

Evaluating the Real-Time Air Quality Data Using IOT

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ABSTRACT: The global pollution is increasing rapidly due to various reasons like increased population, industries, urbanization, vehicle use that can affect human health. When there are sufficient amount of harmful gases present in the air like CO, CO₂, excess smoke, ammonia and its compounds, the sensors used in our paper will automatically detect these gases in PPM. The Arduino IDE transmits the data to the cloud via the Wi-Fi module and then our data are properly monitored and statistically broken down. The main sensors like MQ135 and MQ7 used in our paper are responsible for detecting the most harmful gases and their respective amount in the air.

KEYWORDS: Internet of Things, Air Quality, Arduino UNO, Sensors, ThingSpeak

I. INTRODUCTION

In today's world, air pollution, climate change, and its consequences are of a great concern to everyone. Emission of various poisonous gases from industries and vehicles are not only hazardous for the terrestrial organism, but the marine life is also getting adversely affected. As the world's population is becoming increasingly urban, the cities are under pressure to remain livable. IOT Based Air Pollution Monitoring System monitors the air quality over a web server using Wi-Fi module. The air quality level exceeding above a certain threshold level signifies that there are excessive amount of harmful gases present in the air like CO, CO₂, smoke, NH₃, Nox etc. The air quality is measured in PPM and the statistics of data are stored/displayed on web page called ThingSpeak cloud platform. The system will also show temperature and humidity in the air. The system can be installed anywhere but mostly in industries and houses where gases are mostly to be found and can also be modified to give an alert message when the system crosses threshold limit.

II. RELATED WORK

In [1] authors explained about the Air Quality Index ranges. Firstly, 0-50 PPM can be considered completely safe. [2] 51-100 PPM can be considered as Moderate where this could be usually observed at traffic areas. 100- 150 PPM can be considered as Unhealthy but only for sensitive groups. [1] Above 151 PPM is completely unsafe or unhealthy where India capital New Delhi falls in this range. [3]It's very rare to record 300 PPM and above which can be considered as Hazardous, possibly due to Coal gas in mines. [4]On targeting IoT as a platform, our intension should be to present the idea on internet using the platforms like thinger.io or thingspeak or Cayenne website which are beautifully designed to present the output and even able 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. This paper used Wi-Fi to push the data onto the cloud rather using GSM or GPRS module. In two studies, [5] [6], the authors demonstrated an environmental sensing approach that reinvigorate attention and sympathy of citizens toward pollution. In another study [7], the authors present a cloud-based system that uses knowledge-based discovery to find real-time air quality data. The data are collected by monitoring stations that are placed in various geo-locations. This system uses mobile clients for monitoring purposes. In another study by De Nazelle et al. [8], the authors demonstrated environmental sensing approaches that reinvigorated the awareness and sympathy of individuals towards pollution. "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. By supporting healthier cities [9] and investments in cleaner sources of energy, we can reduce dangerous emissions, slow climate change, and most importantly save lives," said Laura Tuck, Vice President for Sustainable Development at the World Bank.

III. METHODOLOGY

All the sensors namely MQ135, MQ7, DTH11 and ESP8266 are placed on the breadboard and with the help of jumper wires all the pins of these sensors are connected to respective ports available in our Arduino Uno that comes with ATmega328P microcontroller. ESP8266 runs on 3.3V and if you will give it 5V from the Arduino then it won't work properly and it may get damaged. We connect the VCC and the CH_PD to the 3.3V pin of Arduino. The RX pin of ESP8266 works on 3.3V and it will not communicate with the Arduino when we will connect it directly to the Arduino. So, we will have to make a voltage divider for it which will convert the 5V into 3.3V. This can be done by connecting three resistors in series like we did in the circuit. We connect the TX pin of the ESP8266 to the pin 10 of the Arduino and the RX pin of the esp8266 to the pin 9 of Arduino through the resistors. ESP8266 Wi-Fi module gives your projects access to Wi-Fi or internet. It is a very cheap device and makes your projects very powerful. It can communicate with any microcontroller and it is the most leading devices in the IOT platform. Then we will connect the MQ135 sensor with the Arduino. We connect the VCC and the ground pin of the sensor to the 5V and ground of the Arduino and the Analog pin of sensor to the A0 of the Arduino.

The MQ135 sensor can sense NH₃, NO_x, alcohol, Benzene, smoke, CO₂ and some other gases, so it is perfect gas sensor for our Air Quality Monitoring Project. When we will connect it to Arduino then it will sense the gases, and we will get the Pollution level in PPM (parts per million). 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. Sensor was giving us value of 90 when there was no gas near it and the safe level of air quality is 350 PPM and it should not exceed 1000 PPM. When it exceeds the limit of 1000 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air and if exceeds beyond 2000 PPM then it can cause increased heart rate and many other diseases.

