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# IOT BASED AIR QUALITY MONITORING USING PARTICULATE MATTER SENSING IN ONLINE THINK SPEAK CLOUD SERVER

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## Abstract

This platform uses IoT and cloud computing technology to monitor outdoor or indoor pollution and Monitor environmental quality anywhere and at any time. Indoor and Outdoor pollution monitoring is the gathering of data at different places inside or outside of room and at regular intervals to provide information that can be used to characterize present circumstances. Communication between Sensing hardware Devices using MQTT software protocols and online monitoring on any Cloud Platform is challenging. Using IoT-based hardware devices and programming them to sense various air quality metrics and transferring them to Think speak analytics and Cloud Platform for logging and data conversion into graph format. Using Iot based MQTT protocol to communicate hardware with Online cloud server. The goal of this research is to create a low-cost real-time Internet of Things air quality monitoring system. For monitoring Dust level, the system employs Dust level or particulate matter sensor and for Temperature and humidity DHT11 sensors. Furthermore, the system employs an ATmega328 controller with Node MCU ESP8266 development board outfitted with a WiFi module to feed readings to a Thing-Speak web channel platform for immediate and real-time air quality display. To facilitate distant communication, the degree of concentration is graphically monitored through channels using Thing Speak. The threshold value has been determined. As a result, when pollutants become high in concentration, The graphical curve rises indicate high dust Concentration level. The study successfully executed a design of a low- cost air quality monitoring system using Node MCU and Thing Speak.

***Keywords:*** Iot, Think Speak, Node MCU, ESP8266, DHT11, ATmega328, MQTT.

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## 1. Introduction

Indoor air quality is commonly defined as the ambient conditions within buildings and public facilities that can have an impact on an individual's mental and respiratory health. Prior to the COVID-19 epidemic, indoor air quality monitoring was not a priority for public buildings such as shopping malls, hospitals, banks, restaurants, and educational institutions. However, the fast spread of this virus and its negative consequences have focused attention on indoor air quality. In contrast to outside air, interior air is continually recycled, trapping and

accumulating contaminants that may aid in viral transmission. There are various commercially available monitoring methods; a typical system analyses air quality utilising gas and particle sensors. This research presents a method for developing a low-cost standardized pollution monitoring device using wireless technology (i.e., the Internet of Things (IoT) and cloud computing technologies. This paper outlines the creation of a cloud-based IoT system for air quality monitoring that is available via a web interface or Monitoring Through Cloud server.

Monitoring proper air quality is a global problem for governments and individuals alike.To address the problem of decreasing air quality, governments throughout the world have invested multi-billion dollars in policies and solution segmentation. Particulate matter released from industry, automobiles, equipment, waste recycling, industrial operations, and households causes air pollution. Heavy metal dust, carbon monoxide, ozone, carbon dioxide, nitrogen dioxide, suspended particulate matter, hydrogen fluoride oxides of sulphur, and others are examples of noteworthy pollutants. These contaminants enter the atmosphere and have serious health and environmental consequences.

### *1.2 Objective of the Paper*

1) The goal of this research is to create a real-time Internet of Things air quality monitoring system.
2) Using Cloud Server For Real Time Data Feeding, Monitoring and Logging.
3) Using MQTT protocol for Internet Communication.
4) Interfacing External Sensors and Hardware Directly With Cloud Server For interaction.

### *1.3 Problem Identification*

### *1.4 Problem Statement*

Air quality is extremely significant in terms of human safety, security, and health. While expanding large-scale manufacturing and urbanisation generate massive cities, these activities have a variety of negative environmental consequences.

Similarly, one issue is the degradation of air quality in several Indian cities. Particulate matter (PM2.5) is the largest contributor to air pollution, affecting human health difficulties such as asthma and other respiratory disorders. According to one study, those who inhale particulate matter in the air are more likely to get lung cancer than non smokers who are exposed to second hand smoking.

