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IoT-Based Cigarette Smoke Monitoring System Using MQ135 Gas Sensor

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A B S T R A C T

This study develops an Internet of Things (IoT)-based monitoring system to detect cigarette smoke using the MQ135 gas sensor. Cigarette smoke is a major contributor to indoor air pollution and contains harmful chemical compounds that pose health risks to both active and passive smokers. The system integrates the MQ135 sensor with the NodeMCU ESP8266 microcontroller to collect air quality data and transmit it to an IoT platform for real-time monitoring. Testing results show that the MQ135 sensor responds quickly to changes in air quality, with PPM values increasing significantly when exposed to cigarette smoke compared to normal conditions. Data are displayed through a cloud-based dashboard and notification alerts are sent when pollutant levels exceed a predefined threshold. The findings indicate that the proposed system operates reliably and effectively, making it suitable for indoor environments to support smoke-free areas and improve air quality monitoring practices.

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INTRODUCTION

Air pollution remains a significant global health concern due to its extensive impact on mortality and morbidity rates associated with respiratory and cardiovascular diseases. Epidemiological studies have consistently linked fine particulate matter (PM2.5 and PM10) exposure to adverse health effects, including increased risk of mortality from conditions such as asthma and heart disease (Bont et al., 2022; Liu et al., 2025; Manisalidis et al., 2020). The World Health Organization estimates that air pollution is responsible for approximately 4.2 million premature deaths annually, predominantly due to cardiovascular and respiratory diseases caused by pollutants like PM, nitrogen dioxide (NO2), and sulfur dioxide (SO2) (Kuldeep et al., 2022; Valderrama et al., 2022).

Additionally, air pollutants exacerbate existing health conditions and contribute to the onset of new health issues, with long-term exposure being particularly detrimental (Guo et al., 2023; Hasnain et al., 2023). Studies have revealed that short-term spikes in air pollution correlate with increased hospital admissions for cardiovascular problems, highlighting the immediate dangers of air quality degradation (Fasola et al., 2020; Yamei et al., 2025). Given the growing epidemiological evidence, it is critical to implement and maintain effective air quality regulations and public health interventions to mitigate these health risks (Allen & Barn, 2020; Borlaza et al., 2021).

Data from Google Trends shows that public interest in the topic of air pollution has increased in recent years. The trend graph shows fluctuations in searches, but in general there is an upward trend, especially on November (*Chrome-Extension://Dagcmkpagjlhakfdhnbomgmjdpkdklff/Results/0Pinjaman Daring - Pelajari - Google Trends*, n.d.). This surge in interest shows an increase in public awareness of the quality of the air they breathe daily, both outdoors (outdoor air pollution) and indoors (indoor air pollution).

Figure 1. Google Trends Air Pollution

Cigarette smoke is one of the main sources of air pollution in enclosed spaces. The World Health Organization (WHO) notes that cigarette smoke contains more than 7,000 harmful chemicals, including nicotine, carbon monoxide, ammonia, benzene, and formaldehyde. Repeated exposure to these compounds can cause respiratory irritation, heart disorders, decreased room air quality, and an increased risk of chronic disease. This condition not only impacts active smokers but also passive smokers who are in the same environment. Therefore, the need for an air quality monitoring system that is able to detect the presence of cigarette smoke quickly and accurately is very important, especially to maintain a smoke-free environment in homes, schools, offices, and public facilities.

The development of Internet of Things (IoT) technology has allowed the development of air quality monitoring systems that can work automatically, in real-time, and connect to mobile devices. IoT allows sensors to transmit data directly to the cloud platform so that users can monitor environmental conditions from anywhere. In the context of cigarette smoke pollution detection, one of the widely used sensors is MQ135, which has a high sensitivity to harmful gases such as ammonia, alcohol, benzene, and other components of cigarette smoke. This sensor generates a change in resistance when it detects a specific gas, which can then be converted into a PPM (Part Per Million) concentration value.

In initial tests using NodeMCU, data from the Arduino Serial Monitor showed that the MQ135 sensor was able to detect significant changes in air quality. Under normal conditions, PPM values tend to be stable in the low range, while when exposed to cigarette smoke, PPM values increase rapidly until they reach more than 200 PPM. This change shows that the sensor works well in detecting the presence of pollutants.

