# A very simple and cost effective IoT based Air Quality Monitoring System

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## ABSTRACT

**Here, we proposed a system of measuring Air Quality using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Computing Air Quality is a significant part for carrying lot of consciousness in the people to take care of the upcoming generations a improved life. Our proposed system interfaced with IoT platforms like Thing speaks and set the dashboard to public such that everyone can come to know the Air Quality at the location where the system is mounted and will be enlighten a red LED and a green LED when the air quality goes up and down accordingly beyond a certain level 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 webpage so that we can monitor it very easily. The circuit consists of a simple connection and takes fewer components to have its own IoT based air pollution monitoring system.**

**Keywords: IoT, MQ135, MQ7, Thing speak.**

## INTRODUCTION

The Air Quality Indicator (AQI) is calculated and supported on air pollutants like CO and NO2 compounds that consume opposing possessions happening to the atmosphere and human health. The Air Quality Indicator may be a range that represents the very finest meditation of a specific air unused matter at a particular time. We make an air quality as well as air pollution monitoring system that allows us to monitor and check live air quality as well as air pollution in an area through Internet of Things (IoT). It uses air sensors (Gas Sensor MQ135) to sense the presence of harmful gases/compounds in the air and constantly transmit this data. In addition, the system keeps measuring air level and reports it. The sensors interact with node MCU (Microcontroller)which processes this data and transmits it over the application. This allows authorities to monitor air pollution in different areas. In addition, authorities can keep a watch on the air pollution near schools, and hospitals. Normally, little concentration area units measured exploitation ppm (parts per million).According to the recent survey, Dhaka, the capital of Bangladesh is the third in the list of most air-polluted cities. Thus because of this expansion in the quantity of vehicles contamination is developing quickly and it is influencing people groups wellbeing too. This air contamination makes disease and harm safe, neurological, regenerative and respiratory framework. In extraordinary cases, it can likewise cause passing. As indicated by overview 50000 to 100000 unexpected losses occurred to us only because of air contamination. Along these lines, there is a requirement for checking air quality and to monitor it. IoT is the system of physical gadgets, vehicles, home apparatuses, and different things implanted with hardware, programming, sensors, and availability which empowers these articles to associate and trade information. IoT permits articles to be noticed or controlled. In this paper, we are proposing and going to pilot a model which IoT to screen air contamination. This product requirement contains input and output requirements. It gives the wants in terms of input to produce the required productivity. The resource requirements define in brief about the hardware that are needed to achieve the required functionality. In this project we are going to make an IoT based Air Pollution Detection Monitoring System in which anyone can monitor the air Quality over a web server using ESP8266 Wi-Fi device and red LED when the air quality goes down a certain level means when there is amount of harmful gases is present in the air like CO2. It shows the air quality graph in PPM (Parts Per Million) varying with time to time and place to place on webpage "thing speak" so that one can monitor it very easily at any time. And the main objective of this project is to get information about air quality or make people aware about how much polluted the environment they are dwelling in; using the IOT based technology without causing any harm to our environment.

### Proposed Prototype and Schematic Approach towards system modification

This proposed project prototype is based on the air pollution data sensed by MQ135 and MQ7. Here we evidently derived the correct ppm on the screen with correct calibration. We have executed it with less cost i.e., once we are assertive the data to the cloud which make the system cost effective[1]. When we are aiming IoT as a platform, our motive should be to present the awareness on internet using the platforms like thing speak website which is beautifully premeditated to present the output and even capable to download the dataset.

When doing an experiment air quality monitoring, no need to use LPG or methane detecting sensors as it is used for Home/office safety. We have used Node MCU ESP 8266 to push the data onto the cloud rather using GSM or GPRS module [2]. As we are using two sensors, both of them have internal heat element, it draws more power(P= V*I), so though the both sensors are turned ON, its output voltage levels varies and shows unpredictable values due to insufficient power drive. So we used a 9V battery and a 7805 family LM7805 Regulator for the CO sensor MQ7. After connecting all the components correctly we did simulation of our proposed system through Proteus Simulation Software.

The Node MCU ESP 8266 is uploaded with codes to interface with air pollution sensors. Therefore we have compile and run our code. Using "SSID" and password, Node MCU is connected to Thing speak website. Thereafter, we can see the actual value of the air quality in terms of ppm and we can plot the Air Quality vs Time graph. It will change its value by a certain amount of time. We have set that if the quality of air is below 250 ppm then green LED will be turned on and if the air quality is above 250ppm then Red Led will be turned on.

When green Led is enlighten, the message "Air Quality is good " will be displayed in the website. And in case of Red Led, a warning message about the air quality of that place is displayed. In the "Thing Speak" website we can also keep the record of the quality of the air with the respect of time in excel sheet. By the chart we can get the proper analysis of the air quality for that particular region.

