IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, April 2025
Impact Factor: 7.67

A Smart Air Pollution Monitoring System

D. Jagan[1], Navya Sree Nallanagula[2], Supritha Pothukanuri[3], Sandeep Gaddam[4], Sanjay Regula[5]
Assistant Professor, Dept. of Electronics & Communication Engineering[1]
UG Student, Dept. of Electronics & Communication Engineering[2-5]
Christu Jyothi Institute of Technology & Science, Jangaon, Telangana, India

Abstract: *Air pollution is a growing environmental concern that affects human health, ecosystems, and the climate. With the emergence of Internet of Things (IoT) technologies, it has become possible to develop low-cost, scalable, and effective monitoring systems. This paper discusses the creation of a Smart Air Pollution Monitoring System that uses IoT to observe and report air quality in real time.*
The system uses an MQ135 sensor for gas detection and a DHT11 sensor for temperature and humidity, all managed by an ESP8266 microcontroller. Data is transmitted to the Arduino IoT Cloud for remote access and historical analysis, suitable for diverse environments

Keywords: Arduino IDE, ESP8266, IoT

I. INTRODUCTION

Air pollution has become one of the most pressing challenges of the modern world, impacting human health, ecosystems, and the global climate. The growing emission of harmful gases from vehicles, industrial activities, and the burning of fossil fuels has led to a significant decline in air quality, especially in urban areas. Breathing polluted air results in various health issues, including respiratory diseases, heart problems, and other chronic conditions. Traditional air pollution monitoring methods tend to be expensive, bulky, and often lack real-time data visualization. Moreover, these systems are generally centralized, providing little access or control for individuals or communities to monitor or respond.

In response to these challenges, this paper presents a Smart Air Pollution Monitoring System that leverages the power of the Internet of Things (IoT) to provide real-time, location-specific air quality monitoring. The system is based on the NodeMCU ESP8266 microcontroller and integrates sensors such as the MQ135 for gas concentration and the DHT11 for temperature and humidity measurements. The data collected by these sensors is transmitted to the Arduino IoT Cloud and displayed on a local LCD screen, ensuring easy access and visibility. This system aims to empower individuals and authorities to take timely action and make informed decisions regarding air quality management.

II . LITERATURE SURVEY

The Air Quality Index (AQI) is a standard measure to evaluate the safety of the atmosphere for human life. When the AQI level remains between 0 to 100 ppm, the air is considered safe. If the level crosses 100 ppm, it moves beyond the safe zone, and readings above 200 ppm become extremely dangerous for health. This project uses two main sensors: the DHT11 sensor, which monitors temperature and humidity, and the MQ-135 gas sensor, which detects air pollutants. The MQ-135 is capable of sensing gases like carbon dioxide, alcohol, hydrogen, and methane. For this project, it is calibrated with respect to clean, fresh air to ensure accuracy in monitoring. The system's controller is the NodeMCU, which includes a built-in Wi-Fi module, allowing easy Internet of Things (IoT) integration. The coding is done in C++ using the Arduino IDE, and the data collected from the sensors is sent to the ThingSpeak cloud platform, which supports real-time data uploads every 15 seconds under its free version.

Since both sensors have internal heating elements and require more power (based on the formula $P = V \times I$), powering them directly through the NodeMCU can result in unstable output voltages and inconsistent readings. To ensure reliable performance, a separate power source is provided to the sensors. This allows both to function correctly without being affected by insufficient current supply from the microcontroller. This setup helps maintain the accuracy of the readings, especially in long-term monitoring. The design focuses on creating an efficient and sustainable air quality monitoring system that can be deployed in urban or industrial environments to raise awareness and support timely actions.

The broader motivation for this work lies in the increasing impact of air pollution in developing nations. Pollution not only contributes to various environmental problems but also leads to serious health issues. Harmful chemicals and particulate matter in the air are known to cause respiratory and cardiovascular diseases. The proposed system, consisting of an Arduino, LCD, ESP8266 Wi-Fi module, and MQ-135 gas sensor, demonstrates a cost-effective and scalable solution using IoT technologies for real-time environmental monitoring.

III. IOT (INTERNET OF THINGS)

The Internet of Things (IoT) has significantly transformed how devices communicate and share data over the internet. It involves connecting physical objects to the digital world by embedding them with sensors, software, and connectivity. These objects can then collect and exchange data, enabling smarter decision-making and automation. In the context of environmental monitoring, IoT allows real-time tracking of various parameters, providing valuable insights into the surrounding environment.

In the proposed air pollution monitoring system, IoT is utilized with the help of a Wi-Fi-enabled ESP8266 NodeMCU, which serves as the central hub for connecting sensors to a cloud-based platform. This integration enables the system to collect data from the sensors and transmit it wirelessly in real-time. The ESP8266 functions as the bridge between the sensors and the internet, allowing continuous, automated monitoring of air quality without the need for manual intervention.