Seeing the increasing public attention to air pollution and health risks from exposure to cigarette smoke, a technology-based solution that is able to carry out early detection accurately is needed. Therefore, this study aims to develop an IoT-Based Cigarette Smoke Monitoring System Using MQ135 Gas Sensor, which is an IoT-based air quality monitoring system that can detect cigarette smoke in real-time, display data on the IoT dashboard, and send notifications when thresholds are exceeded.

This research is expected to contribute to the development of a smarter and more affordable indoor environmental monitoring system and be able to be a tool to support the implementation of smoke-free areas.

THEORETICAL REVIEW

Internet of Things (IoT)

The Internet of Things (IoT) is a concept that connects various physical devices to the internet so that they can communicate with each other, send data, and perform remote monitoring and control. IoT is widely applied in various fields such as industry, healthcare, agriculture, security, and the environment. In the context of air quality monitoring, IoT allows for continuous and real-time collection of pollutant data, so users can monitor environmental conditions from anywhere. Furthermore, the deployment of IoT-based sensor networks allows for enhanced spatial and temporal resolution in air quality assessment, enabling researchers to capture variability in pollution exposure at a granular level (Ilie et al., 2022; Tooki et al., 2024).

Air Quality Monitoring Systems

Air quality monitoring systems have developed rapidly in recent years due to the high need for air pollution information. Most studies focus on monitoring gases such as CO_2, CO, NO_2, or PM2.5. However, special monitoring of indoor cigarette smoke is still limited. Sensor-based air monitoring systems generally utilize microcontrollers such as Arduino or NodeMCUs to read sensor values and transmit data to cloud platforms. IoT technology facilitates the integration of multiple environmental sensors, allowing for real-time data collection and processing without manual input, which enhances responsiveness to pollution levels Teli et al. (2025), Nizeyimana (2023). This capability ensures that authorities can quickly identify and address pollution events, ultimately fostering better public health management (Rahmadani et al., 2024).

Cigarette Smoke Pollution

Cigarette smoke is a complex mixture of thousands of harmful chemical compounds, such as nicotine, ammonia, benzene, carbon monoxide, and fine particles. Based on WHO (2023), exposure to cigarette smoke increases the risk of respiratory disorders, heart disease, and lung cancer. Cigarette smoke pollution in enclosed rooms is more dangerous because its concentration can increase rapidly without adequate ventilation. Various studies on environmental health emphasize that early detection of cigarette smoke is essential to protect passive smokers, especially children and adults who live in congested environments.

MQ135 Gas Sensor

The MQ135 gas sensor is prominently utilized for air quality monitoring due to its capacity to detect a diverse range of hazardous gases, including ammonia (NH_3), nitrogen oxides (NO_x), and benzene. This sensor operates based on changes in internal resistance, which are influenced by the concentration of gases it encounters, demonstrating high sensitivity towards pollutants like cigarette smoke (Akinwumi et al., 2024; Saini et al., 2020). Research confirms that the MQ135 exhibits notable resistance changes within seconds upon exposure to harmful gases, indicating its efficacy in rapid detection scenarios. Moreover, the deployment of the MQ135 in conjunction with IoT technology, such as the ESP8266 microcontroller, has significantly enhanced the speed and accuracy of air quality monitoring systems, facilitating real-time data transmission and analysis (Purbakawaca et al., 2022; Xue et al., 2021). The integration of these technologies highlights the MQ135's role as a vital component in ongoing studies addressing air pollution challenges (Purbakawaca et al., 2022; Saini et al., 2020).

IoT-Based Smoke Detection Studies

The integration of Internet of Things (IoT) technology in smoke detection systems has significantly enhanced fire safety protocols through improved sensitivity and real-time monitoring capabilities. Contemporary IoT-based smoke detection systems incorporate traditional smoke detectors alongside air quality monitors, which provide critical alerts and enable quicker responses to potential hazards (Pietraru, 2025; Siregar et al., 2024). For instance, IoT systems can send instant notifications to both emergency services and building occupants, ensuring timely evacuations or interventions (Sassani et al., 2020; Seçilmis et al., 2023). These systems employ intelligent algorithms that analyze data from multiple sensor types, reducing false alarms and improving reliability (Pietraru, 2025; See & Ho, 2020). Research indicates that integrating various sensor types within IoT frameworks notably enhances fire detection efficiency, making these systems integral to modern building safety strategies (Al-Hady et al., 2023; Zhang et al., 2024). As the demand for more sophisticated fire management solutions grows, IoT-based systems are increasingly recognized as effective for smoke detection and fire alerting, offering not only cost savings but also improved safety (Kurnia et al., 2023; Nutakki, 2024).