### *1.5 Followings are the Points for the Problem Statement*

a) Previously in the past data's has to be fed in the website manually for analyzing purpose.
b) Online Live Data Monitoring is not Available.
c) Hardware and Internet Interface is Challenging and Future Promising Task.

d) For Live Data Feeding and Graph Analysis and Internet Communication MQTT Protocol based Publisher, Subscriber, Broker is need.

c) Cloud Space server is need for the Interaction

## 2. Literature Review

1) Ravi Kishore Kodali and Borade Samar Sarjerao,2017, National Institute of Technology Warangal, The suggested pollution monitoring system is built around a WiFi microcontroller ESP8266 node mcu, a sharp dust sensor GP2Y1010AU0F (for particle measurement), and a MQ-7. Sensors for measuring carbon monoxide and the MQTT protocol ESP8266, GP2Y1010AU0F sharp dust sensor, and We constructed a low-cost MQ-7 (carbon monoxide) sensor. Implementation and maintenance, portability, and ease of use The subscriber can view the polluted content simply utilising a web browser. application for mobile A straightforward pollution monitoring system (particulate) measuring matter and carbon monoxide levels) device based on ESP8266 node mcu microcontroller with MQTT protocol with A price of less than $40 has been provided.

2) JunHo Jo , ByungWan Jo , JungHoon Kim , SungJun Kim, and Woon Yong Han,2020,Department of Civil and Environmental Engineering, Hanyang University, 04763 Seoul, Republic of Korea 2Smart IS, 22101 Incheon, Republic of Korea,,The creation of an IoT-based indoor air quality monitoring systems is reported in this research. Experiments were carried out. done in order to validate the air quality measuring equipment A platform-based technique proposed by the Ministry of Korea's environment. We tested the precision of indoor air quality. quality control and desired performance of the device. Experiments utilising the platform were also conducted. carried out and exhibited appropriate performance and convenience of the platform for monitoring air quality Several The platform's accomplishments included the following: (1) The indoor air quality may be efficiently checked Using IoT and the cloud, you may access information from anywhere and in real time. Technology of computation;(2) For platform and data security, the platform used Amazon Web Services as a certified web server; (3) the Smart-Air device has an expandable interface, and the web server is also easily extendable, allowing easy application to various environments through the addition of appropriate sensors to the device or the installation of more Smart-Air devices in appropriate monitoring locations.The gadget and platform will be tested further in the future. The experiment in this study focuses on validating the device's dependability and deploying the platform, where further experiments are required to assure data correctness over lengthy time periods. A ventilation system can also be linked to the platform. As a result, when the air quality is poor, the system can function automatically to enhance it.

3) T.Veeramanikandasamy, Gokul Raj.S, A.Balamurugan, A.P.Ramesh, Y.A.Syed Khadar,2020,One of the most significant risks in many sectors is air pollution. It is essential to monitor and guarantee that the workplace is safe and free of pollution. This IoT-based air quality monitoring and control system employs an embedded system to continuously maintain air quality in industrial workplaces and to show the measured air quality index (AQI) on the ThingSpeak IoT platform and the Virtuino mobile app display. It supports new technologies by monitoring real-time environmental data such as CO, CO2, and ammonia gas concentrations, particulate matter

PM2.5 and PM10 in air, and temperature-humidity. The data is kept in the cloud server and may be sent to the user through e-mail.The system has maintained the air quality index (AQI) in the workplace if the threshold values for gas concentrations and PM are exceeded. This technology will eliminate the source of explosions and fires caused by gas leaks. Real-time air quality monitoring and control system based on IoT to decrease detrimental impacts in the industrial workplace.

4) Anabi Hilary Kelechi1, Mohammed H. Alsharif, Chidumebi Agbaetuo, Osichinaka Ubadike1 Alex Aligbe1, Peerapong Uthansakul, Raju Kannadasanand Ayman A. Aly,2021,This study successfully developed a low-cost air quality monitoring system design using Arduino and ThingSpeak, demonstrating that an air quality system can be constructed utilising low-cost technologies, such as Arduino and ThingSpeak. The project was tested in several areas, including unit, sub-unit, system, acceptability, and programme testing. In all testing settings, the system operates admirably. This method may be used to create a smartphone app that can be simply deployed to monitor air quality across the spectrum, ultimately benefiting public health.

