we have m, we can calculate the y-intercept. To do so, we need to choose one point from the graph (once again from the CO2 line). In our case, we chose (5000,0.9)

$$\log(y) = m * \log(x) + b \quad (17)$$

$$b = \log(0.9) - (-0.318) * \log(5000) \quad (18)$$

$$b = 1.13 \quad (19)$$

Now that we have m and b, we can find the gas concentration for any ratio with the following formula:

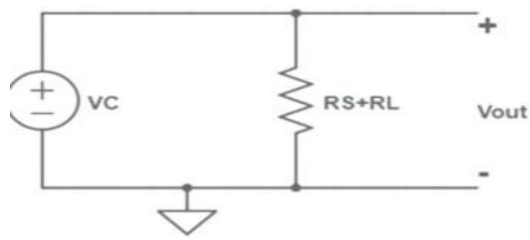
$$\log(x) = \{\log(y) - b\} \;/\; m \quad (20)$$

However, in order to get the real value of the gas concentration according to the log-log plot we need to find the inverse log of x:

$$x = 10 \wedge [\{\log(y)-b] \;/\; m \quad (21)$$

Using eqns. 9 and 21, we will be able to convert the sensor output values into PPM (Parts per Million). Now we developed the Code and flashed into the NodeMCU giving proper connections.

VI. Figures involved in working of sensors:



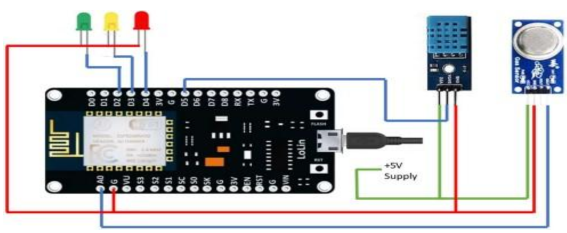
A.(Internal circuit diagram of MQ-135)

VII.Cost estimation of System:

For making the project we have used the following components (as mentioned in Table 2). As per the pricing on the online websites for electronic components, we have formulated a cost estimation.

Components	Price (in Rs)
NodeMCU V3	288
DHT11 Sensor Module	120
MQ135 Gas Sensor Module	135
Connecting Wires	60
LEDs (Red, Green & Yellow)	9
AC-DC Power Adapter	120
Female PCB Berg Terminal and cable	80
Veroboard	100
Breadboard	70
Total	**982**

B.(Circuit Diagram Of The System):



Vii. Conclusion :

In this project IOT based on measurement and display of Air Quality Index (AQI), Humidity and Temperature of the atmosphere have been performed. From the information obtained from the project, it is possible to calculate Air Quality in PPM. MQ135 sensor is that specifically it can't tell the Carbon Monoxide or Carbon Dioxide level in the atmosphere, but the advantage of MQ135 is that it is able to detect smoke, CO, CO2, NH4, etc harmful gases, it can be easily concluded that the setup is able to measure the air quality in ppm , the temperature in Celsius and humidity in percentage with considerable accuracy. Therefore, it is possible to conclude that the designed prototype can be utilized for air quality, humidity and temperature of the surrounding atmosphere successfully.

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