By leveraging IoT, this project provides intelligent environmental sensing, where air quality data is continuously updated and users are alerted when pollution levels exceed safe thresholds. This real-time monitoring ensures that individuals and authorities can take immediate action if air quality becomes hazardous. Ultimately, the system supports the development of smart cities and environmentally conscious initiatives, offering an efficient and scalable solution for air pollution monitoring across remote locations.

IV. WORKING

Smart air pollution monitoring systems rely on sensors that collect air samples and measure pollutants, along with various weather parameters. These sensors are equipped with different detection methods, including optical, electrical, and thermal techniques, to identify harmful substances in the air. For example, laser scattering can be used to measure particulate matter concentrations, helping to assess air quality and the level of airborne pollutants.

In addition to particulate matter, these sensors can detect gases like carbon dioxide (CO_2) and carbon monoxide (CO), as well as other toxic gases that may be harmful to human health. The sensors can also measure temperature, humidity, and smoke levels. By collecting data on these various environmental factors, the system provides a comprehensive understanding of the surrounding air quality and climate conditions.

The sensor output circuits are connected to a

controller, which processes the collected data. Through the Internet of Things (IoT), this data is transmitted to a modem, allowing for remote access and real-time monitoring. The system analyzes the data and provides up-to-date atmospheric quality information to users, allowing them to make informed decisions about environmental conditions and air quality.

V. EXISTING SYSTEM

Traditional air pollution monitoring systems face several limitations that hinder their effectiveness in everyday use. Most of these systems are expensive and lack portability, making them impractical for personal or household applications. They are typically designed for large-scale monitoring by government agencies and require laboratory analysis to assess air quality. This often makes the systems inaccessible for individual users who need real-time data.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429 Volume 5, Issue 11, April 2025 Impact Factor: 7.67

Another key drawback of existing systems is the lack of real-time or remote access. These systems usually don't provide historical data storage or alert mechanisms to notify users of dangerous air quality levels. Due to their complexity and high cost, they are not feasible for everyday use, and they fail to offer an intuitive user experience for people who need constant monitoring of air pollution levels in their environment.

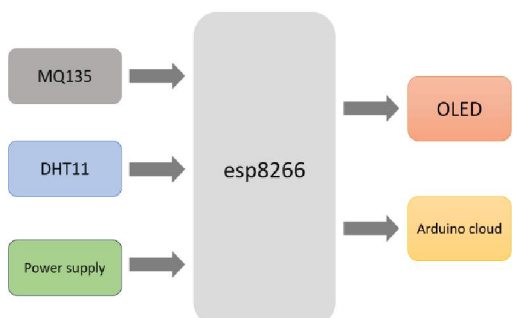
Earlier methods of air quality monitoring also lacked important features such as data visualization and integration with smart devices. There were no provisions for remote data access or automated actions that could be triggered based on pollution levels. These limitations created a clear need for an affordable, real-time, and user-friendly system—such as the one proposed in this project—that addresses these challenges and empowers users to actively manage their environment.

VI. PROPOSED METHOD

The proposed system addresses the limitations of traditional air pollution monitoring by using a Wi-Fi-enabled ESP8266 NodeMCU as the central processing and communication unit. This microcontroller connects to environmental sensors, including the MQ135 gas sensor and the DHT11 temperature and humidity sensor, to gather crucial data. The MQ135 measures pollution levels in parts per million (PPM), while the DHT11 tracks temperature and humidity conditions.

Once the data is collected, it is displayed locally on a 16x2 LCD screen for immediate feedback. At the same time, the ESP8266 transmits the data via Wi-Fi to the Arduino IoT Cloud, where it is visualized in a graphical format. The cloud platform allows users to track air quality over time and set up alerts for dangerous pollution levels.

This real-time monitoring system provides both local and remote access to air quality data, enabling users to monitor their environment from anywhere. It is compact, energy-efficient, and reliable, making it suitable for a variety of settings such as schools, homes, offices, and public spaces. By combining real-time data collection with cloud-based monitoring, the system offers an affordable, user-friendly solution for managing air pollution and promoting better air quality in everyday environments.



BLOCK DIAGRAM FOR AIR POLLUTION MONITORING SYSTEM

VII. SOFTWARE EMPLOYED

The system software is developed using the Arduino IDE, which is compatible with programming the ESP8266 NodeMCU. To manage Wi-Fi connectivity, sensor communication, and LCD interfacing, various libraries are utilized, such as ESP8266WiFi.h, DHT.h, and LiquidCrystal_I2C.h. These libraries allow seamless integration of sensors and devices into the system, enabling effective data transmission and display. Additionally, the ThingProperties.h library is used to connect the device to the Arduino IoT Cloud, facilitating cloud-based monitoring.