5) Chaitra N, Bhavana S, Vilas Reddy D N, Nikhil AS,2020,Temperature, pressure, humidity, and, most crucially, PM2.5 AND PM10 detection play a vital part in residential, industry, and air quality monitoring. The system we are constructing is very modest when compared to prior and current air excellence intensive automobilee plans. This design provides the benefits of stability, low power usage, and self-sufficiency. Users may watch real-time information and track changes in the data. This design will also be useful for checking the atmospheric conditions in a specific area, which are difficult for humans to measure. By using trending approaches, this solution contributes to quality of life support.

6) Martin M. Soto-Cordova, Martha Medina-De-La-Cruz, Anderson Mujaico-Mariano,2020,The Internet of Things has aided in the resolution of tasks in several areas by managing data and making judgments that may lead to societal health improvement. As a result, the usage of this device will allow acquiring this information in real-time and publishing it via a link so that the population becomes aware of these circumstances while keeping in mind the principle of regulating by monitoring the emissions caused by human activities.

7) S. Nandhakumar, T. RoobanVengat, R. Ramkumar, K. Rakesh,2020,To measure air quality, a system to monitor the environment's air quality utilising an Arduino microcontroller and IOT technology is presented. The use of IOT technology allows for the monitoring of numerous components of the environment, such as air quality monitoring, and it may be retrieved when and when it is needed. The MQ135 gas sensor detects numerous harmful gases, and Arduino is at the core of this device, which regulates the entire operation. The Wi-Fi module connects the entire process to the internet, and the LCD is used for visual output. The Automatic Air & Sound Management System might be a game changer in contributing to a solution to the most serious problem.The air and sound monitoring system solves the problem of severely polluted locations, which might be a big concern. Furthermore, it is an auto monitoring system, which has the significant advantage of reducing human participation in dangerous environments while yet ensuring safety. It promotes innovative technologies and effectively promotes the healthy lifestyle philosophy. This system has capabilities that allow individuals to monitor the amount of pollution on their mobile phones while using the appliance.

## 3. Methodology

The goal is to gather data from sensors and communicate it to the user anytime the user wants to check the appropriate particle matter data (GP2Y1010AU0F sharp dust sensor) and carbon monoxide level (MQ-7). The Esp8266 NodeMCU-12E microcontroller serves as a gateway server for connecting to the Internet through Wi-Fi. It functions as a network, with control over the sensors that provide updates on the particulate matter value (PM 2.5), carbon monoxide value, and component condition. The data is protected by the Security Protocol (Transport layer security).For this study, we utilized a sharp dust sensor GP2Y1010AU0F (which detects analogue values) and a DHT11 (which measures both Temperature and Humidity). Furthermore, the data is continually kept in the MQTT Server. The benefit of utilizing the MQTT protocol with the Secure Socket Layer (SSL) cryptographic protocol is that no misleading data is saved alongside the needed data, and security is maintained.

### *4.2 Methods used For this Study is as Follows*

1) For programming controllers, use the Arduino Ide Embedded Programming Platform.
2) C and C++ are the official programming languages of the Arduino Ide software.
3) Communicating with the Thinkspeak Cloud Server using MQTT Protocol in Header Files.
4) An ATmega328 Programmable Hardware Microcontroller was also utilised, which was programmed using the Arduino IDE Software.
5) The Thinkspeak Cloud Server is used to monitor and log data from the IoT Controller NodeMCU.
6) ESP8266 Processor-based Hardware NodeMCU Controller, Foot IoT Communication
7) Using a Wi-Fi signal as a source to link the NodeMCU Controller to the internet.

