IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 6, June 2026

DOI: 10.17148/IJIREEICE.2026.14609

"AIR POLLUTION DETECTION USING IOT "

Prof. P. K . Digge [1], Shrushti Sanjay Ghante [2], Sanchita Rajesh Devkate [3], Pradnya Pradeep Kumri [4]

Department of Electrical Engineering, Shree Siddheshwar Women's College of Engineering, Solapur, India [1-4]

Abstract: Air pollution has become a critical global challenge, demanding continuous and accurate monitoring to support timely mitigation efforts. This paper presents an Internet of Things (IoT)–based air pollution detection system designed to provide real-time assessment of key atmospheric pollutants. The proposed framework integrates low-cost environmental sensors with a microcontroller and wireless communication modules to measure parameters such as particulate matter, carbon monoxide, nitrogen dioxide, temperature, and humidity. Sensor data are transmitted to a cloud platform for storage, visualization, and analysis, enabling remote access through a web or mobile interface. Intelligent data processing techniques are employed to identify abnormal pollution patterns and trigger alerts. The system emphasizes energy efficiency, scalability, and ease of deployment, making it suitable for urban, industrial, and residential environments. Experimental results demonstrate reliable performance and show that IoT-based monitoring can deliver high-resolution environmental insights at a significantly lower cost compared to conventional monitoring stations. The study concludes that the proposed solution can support smart-city infrastructures and inform public health and policy decisions through continuous, real-time air quality surveillance.

Keywords: Internet of Things (IoT),Air Quality Monitoring,Pollution Detection, Smart Environment,GasSensor,MQ135 Sensor,MQ2 Sensor,Arduino Uno,NodeMCU,ESP8266,Environmental Monitoring,Real-Time Monitoring,Wireless Sensor Network,Smart City,Temperature and Humidity Sensor,Cloud Computing, Air Pollution Control,Embedded System,Data Analytics,IoT-Based Monitoring System.

I. INTRODUCTION

Air pollution has emerged as one of the most critical environmental challenges affecting human health, climate, and overall ecosystem stability. Rapid urbanization, industrial growth, vehicular emissions, and population expansion have significantly deteriorated air quality in many regions. Traditional air monitoring stations, although accurate, are expensive, limited in number, and incapable of providing localized real-time pollution levels. Therefore, there is an urgent need for a low-cost, scalable, and continuous air quality monitoring solution.

The Internet of Things (IoT) has enabled the development of smart, interconnected sensing systems capable of collecting, processing, and transmitting environmental data in real time. By integrating gas sensors, microcontrollers, and wireless communication technologies, IoT-based air pollution detection systems can monitor harmful pollutants such as CO_2, CO, NH_3, PM2.5, and PM10 with improved accessibility and affordability. These systems allow users, researchers, and authorities to observe pollution trends, receive alerts, and take preventive measures. This work presents an IoT-enabled air pollution detection system that employs sensors such as MQ-135 for toxic gases, along with temperature and humidity modules, connected to an ESP32/Node MCU microcontroller. The captured data is transmitted to a cloud platform using Wi-Fi or MQTT protocol for visualization and analysis. The system provides real-time monitoring, early warning alerts, and data logging capabilities, making it suitable for smart city applications and environmental protection initiatives.

The proposed design aims to offer a cost-effective, energy-efficient, and user-friendly approach to continuous air quality assessment. Despite these advances, challenges remain in terms of sensor calibration, data reliability, energy efficiency, and system scalability. Addressing these limitations is essential for developing robust monitoring platforms suitable for smart cities, industrial zones, and vulnerable residential communities. This research focuses on designing and implementing a practical, low-cost IoT-based air pollution detection system that provides accurate, real-time air quality assessments. The study highlights the system architecture, communication framework, data processing methods, and performance evaluation, demonstrating how IoT can significantly improve environmental monitoring and decision-making processes.

