International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 09 | Sept - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Air Quality Monitoring System Using Raspberry PI

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Abstract -In addition to influencing human activity and contributing to global warming, air pollution endangers the ecology and the standard of living on Earth. Improving the effectiveness of air pollution monitoring techniques and methodologies is crucial to preventing such unfavourable instability in nature. This research proposes the creation and deployment of an efficient IoT-based remote air pollution monitoring system. The Raspberry Pi microcontroller and Arduino Leonardo module are used in the system's development. The MQ2, MQ7, MQ9, and MQ135 gas sensors are used to measure the concentration levels of LPG, carbon monoxide, methane, and carbon dioxide in the air. These sensors are capable of detecting a wide range of dangerous gases and accurately determining their concentration. The air pollution monitoring system provides remote access by measuring air quality parameters and sending them in real-time to a cloud server. The results of experiments conducted with the computerized air quality monitoring system demonstrate that it offers a trustworthy source of up-to-date information on air pollution. The creation of an inexpensive infrastructure that permits data aggregation and dissemination to all users is the primary goal of this effort.

Key Words: Air pollution, raspberry pi, Think speaks, Remote Monitoring.

1. INTRODUCTION

The most important factor for our happiness is a healthy atmosphere. To live a safe and secure existence, we require an environment free from pollution. It is concerning that pollution levels in major cities, particularly Delhi, have recently increased. Air pollution shouldn't be a major worry in a world where technology is developing quickly and automobiles might drive themselves and drones could even pick up your meals, but the data above show that this isn't the case. One such item that can give the user the surrounding air quality index is our application. This is a simple system that alerts the user to the many types of pollutants and their concentrations in the atmosphere.

Figure 1: Air Quality Monitoring System

Additionally, we can add a buzzer alarm to alert the user when the pollution level crosses a predetermined threshold. This will let the user realize that living there is not safe or healthy. The user can now relocate to a safer area or take the required actions to lessen air pollution. The Internet of Things concept enables us to record information on the kinds and concentrations of air pollutants so that users may examine changes over time. So that the user may determine if the quality of the air is becoming better or getting worse over time.

These devices, which are accessible to everyone, are desperately needed, particularly in areas with high pollution levels. Therefore, after carefully examining the statistics, we might consider reducing the daily human activities that contribute to air pollution. This provides us with the chance to investigate the reasons

behind rising pollution levels or what positive developments should be maintained when pollution levels fall. The information that the user receives from our system may be used to make these kinds of judgments.

2. Literature Review

To enhance environmental quality, engineers and researchers working in the field of air pollution monitoring made numerous attempts. The findings of numerous studies on air quality monitoring techniques have been published during the past few decades. Numerous researchers used wireless sensor networks in their studies, according to the assessment and analysis of scientific literature sources. A comparative analysis of contemporary air pollution monitoring methods is presented in the work [4]. The authors examined techniques for analyzing pollution data as well as both static and dynamic monitoring systems. The following criteria were used to compare the systems: methods analysis, gearbox data approaches, and gas kinds that are measured with sensors. There was discussion of the reviewed systems' advantages and disadvantages.

An IoT and edge computing-based air pollution monitoring system was presented in [5]. The Arduino module was used to create a hardware prototype for the system. The ESP8266 WiFi module is used to send the measured data to the cloud service IBM Watson IoT platform.

An Arduino platform was used in the design of the air pollution monitoring system presented by the authors in [6, 7]. Real-time data storage on the remote server is a possibility for the system under consideration. The Arduino Uno module's low microcontroller processing power and the system's restricted number of channels for connecting sensors are its drawbacks.

The IoT-based air quality monitoring system is described in the publication [8]. Temperature, humidity, and gas sensors are used by the system to gather data, which is then sent to the ESP8266 module, which then sends it to the web server. To forecast future pollution levels, the suggested method makes use of a Recurrent Neural Network based on Long Short Term Memory. Nevertheless, the ESP8266 module's microprocessor only has one channel available for interfacing analogue sensors. The system's functionality is diminished by this restriction.