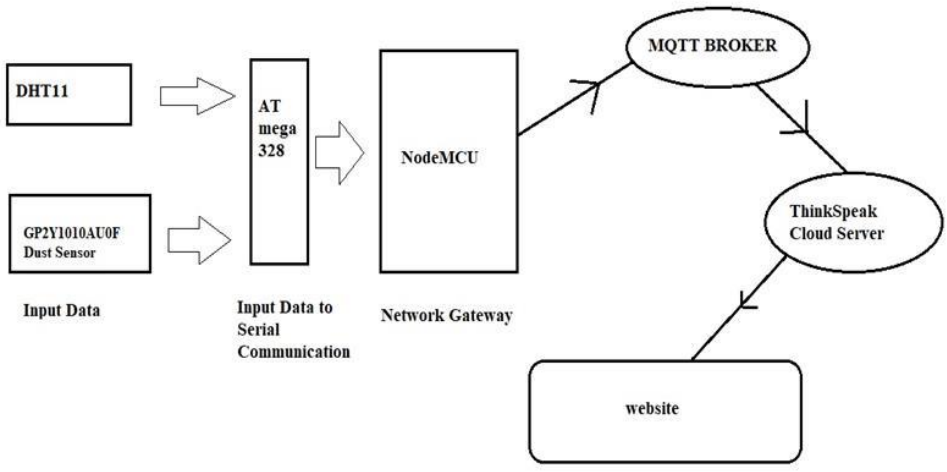


Figure 1. Block Diagram Explanation Of system

**Working Procedure:**

1) DHT11 is used to measure ambient temperature and humidity, while Dust Sensor (GP2Y1010AU0F) is used to measure dust levels ranging from 0.1 to 0.10 mg/m3.

2) The Atmega328 Microcontroller is utilised to receive data from sensors and calculate the surrounding parameters based on the computations in the Header File.
3) Using the serial Communication Program, send the data output to the NodeMCU.
4) The NodeMCU receives serial communication and filters the data from the characters.
5) Identify the specific character sign and filter the data.
6) Using logical operations, convert the character to an integer.
7) Use the configured wifi id and password to connect.
8) Use the Thinkspeak Header File to upload the data to the Thinkspeak Server.
9)All programming is done in the Arduino IDE software in C and C++.

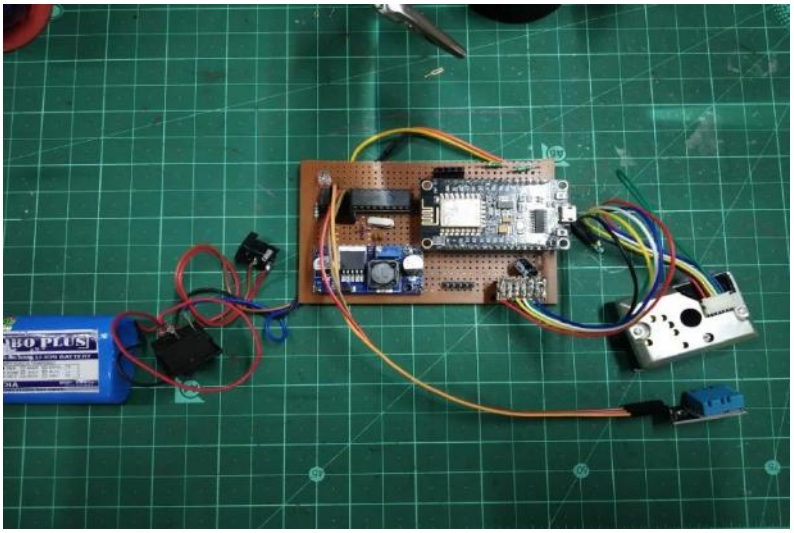

Figure 2.: Real Combined Circuit with ATmega328 ,NodeMCU,Dust Sensor,DHT11 Temp and Humidity sensor