In MQ7, there are 4 leads: +5V, AOUT, DOUT, and GND. The +5V and GND leads establishes power for the alcohol sensor. The other 2 leads are AOUT (analog output) and DOUT (digital output). How the sensor works is that the terminal AOUT gives an analog voltage output in proportion to the amount of carbon monoxide the sensor detects. The more CO it detects, the greater the analog voltage it will output. The connections are pretty basic. To connect the sensor, there are 4 leads. 2 of them are for power. The +5V terminal of the sensor connects into the 5V terminal of the arduino board. The GND terminal of the sensor connects into the GND terminal of the arduino. This establishes power for the sensor. The analog pin of MQ7 is connected to the analog port A0 of Arduino. Now, MQ7 sensor can be calibrated in Arduino IDE using any programming languages connecting it to ThingSpeak via Wi-Fi module.

DTH11 sensor has been used to identify the temperature and humidity in the environment. The configuration and interfacing of DTH11 sensor to the Arduino is similar to the MQ135 and MQ7 sensors. However the calibration step is completely different than these sensors but can be achieved effectively.

Coming to the use of ThingSpeak platform for air quality monitoring, we have carefully setup the network configurations and clearly setup the API configurations as well. Once all the raw data that are gathered from the sensors have been deployed into the ThingSpeak server and the monitoring was achieved in graphical manner, anyone with the proper credential can easily access and monitor the system from anywhere.

IV. EXPERIMENTAL RESULTS

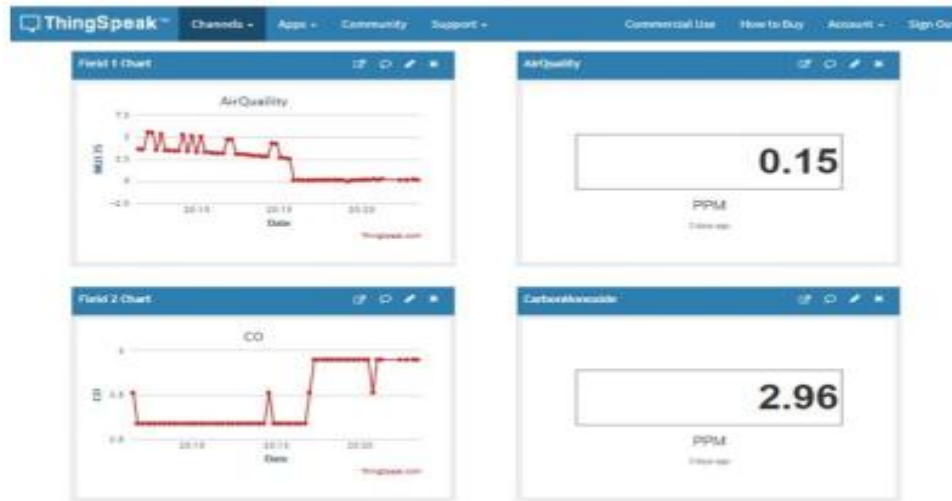


Fig 1: ThingSpeak Data Display

After connecting the ESP-01 successfully to the hotspot, it gets established with Thingspeakwebsite and the account API Key is written in Arduino Code which helps to save the data only to our account bearing the given API key. Thingspeak needs 15 seconds of refresh interval to push to the data. The figure above shows the field charts of MQ135 and MQ7 sensor values for the location where the experiment is conducted in PPM (Parts per million). It also shows the visualization charts for corresponding sensors.