DOI: 10.17148/IJIREEICE.2026.14609

II. BLOCK DIAGRAM

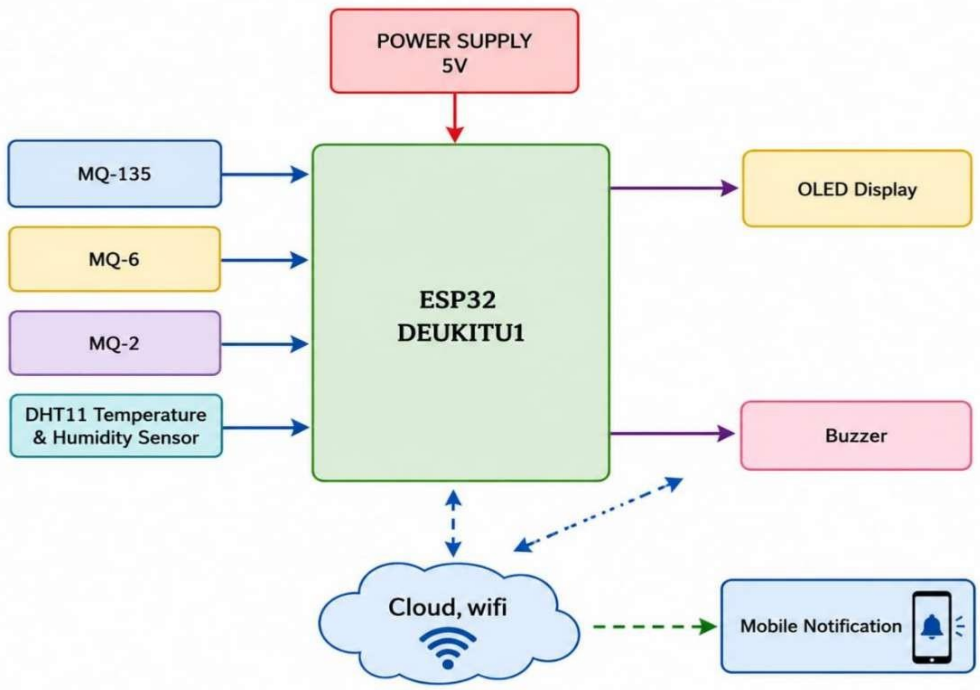

Fig Block Diagram of Air Pollution Detection

The illustrated system is centered around the ESP32 microcontroller, which serves as the primary processing and communication unit for real-time air quality monitoring. Several sensors are interfaced with the ESP32 to detect different environmental parameters: the MQ-135 sensor measures overall air quality and identifies harmful gases such as ammonia and benzene; the MQ-6 sensor detects the presence of LPG and related combustible gases; the MQ-2 sensor identifies smoke, methane, and other flammable gases; and the DHT11 sensor provides essential temperature and humidity data that help in understanding environmental conditions and calibrating gas readings. A regulated 5V power supply ensures stable operation of the ESP32 and all connected components. Once the ESP32 receives data from the sensors, it processes the readings, evaluates pollutant levels, and displays the measured values on an OLED display for immediate local monitoring. If any sensor value exceeds predefined safety thresholds, the ESP32 triggers a buzzer to provide an audible alert, ensuring quick attention to hazardous conditions. Simultaneously, the ESP32 utilizes its built-in Wi-Fi capability to transmit the collected data to a cloud platform, where it can be stored, analyzed, and accessed remotely. Through the cloud service, users receive mobile notifications whenever abnormal or dangerous air quality levels are detected, enabling timely action even when they are not physically near the device. This integrated architecture ensures continuous, accurate, and accessible environmental monitoring suitable for smart-home and smart-city applications.

III. WORKING PRINCIPLE

The working principle of the IoT-based air pollution detection system is based on continuous sensing, data processing, and wireless communication. When powered by a stable 5V supply, the ESP32 microcontroller activates the connected sensors—MQ-135, MQ-6, MQ-2, and DHT11—which begin measuring air quality parameters such as harmful gases, smoke, LPG leakage, temperature, and humidity. Each sensor produces an analog or digital output proportional to the concentration of the detected pollutant. The ESP32 reads these signals, converts them into meaningful values using its internal ADC and programmed calibration formulas, and then compares the measurements against predefined safety thresholds stored in the system. If the gas concentration surpasses safe limits, the ESP32 immediately drives the buzzer to issue an audible warning, while the OLED display shows real-time readings for local monitoring. In parallel, the ESP32 connects to the internet via built-in Wi-Fi and uploads the processed data to a cloud platform. This enables remote observation of air quality trends and triggers automatic mobile notifications to alert users about hazardous conditions.

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.021 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 6, June 2026
DOI: 10.17148/IJIREEICE.2026.14609

Through this integrated sensing, decision-making, and communication process, the system continuously monitors environmental pollution and ensures timely alerts for preventive action.

III. BACKGROUND

Air pollution has become a major global concern due to rapid industrialization, unplanned urban growth, and the increasing use of motor vehicles and fossil fuels. Pollutants such as particulate matter, carbon monoxide, nitrogen oxides, and volatile organic compounds significantly degrade air quality and pose serious health risks, including asthma, respiratory infections, heart diseases, and long-term environmental damage. Traditional air monitoring stations, although highly accurate, are expensive, stationary, and limited in number, which restricts their ability to capture localized variations in pollution levels. As pollution levels can change rapidly depending on human activities and environmental conditions, there is a growing need for real-time, continuous, and widely distributed monitoring solutions. The emergence of the Internet of Things (IoT) has transformed the way environmental data can be gathered and analyzed. IoT enables the integration of low-cost sensors, wireless communication, and cloud computing to create smart, interconnected monitoring networks capable of capturing real-time air quality data across multiple locations. These systems allow users and authorities to remotely access environmental information, receive alerts during hazardous conditions, and take timely action to reduce exposure or mitigate pollution sources. Compared to traditional methods, IoT-based solutions offer flexibility, scalability, and affordability, making them suitable for deployment in homes, industries, urban environments, and smart-city infrastructures. The growing interest in IoT-driven environmental monitoring forms the foundation for developing affordable and reliable air pollution detection systems, which can play a crucial role in protecting public health and supporting sustainable development.