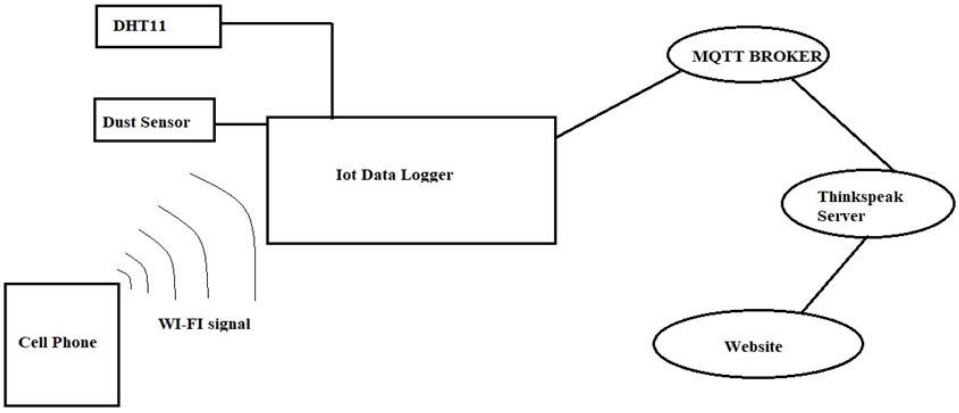


Figure 3. Block Diagram for Wi fi Communication

## 4. Result

As from the above Programming the Output Received in the Thinkspeak Server as Followings:

1) Temperature Data
2) Humidity Data
3) Dust Level Concentration

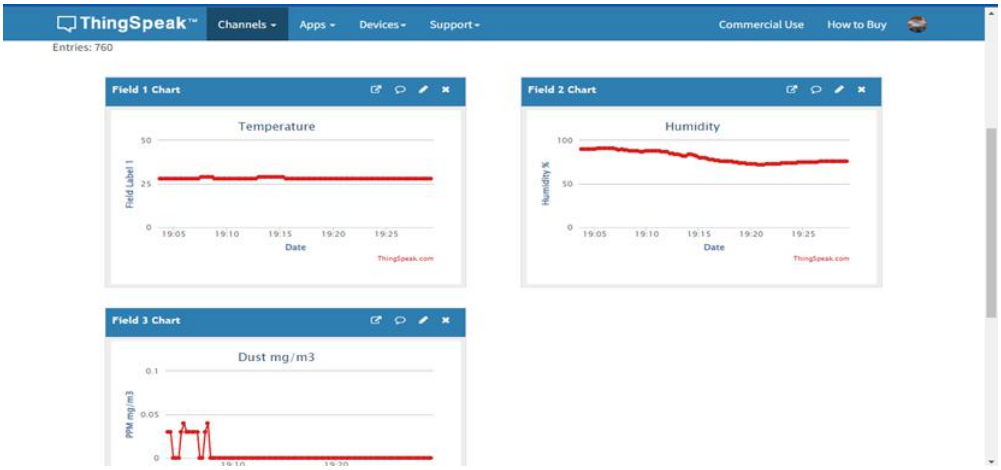


Figure 4. ThinkSpeak Server all Sensors Data Outputs

Connection established successfully in between Node MCU Hareware and Thinkspeak Cloud Server. The Result Output Obtained From the Programming and Real Time Data Monitoring of Sensors Output From Iot based hardware NodeMCU is shown Below.

### 1) Surrounding Temperature Data Out

To take temperature data from the DHT11 sensor and upload it to the Thinkspeak Sever. Temperature readings are monitored and saved in the figure below. Temperature readings in the surrounding area will be constant, so an external heat source (such as finger touching) is used to cause variation in the graph.

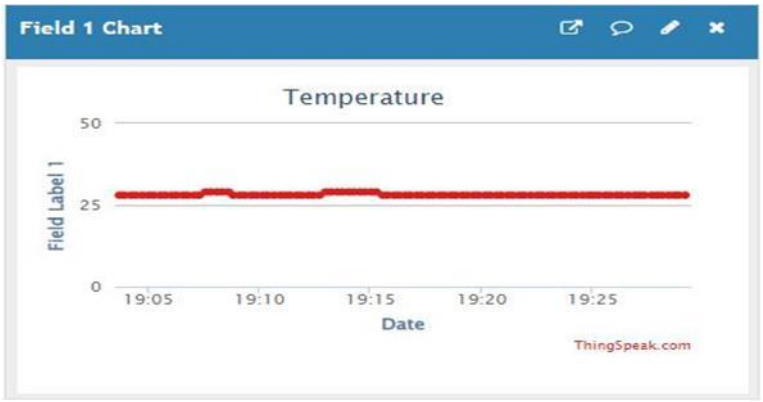


Figure 5. Surrounding Temperature data output in Thinkspeak Server

### 2) Surrounding Humidity Data

To take Humidity data from the DHT11 sensor and upload it to the Thinkspeak Sever. Humidity readings are monitored and saved in the figure below. Humidity readings in the surrounding area will be constant, so external dehumidifier is used (example Air Conditioner) to Reduce Humidity Value.