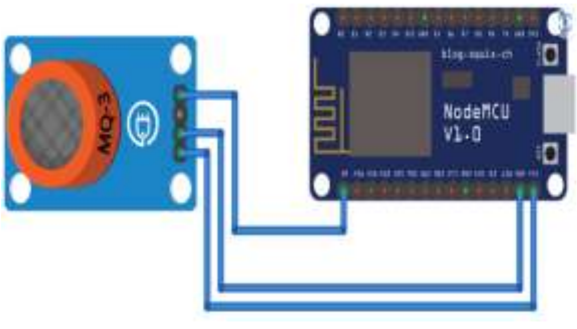


**Fig 1: Circuit Diagram of IoT Based Air Quality Monitoring System**.

A microcontroller-based device with appropriate bio-medical sensors will be attached to patient to provide constant cloud-based monitoring. The vital signs i.e. temperature and pulse rate of human body which are major clues to detect any health problem will be sensed by respective sensors supported by Node MCU in a Wi-Fi environment and the data will be sent to Thing Speak cloud where the data will be analysed to look for any irregularity. In case of any irregularity a notification will be sent to doctors and nurses.

The entire system is described through the flow chart given below.

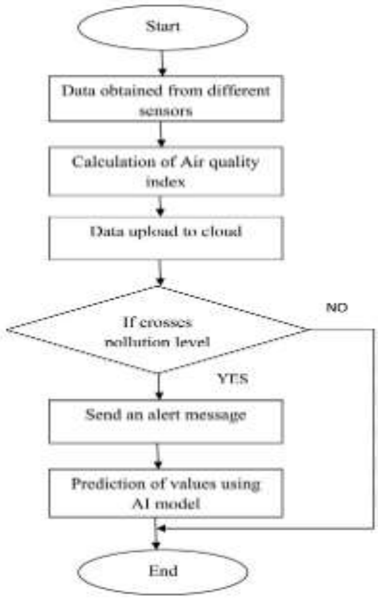


**Fig 2: Flow chart of IoT Based Health Monitoring System**

The most important step is to calibrate the sensor in fresh air and then draw an equation that converts the sensor output voltage value into our convenient units PPM (parts per million).

Here are the mathematical calculations derived [6]. Fig 5: Internal circuit diagram of MQ135 sensor RS and RL combined From Ohm's Law, at constant temperature, we can derive I as follows:

$I = V / R$ ------------------------------------------------- (1)

From fig , equation 1 is equivalent to

$I = Vc / Rs + Rl$ ------------------------------------- (2)

From, we can obtain the output voltage at the load resistor using the value obtained for I and Ohm's Law at constant temperature. V = I*R

$VRl = [\ Vc / Rs + Rl\ ] * RL$ ----------------------- (3)
$VRl = [\ Vc * Rl\ [Rs + Rl\ ]$ ------------------------ (4)
$(VRl * Rs) + (VRl * Rl) = Vc * RL$ ------------- (5)
$VRl * Rs = (Vc * Rl) - (VRl * Rl)$ --------------(6)
$Rs = (Vc * Rl) - (VRl * Rl)\ VRl$ ---------------- (7)
$Rs = (Vc * Rl)\ VRl - Rl$ ------------------------- (8)

Equation 9 helps us to find the internal sensor resistance for fresh air :

$Rs = (Vc * Rl)/ VRl – Rl$------------------------- (9)

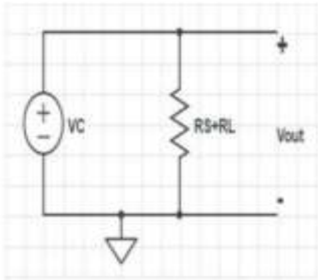


**Fig 3: Internal Circuit Diagram of MQ135**

Equation 10 is depicted from the datasheet mentioned in Fig 6. To calculate R0, we will need to find the value of the Rs in fresh air. This will be done by taking the analog average readings from the sensor and converting it 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. The formula for a line is [9]: From above Figure 3, we try to derive the following calculations.

$y = mx + b$---------------------- (10)

For a log-log scale, the formula looks like this:
$\log10y = m * \log10x + b$

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)

$Log(y) = m * \log(x) + b$-------------- (11)
$b = \log(0.9) − (−0.318) * \log(5000)$ (18) $b = 1.13$ --- (12)

Now that we have m and b, we can find the gas concentration for any ratio with the Following formula: $Log(x) = \log(y) − b\ m$ -------------------(13)

However, in order to get the real value of the gas concentration according to the log plot we need to find the inverse log of x: $x = 10 / m$

Using eq. 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 Node MCU giving proper connections as mentioned.

## RESULT


**Fig 4: Output one Thing speak**

Before implementing the prototype of our proposed system, we simulated it using Proteus Software. In this simulation, if any object is detected within 100cm of any ultrasonic sensor, the LED will be turned on.

After connecting the wifi successfully to the ESP-01, it gets established with Thing speak account with the help of the API key of our account provided. Thing speak needs 15 seconds of refresh interval to push to the data. Fig 7 shows the field charts of MQ135 and MQ7 sensor values which made to convert to PPM [7] [8]. Fig 8 showing the graphical analysis of the values collected with time on X axis and Air Quality PPM on Y axis.


**Fig 5: Air Quality Data on Thing speak**

## CONCLUSION

Air quality monitoring systems are designed using different sensors for indoor and outdoor air quality monitoring in the previous works by using Bluetooth, GPS, GPRS wireless technologies. In a previous work WASP module is used which is costly. Instead of that different sensors can be used. The proposed system is developed for indoor air quality monitoring remotely. It is cost and energy efficient request and respond protocol is used along with combination of address and data centric protocols. Paper presents the summary of various techniques of air quality monitoring. These techniques are elaborately discussed in the paper. In the proposed system, one of the most preferred techniques is cloud based air quality monitoring system. Using the same cloud data, website is hosted and data is displayed on the website.

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