After writing and compiling the software code, it is uploaded to the ESP8266 NodeMCU using a USB cable. The cloud dashboard is then customized to visualize environmental data, such as temperature, humidity, and gas levels. The dashboard includes interactive widgets like gauges and charts, providing an intuitive way for users to track air quality. The system updates values every 15 seconds to ensure real-time monitoring, and users can configure thresholds for alerts through the cloud interface.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, April 2025
Impact Factor: 7.67

Before implementation, the hardware setup and sensor outputs were validated using Proteus software to simulate the circuit. This step ensured that all components were correctly connected and that the sensor outputs functioned as expected, minimizing the risk of errors during the actual deployment of the system. The simulation provided valuable insights and allowed for adjustments before finalizing the setup.

VIII. RESULTS & DISCUSSION

After successfully implementing both the hardware and software components, the system was tested in various environments to assess its performance. During testing, the LCD display consistently showed accurate real-time readings for temperature, humidity, and gas concentrations. The data collected by the system was updated continuously on the Arduino IoT Cloud dashboard, where it was displayed graphically, making it easy for users to monitor air quality.

The gas sensor proved to be effective in detecting increased pollution levels, particularly near sources such as kitchens, vehicles, and areas with smoke. Similarly, the temperature and humidity sensors accurately responded to environmental changes, demonstrating the system's capacity to monitor a range of environmental factors. The system ran continuously during testing, providing real-time updates without any significant delay, further confirming its reliability.

One of the key features observed during testing was the alert mechanism. Gas concentration values exceeding 150 PPM triggered alerts, which could be used to warn users or automatically activate air purification systems. These results confirmed that the system is a reliable and practical solution for everyday air quality monitoring, offering real-time updates and automation for a wide range of environments.

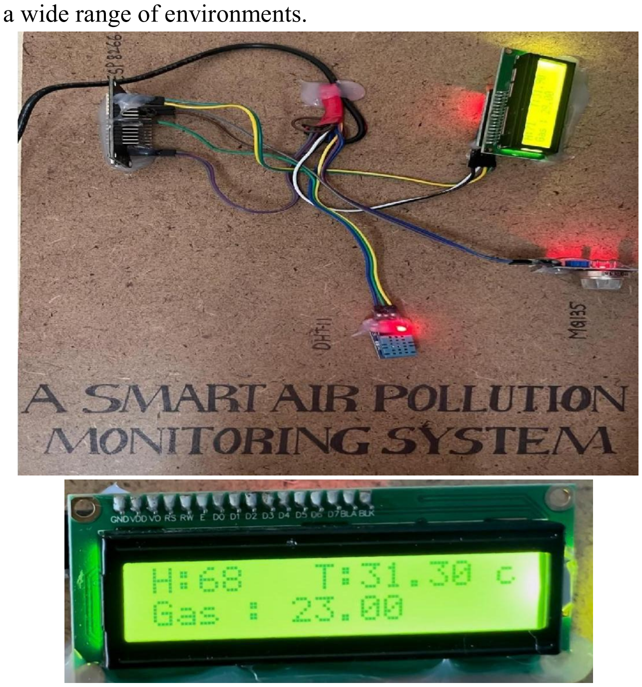


Fig: Output Diagram

IX. CONCLUSION

The Smart Air Pollution Monitoring System is a cost-effective and efficient IoT-based solution for real-time air quality monitoring. It integrates gas and weather sensors with a Wi-Fi-enabled ESP8266 microcontroller to display and transmit environmental data locally and remotely via the Arduino IoT Cloud. Designed for ease of use and installation, the system supports public health awareness and is suitable for homes, schools, offices, and urban spaces. Its compact design and cloud dashboard enable users to track air conditions and detect harmful levels early

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, April 2025
Impact Factor: 7.67

X. FUTURE SCOPE

The future scope is that device which we are having can be done in an compact way by reducing the size of the device. For further implementation or the modifications which can be is that detecting the vehicles amount of pollution which can be determined. Infuture the range can be made increased according to the bandwidth for the high range frequencies.

REFERENCES

[1] D. J. and A. Ravindhar, "A System for Monitoring Air Pollution Using IoT and ESP8266-12", 2019
[2] B. Kim et al., "Creation of a Monitoring System for the Air Environment Based on IoT", 2017
[3] Simon et al., "IoT-Based Air Quality Monitoring", 2019
[4] D. Yamanathangam et al., "IoT-Based Air Pollution Awareness System", YMER, 2024
[5] Kamble et al., "An IoT Approach to Air Quality Monitoring", 2018

DOI: 10.48175/IJARSCT-25862