The creation of an Arduino-based air pollution monitoring system has been detailed in [9]. To improve the accuracy of measuring the amount of air pollution caused by CO and CO2 emissions, the scientists suggest using fuzzy logic algorithms built into the Arduino microcontroller software. Nevertheless, the system can only show the monitoring findings on the LCD and cannot send them to a distant web server.

The IoT-based air quality monitoring system for smart cities, as detailed in [10], is another intriguing deployment. This system collects information about the level of air pollution from sensors using a Raspberry Pi microprocessor equipped with an analogue to digital converter (ADC) called the MCP3208. In order to use graphs to display monitoring results, the Raspberry Pi communicates with the IoT cloud platform Thing Speak. Additionally, the data can be shown in tabular form using an Android application.

A method for monitoring air pollution that uses semiconductor sensors and the Nucleo F401RE board to measure the concentrations of NO2, SO2, CO2, and CO gases is presented in the publication [11].

The Raspberry Pi platform served as the authors' base station for gathering sensor data and building the web server that would show the monitoring results. Using gas and dust sensors, the authors of [12] have created an Internet of Things-based system that offers an efficient way to track the amount of air pollution. Through the SPI interface, the MCP3008 ADC transfers the digitally formatted sensor data to the ESP8266 microcontroller.

The monitoring data is transferred to an IoT-based cloud platform by the system via WiFi and GPS modules. Moreover, Google Maps has shown the different pollution values.

3. Methodology

A block diagram of the proposed information-measuring system for air quality monitoring is depicted in Figure 2.

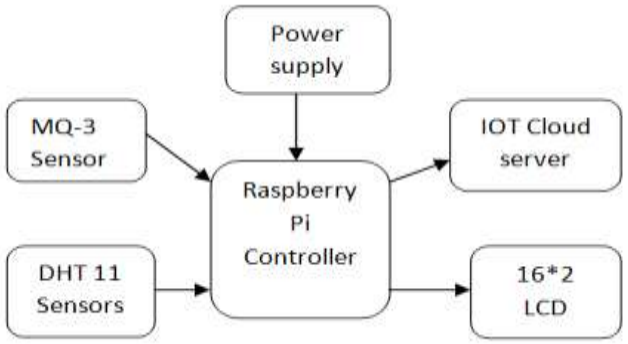

Figure 2: Structure of air pollution monitoring system

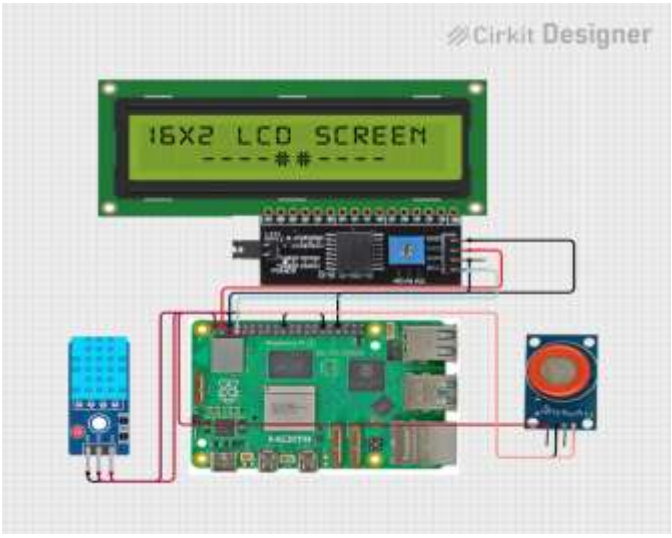

Figure 3: Circuit Diagram of air pollution monitoring system

The following are the primary elements of the suggested system:

- Gas sensors
- Dht 11 sensor
- Cloud platform
- Raspberry Pi microcomputer

The concentrations of dangerous gases in the air are measured by the gas sensors. In the planned Internet of Things architecture, the Raspberry Pi module serves as the computing node's gateway. It sends the measured results to a distant server after receiving them from the microcontroller. For additional processing and analysis, the measurement results are stored on an IoT-based cloud platform and shown as graphs.