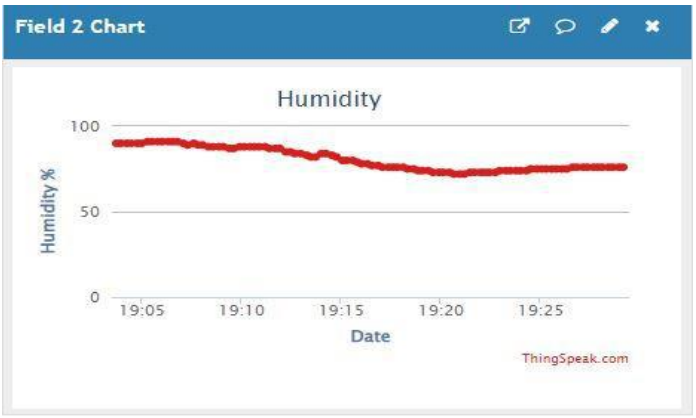


Figure 6. Surrounding Humidity Value in Thinkspeak Server website

### 3) Surrounding Dust Concentration In mg/m$^3$

To take Dust Concentration data from the DHT11 sensor and upload it to the Thinkspeak Sever. Dust Concentration readings are monitored and saved in the figure below. Dust Concentration readings in the surrounding area will be constant, so external Dust or particle source such as smoke is used to change the reading or for variation in reading.

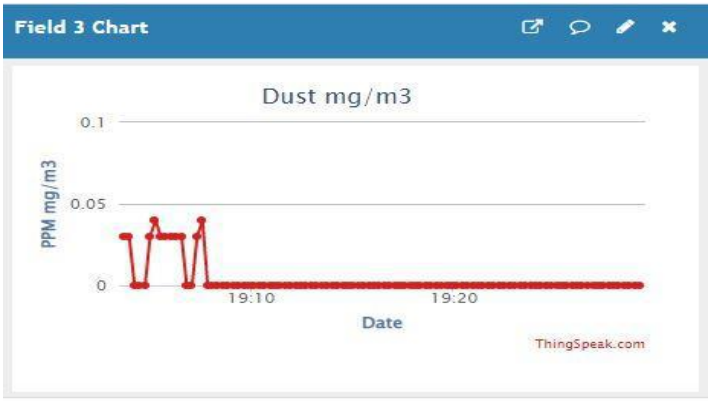


Figure 7. Surrounding Dust Concentration Value in Thinkspeak Server website

Figure 8. External Dust or smoke Source for variation in reading

**Data logged In Think speak Server**

As Think speak Server do two tasks Monitoring and Logging the datas so Readings also get logged in the Microsoft Excel Format. By Logged Datas Further Study and Graph Making Between particulate Times is also Possible. Further Comparison between multiple parameters can also be done using the Logged Data.

## 5. Conclusion

NodeMCU Controller is an excellent and low-power consumption module for IOT-based live data monitoring and logging with sensors. Because many sensors provide 5v output but the NodeMCU can only receive 3.3v input, an additional controller or hardware is necessary to receive the sensors data and transfer it to the NodeMCU Controller. Because Thinkspeak Cloud Server is a Cloud Platform, it requires a subscription (paying version) to update data in real time. As an example, in this project, a Trail version account is built that updates data every 15 seconds. Many other IoT-based hardwares are too expensive and need extensive Embedded programming. Low-cost IoT-based hardware is employed in this system, together with the C and C++ programming languages for Embedded Programming and Server Interfacing. For programming, the Arduino Ide open-source software compiler is utilized. For connectivity with the Thinkspeak server, the MQTT internet communication protocol is already included in the ESP8266.h header file. In this project, two programs are used: one for the ATmega328 Controller to communicate serially with the NodeMCU and another for the NodeMCU to post data to the internet. Other Cloud systems can also be used to upload and analyze data. Thinkspeak's shortcoming is that it does not display comparison graphs or graphs for certain time periods separately. Although it offers advanced features such as Matlab analysis for advanced analysis.

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