IV. SYSTEM REQUIREMENTS

The proposed IoT-based air pollution detection system requires a combination of hardware and software components to ensure accurate sensing, reliable processing, and seamless communication. The primary hardware requirement is the ESP32 microcontroller, selected for its fast-processing capability, built-in Wi-Fi, low power consumption, and multiple analog/digital input pins for sensor integration. The system also incorporates environmental sensors such as the MQ-135 for air quality measurement, MQ-6 for LPG detection, MQ-2 for smoke and flammable gases, and the DHT11 sensor for temperature and humidity monitoring. Additional hardware components include a 5V regulated power supply for stable operation, an OLED display for local visualization of readings, and a buzzer to provide audible alerts during hazardous conditions. Jumper wires, a breadboard or PCB, and connectors are required for proper assembly and signal transmission. On the software side, the system requires a suitable embedded development environment, such as the Arduino IDE or ESP-IDF, to program the ESP32 and manage sensor calibration, data processing, and threshold evaluation. The system also relies on Wi-Fi connectivity and a cloud platform, such as Firebase, Thing Speak, or MQTT-based servers, for real-time data storage, remote monitoring, and user notifications. Additionally, a mobile or web dashboard is needed to present air quality information to users in an intuitive and accessible format. Together, these hardware and software elements form a complete and efficient system capable of providing continuous, real-time air pollution monitoring

V. PROPOSED SYSTEM

The proposed system is designed to provide real-time air pollution monitoring using an IoT-based approach that combines environmental sensors, a microcontroller, and cloud communication. The main objective is to detect harmful gases and particulate matter in the environment, process the data locally, and make it accessible remotely to ensure timely alerts and informed decision-making. The system architecture integrates an ESP32 microcontroller with multiple sensors, including MQ-135 for general air quality detection, MQ-6 for LPG leakage, MQ-2 for smoke and combustible gases, and the DHT11 sensor for measuring temperature and humidity. The ESP32 continuously collects data from all sensors, converts the analog readings into meaningful values, and compares them with predefined safety thresholds. Sensor readings are displayed on an OLED screen for local monitoring, while a buzzer is activated when pollutant concentrations exceed safe limits, alerting nearby individuals immediately. Simultaneously, the processed data are sent to a cloud platform via the ESP32's built-in Wi-Fi module, enabling remote monitoring and historical data analysis. Through the cloud platform, users receive notifications on mobile devices when air quality becomes hazardous. The proposed system emphasizes cost-

DOI: 10.17148/IJIREEICE.2026.14609

effectiveness, scalability, and energy efficiency, making it suitable for deployment in homes, offices, schools, industrial zones, and urban areas. It not only provides continuous monitoring but also allows for data-driven decision-making to mitigate air pollution and protect public health. By integrating real-time sensing, local alert mechanisms, and remote cloud-based monitoring, the system offers a practical solution for modern smart-city applications

V. HARDWARE IMPLEMENTATION

VI. CONCLUSION

This study presents an IoT-based air pollution detection system capable of continuously monitoring environmental parameters such as harmful gases, smoke, temperature, and humidity in real time. By integrating multiple low-cost sensors with the ESP32 microcontroller, the system not only provides accurate local readings via an OLED display and audible alerts through a buzzer but also enables remote monitoring through cloud connectivity. The system ensures timely notifications to users when pollutant levels exceed safe thresholds, promoting immediate preventive action and contributing to public health safety. The proposed design is cost-effective, scalable, and energy-efficient, making it suitable for deployment in homes, industrial areas, schools, and urban environments. By leveraging IoT technology, the system overcomes limitations of traditional monitoring stations, such as high installation costs and limited coverage, while providing continuous, real-time data for analysis and decision-making. In conclusion, this IoT-enabled air pollution detection system represents a practical and efficient solution for modern environmental monitoring, with the potential to support smart-city initiatives, enhance community awareness, and aid in pollution management strategies.

REFERENCES

[1]. Abdullah Kadri, Elias Yaacoub, Mohammed Mushtaha, Adnan AbuDayya, "Wireless sensor network for real-time air pollution monitoring",2013 1st International Conference onCommunications, Signal Processing, and their Applications (ICCSPA), pp. 1-5 [7]

[2]. Bhavika Bathiya, Sanjay Srivastava, Biswajit Mishra, "Air pollution monitoring using wireless sensor network", 2017 IEEE International WIE Conference on Electrical and Computer Engineering, pp. 117-121 [8]

[3]. Khaled Bashir Shaban, Abdullah Kadri, EmanRezk, "Urban Air Pollution Monitoring System with Forecasting Models", IEEE Sensors Journal 2016, pp. 2598-2606 [9]

[4]. Harsh N. Shah , Zishan Khan , Abbas Ali Merchant, Moin Moghal, Aamir Shaikh 'IOT Based Air Pollution Monitoring System", IJSER 2018