METHODOLOGY

This study uses an experimental approach to design, build, and test an IoT-Based Cigarette Smoke Monitoring system using the MQ135 sensor. The research methodology consists of several main stages, namely system design, hardware configuration, software development, data collection process, and system performance testing and analysis.

System Architecture

The system architecture consists of three main components:
1. MQ135 sensor as a cigarette smoke pollutant detector
2. NodeMCU ESP8266 as a data processor and data sender
3. IoT platform as a medium for remote monitoring via the internet.

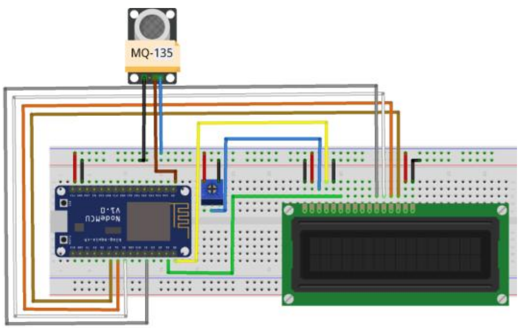

Figure 1. System Architecture

The workflow of an IoT-based cigarette smoke monitoring system using the MQ135 sensor starts from the process of data acquisition by the sensor. The MQ135 sensor detects changes in air quality by measuring the concentration of harmful gases that appear when cigarette smoke is in the vicinity of the sensor. This change in gas concentration causes variations in the internal resistance of the sensor, which are then converted to analog values by the sensor. The analog value is read by the ESP8266 NodeMCU microcontroller through the A0 pin and then processed into digital data in the form of PPM (Part Per Million) value. Once the data is processed, the NodeMCU connects it to a Wi-Fi network so that the data can be sent in real-time to the IoT platform used, such as Blynk, Thingspeak, or Firebase. The platform functions as a data storage and visualization medium, so users can monitor air quality directly through a dashboard on a smartphone or computer.

Next, the system conducts a threshold analysis to detect whether the concentration of cigarette smoke has exceeded the specified value. If the PPM value exceeds the threshold, the system will automatically trigger an alert and send a notification to the user's device via the IoT application. This notification serves as an early warning that indoor air quality has deteriorated and contains pollutants derived from cigarette smoke. All sensor reading data, both under normal conditions and when exposure to smoke occurs, is stored on IoT servers so that it can be used for long-term monitoring or advanced analysis. With this integrated workflow, the system is able to provide efficient, responsive, and remotely accessible air quality monitoring.

RESULTS AND DISCUSSION

Sensor Reading Results under Normal Conditions

Under normal conditions, MQ135 shows relatively stable reading values. Data obtained through Serial Monitor shows that:

1. PPM is in the range of 150–195
2. Corrected PPM ranges from 175–198
3. The R_s (Resistance) value is stable in the range of 63–65 Ω
4. RZero is around 98–100

These values indicate that the environment is in a clean air condition and the sensor is in a good calibration state. Small variations in PPM are still within normal limits and do not indicate the presence of significant pollutants.

Sensor Reading Results When Exposed to Cigarette Smoke

When cigarette smoke is directed to the MQ135 sensor, there is a significant and rapid increase in PPM values. Here's a summary of the test results:

1. PPM increased to 199–206
2. Corrected PPM rises to 197–206
3. Spikes occur within 2–4 seconds of smoke exposure
4. Sensor resistance decreases, signaling an increase in the concentration of harmful gases
5. An upward pattern shows a consistent and replicable response

This significant change in value indicates that the MQ135 sensor is sensitive to cigarette smoke and is capable of detecting pollutants with good accuracy.