The solder less breadboard is used to install the air quality sensor modules. Raspberry Pi into a single device to benefit from both platforms was a problem during the construction of the suggested solution. On the other hand, the Raspberry Pi uses its networking and computational power to process and send data over the Internet.

Thing Speak is an Internet of Things cloud platform that enables the collection, visualization, and analysis of streaming data. It can retrieve data from a wide range of computing devices, including Raspberry Pi, Arduino, ESP, and other comparable modules. Thing Speak is a free service that offers robust IoT capabilities, including the ability to show data in real time. It is therefore the ideal option for the planned air pollution monitoring system. MATLAB functions can be used to visualize, handle, and analyze the data after it has been received over the Thing Speak channel.

4. Results and Discussion

The hardware implementation of the proposed system for air quality monitoring using raspberry pi, mq3 sensor and dht11 sensor is shown in Figure 6

Figure 4: The hardware implementation of the designed system with temperature and humidity outputs

Figure 5: The hardware implementation of the designed system with Gas outputs

The measurement results of air quality parameters are shown in Figure 6.

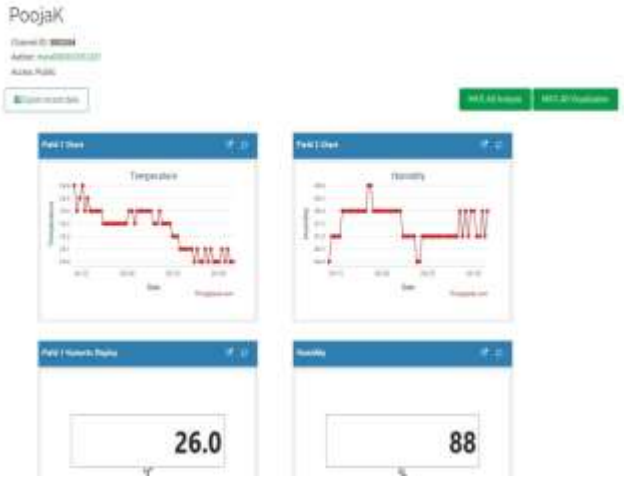

Figure 6: The hardware implementation of the designed system with temperature and humidity outputs on Think Speak IOT Platform

Measurements of air pollution were made using the parts per million metric. Numerous options are available for visualizing sensor data through the Thing Speak cloud platform. Monitoring results are visualized graphically on a webpage to show data in real time. A mobile application can also be used to obtain this data.

Figure 7: The hardware implementation of the designed system with MQ3 gas sensor outputs on Think Speak IOT Platform

All year long, all of the information can be stored on the server thanks to the Thing Speak platform. Any program can export data for additional processing. Numerous chances for statistical data processing, extra computations, and in-depth data analysis are thus presented.
Tests of the designed remote air pollution monitoring system were conducted employing a range of measurements in common and typical air states as well as uncommon and abnormal ones.

5. CONCLUSIONS

One significant issue that has a direct impact on human health is air quality. A computerized remote air pollution monitoring system that offers real-time access to air quality measurement results was proposed in this research. The Raspberry Pi, MQ3 sensor, and DHT11 sensor form the basis of the system. The Thing Speak IoT cloud platform receives and retains the measured data from the system.
The monitoring system that was successfully created and put into use shows the data on air pollution in real time on a webpage. Data is being gathered using this method in order to thoroughly analyze a number of parameters. The results of the installation demonstrate that the system is easy to use, reasonably priced, and offers real-time online access to data regarding the air pollution concentration. In order for the user to take the appropriate action or relocate to a safe area, the system also notifies them

when the pollutants reach a threshold value. The Thing speak IoT platform is helpful for future analytics in terms of data storage and comprehensive, visually appealing analysis. The realm of technology is seeing a lot of inventions. Our system might get some intriguing features with a lot more advancements in the future. The design of our system allows for the addition of additional features for future development. Our air pollution monitoring system has been effectively put into place, and it might be improved with more advancements and prolonged technological use.

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