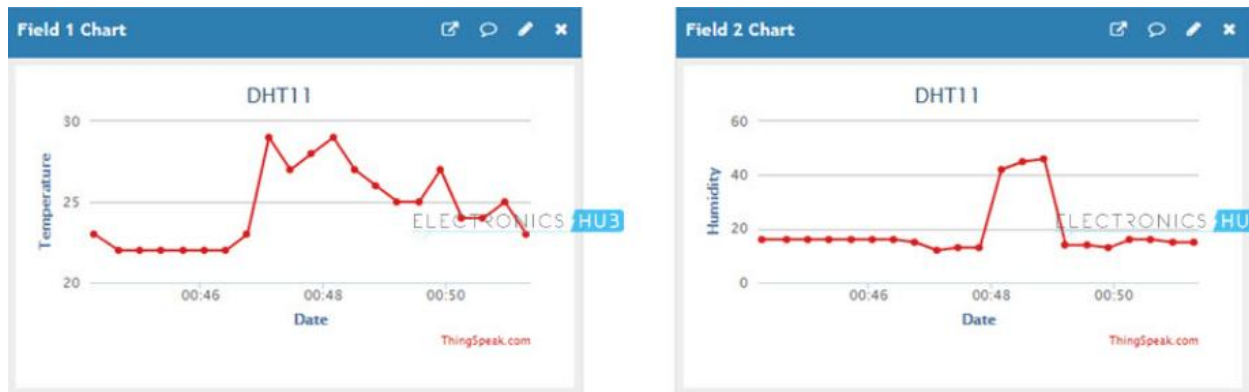


Fig 2: ThingSpeak DHT11 Temp & Humidity Data

The figure above shows the field charts of DHT11 sensor values for the location where the experiment is conducted in PPM (Parts per million). We can see the visualization charts for this sensor as well.



Fig 3: Air Quality Graph

Also, we can see above how the graphical analysis of the values are collected with timestamping on X axis and Air Quality PPM on Y axis.

V. CONCLUSION

In this paper it is successfully able to calculate Air Quality in PPM and the information mentioned above verifies it clearly. MQ7 sensor is used for the sake of measuring the level of CO₂ present in the atmosphere. The problem with MQ135 sensor is that specifically it can't tell the Carbon Monoxide or Carbon Dioxide level in the atmosphere, but the pros of MQ135 is that it can brilliantly detect smoke, CO, CO₂, NH₄ as mentioned in above figure. This paper also corrects the PPM calculations. Hence, this paper can be used both for outdoor as well as indoor locations. For outdoor purpose, certainly one sensor is not sufficient because one sensor has a sensitivity range of around 1 meter, so a network of sensors has to be deployed to monitor the outdoor air quality. But, for the indoor, compact device can be with each sensors closely connected such that if every home started using the device, air quality of a particular targeted area can be monitored effectively. Each sensors that are used in this paper are calibrated efficiently. Furthermore, the monitoring of the air quality was effectively achieved through the ThingSpeak cloud-based platform. This particular monitoring feature will enable to be pro-active and be ready for any disaster and this is the heart of our paper.

REFERENCES

- [1] Cho, R. (2018, June 26). What you should know about air quality alerts. Retrieved from <https://phys.org/news/2018-06-air-quality.html>
- [2] Xiaojun, C., Xianpeng, L., & Peng, X. (2015, January). IOT-based air pollution monitoring and forecasting system. In 2015 International Conference on Computer and Computational Sciences (ICCCS) (pp. 257-260). IEEE.
- [3] Ahlgren, B., Hidell, M., & Ngai, E. C. H. (2016). Internet of things for smart cities: Interoperability and open data. *IEEE Internet Computing*, 20(6), 52-56.
- [4] Shah, J., & Mishra, B. (2016, January). IoT enabled environmental monitoring system for smart cities. In 2016 International Conference on Internet of Things and Applications (IOTA) (pp. 383-388). IEEE.
- [5] R. Peterová and J. Hybler, "Do-it-yourself environmental sensing," *Procedia Comput. Sci.*, vol. 7, pp. 303–304, 2011
- [6] M. R. B. and A. J. B. Alok N. Bhatt, "Automation Testing Software that Aid in Efficiency Increase of Regression Process," *Recent Patents Comput. Sci.*, vol. 6, no. 2, pp. 107–114, 2013.
- [7] Y. Zheng, X. Chen, Q. Jin, Y. Chen, X. Qu, X. Liu, E. Chang, W.-Y. Ma, Y. Rui, and W. Sun, "A cloud-based knowledge discovery system for monitoring fine-grained air quality," *Prep. Microsoft Tech Report*, <http://research.microsoft.com/apps/pubs/default.aspx>, 2014.
- [8] A. De Nazelle, E. Seto, D. Donaire-Gonzalez, M. Mendez, J. Matamala, M. J. Nieuwenhuijsen, and M. Jerrett, "Improving estimates of air pollution exposure through ubiquitous sensing technologies," *Environ. Pollut.*, vol. 176, pp. 92–99, 2013.
- [9] aZanella, N. Bui, a Castellani, L. Vangelista, and M. Zorzi, "Internet of Things for Smart Cities," *IEEE Internet Things J.*, vol. 1, no. 1, pp. 22–32, 2014.
- [10] <https://jayconsystems.com/blog/understanding-a-gas-sensor>

BIOGRAPHY

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