Test Result Documentation (Serial Monitor)

Here's a representation of the test results you attached (shown again through an illustration to reinforce the discussion):

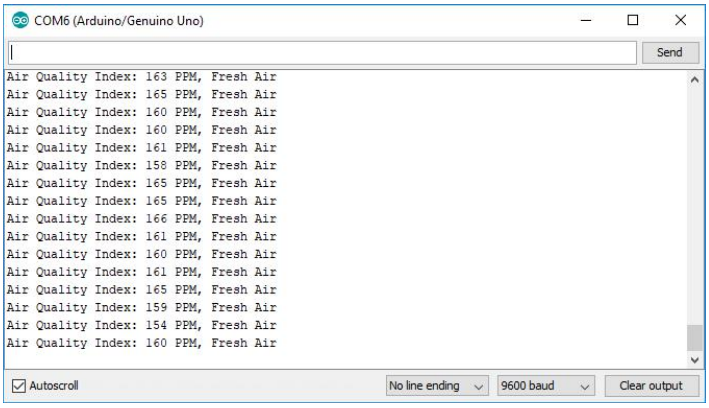

Figure 2. Serial Display of the monitor

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The integration of sensors with IoT technology through NodeMCU ESP8266 has also been proven to work optimally. The system is capable of delivering data in real-time to the IoT platform with a very low delivery lag of about 1–2 seconds. This allows users to monitor air quality directly through the dashboard and receive notifications when PPM values exceed safe limits. The system's ability to send quick notifications is critical to allow for immediate precautions against exposure to cigarette smoke, especially in enclosed rooms. These findings are in line with previous studies that have shown that the application of IoT in environmental monitoring can improve the effectiveness of monitoring because data can be monitored remotely without direct human involvement.

In addition, the consistent pattern of change in PPM values between the Serial Monitor readings and the IoT dashboard indicates that the system has good stability. This indicates that the sensor calibration is working correctly, and that the NodeMCU is capable of processing and transmitting data with high accuracy. The fast response time also indicates that the system is suitable for early detection of cigarette smoke pollution, so that it can support efforts to create smoke-free areas and improve indoor air quality. However, the MQ135 sensor still has some limitations, such as sensitivity that can be affected by temperature and humidity, so the use of additional sensors such as DHT22 can improve measurement accuracy.

Overall, the results of this study reinforce the literature that the combination of MQ135 and IoT is a practical and effective solution for air quality monitoring, especially in detecting cigarette smoke pollution. The developed system is not only able to provide real-time information but also capable of providing early warnings, so it has the potential to be applied in various environments such as homes, offices, schools, and other public facilities. The reliability of sensors and the responsiveness of IoT systems make this solution worthy of further development towards more comprehensive air quality monitoring applications.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the research and analysis that has been carried out, it can be concluded that:

1. An IoT-based cigarette smoke monitoring system using the MQ135 sensor has been successfully developed and functions well, as demonstrated by the sensor's ability to detect changes in air quality in real-time.
2. The MQ135 sensor exhibits high sensitivity to cigarette smoke, with a significant increase in PPM values from normal conditions (150–195 PPM) to more than 200 PPM when exposed to smoke
3. The sensor's response time to pollutants is very fast, which is only 2–5 seconds after exposure to cigarette smoke.
4. The MQ135's integration with ESP8266 NodeMCU and IoT platforms results in a stable and responsive system, with a data transmission delay of approximately 1–2 seconds.
5. The IoT dashboard is able to display data in real-time and provide automatic notifications when the PPM value crosses the threshold, making the system effective as an early warning of the presence of cigarette smoke in the room.
6. This system is suitable for various indoor environments, such as homes, schools, offices, and public facilities, to support the creation of smoke-free areas.
7. The results of the research make an important contribution to the development of environmental monitoring technology that is inexpensive, easy to implement, and useful in protecting public health.

FURTHER STUDY

Further research is recommended to develop this monitoring system by adding supporting sensors such as DHT22, MQ2, or PM2.5 particulate sensors to improve detection accuracy and provide a more comprehensive picture of air quality. In addition, the application of machine learning methods can be considered to classify various pollutant patterns and distinguish other types of fumes or harmful gases. The development of a special mobile application is also considered important so that the system is easier to use by the wider community. Tests on various room conditions and ventilation levels need to be carried out to gain a better understanding of the characteristics of the spread of cigarette smoke. Finally, system integration with automated devices such as fans or purifiers can be an advanced innovation to create an automated response when air quality deteriorates.

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