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Air Quality Monitoring System Based Internet Of Things

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ABSTRACT

This research aims to develop an Internet of Things (IoT)-based air quality monitoring system using the ESP8266 module along with DHT11 and MQ135 sensors. The system is designed to monitor temperature, humidity, and the concentration of harmful gases in the air, with real-time results accessible through the Blynk application on Android devices. The DHT11 sensor measures temperature and humidity, while the MQ135 sensor detects air quality based on concentrations of harmful gases such as carbon dioxide (CO2) and ammonia. Data from these sensors is transmitted to an IoT platform for real-time display. The research methodology follows a prototype model, starting with planning, system modeling, hardware development, and finally, system testing. During testing, the DHT11 and MQ135 sensors demonstrated accuracy in measuring temperature, humidity, and pollutant levels. Results show that the system functions as expected, with sensors responsive to environmental changes such as increases in temperature or pollutant levels. Additionally, the Blynk platform allows users to monitor air quality remotely and receive notifications if air quality reaches hazardous levels. This system is expected to be applicable in environments that require continuous air quality monitoring, such as hospitals, offices, or other enclosed spaces. The study's findings indicate that this IoT-based air quality monitoring system effectively detects rapid changes in air quality, contributing to environmental health efforts and raising public awareness about the importance of clean air.

INTRODUCTION

Air quality is a significant environmental factor that directly affects human health, comfort, and ecosystem sustainability. Increasing levels of air pollution, especially in densely populated urban areas, stem from various sources such as transportation, industrial activities, and residential emissions. Harmful pollutants like carbon monoxide (CO), nitrogen dioxide (NO2), volatile organic compounds, and particulate matter have been linked to respiratory and cardiovascular diseases, emphasizing the need for effective monitoring systems. Monitoring air quality is crucial to protect public health and increase community awareness regarding air pollution and its dangers(Kusumah et al., 2021).(Harpad et al., 2022; Studi, n.d.)

This study focuses on designing an Internet of Things (IoT)-based air quality monitoring system using the NodeMCU ESP8266 module combined with DHT11 and MQ135 sensors. The DHT11 sensor measures temperature and humidity, which helps to track indoor and outdoor environmental conditions, while the MQ135 sensor detects harmful gas levels in the air, such as carbon dioxide (CO2) and ammonia. The data collected from these sensors is transmitted via the IoT platform Blynk, allowing users to monitor air quality through a mobile application on smartphones. This real-time access enables users to observe changes in air conditions and receive notifications if pollution levels reach unsafe thresholds, supporting swift responses to poor air quality,IoT-based air quality monitoring systems have been widely studied and implemented in various environments, including highways, industrial zones, and enclosed spaces like offices and laboratories. Past research has proven IoT's effectiveness in providing accessible, continuous, and remote air quality data that empowers individuals and organizations to make informed decisions to improve air quality(Perintis Kemerdekaan Km, n.d.; Pertama et al., n.d.).

This study aims to develop a system that is applicable in settings needing continuous air quality assessment, such as hospitals, offices, or other enclosed spaces. By enabling real-time monitoring and early warning notifications, this IoT-based air quality system can serve as a proactive tool for environmental health management and increase public awareness about the importance of maintaining clean air in everyday environments. This research ultimately supports efforts to create healthier spaces for communities by encouraging data-driven responses to air quality changes(*Making+Indoor+Air+Quality+Monitoring+System*, n.d.).(Hanum & Elfizon, 2023; Humairoh et al., 2022; Teguh et al., n.d.)

LITERATURE REVIEW

Research related to Internet of Things (IoT)-based air quality monitoring systems has been applied in various environments, such as highways, factories, laboratories, and workspaces. The technology used generally involves the

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MQ-135 sensor for detecting harmful gases such as CO, CO2, and other pollutants, as well as microcontrollers such as NodeMCU ESP32, Wemos D1, or ATMega328 as the main operator. The data obtained is sent via the ThingSpeak, Blynk, or Telegram platforms, which allow real-time monitoring of air quality and provide notifications in case of hazardous conditions. Salman and Amirah (2023) measured air quality in cement factory areas, with results showing harmful pollution, while other studies, such as those conducted by Waworundeng and Lengkong (2022) and Muttaqina et al. (2023), focused more on enclosed rooms, such as laboratories, to monitor levels of harmful gases such as CO2 and acetone. On highways, research by Sadali et al. (2022) and Hakim and Susanto (2023) developed a system to monitor pollution from motor vehicles that contribute greatly to the decline in air quality. Overall, all of these studies demonstrate the effectiveness of IoT in providing real-time air quality monitoring solutions, both in open and closed environments, with the aim of raising awareness of the importance of maintaining clean air for public health(Chaerur Rozikin, n.d.; Dede & Widiawaty, n.d.).(Muttaqin et al., 2024; Sadali et al., 2022)

METHOD

The method in this study refers to the systematic steps taken to design, develop, and test an air quality monitoring system based on the Internet of Things (IoT). This method covers a wide range of aspects, from the selection of the right hardware components, to the development of software for data processing and transmission, to the analysis of air quality measurement results

System development methods

This study refers to a prototype model with stages as shown in Figure 1 This research begins with a communication process to determine goals and quick planning to identify the needs and modelling designed. The next stage is the construction of prototype which involves hardware assembly and programming. After the hardware and programs are completed, the next stage is to present for evaluation (deployment delivery and feedback) by potential users to get input regarding what is created and for further development(Hidayat, n.d.; Susilawati et al., 2023).

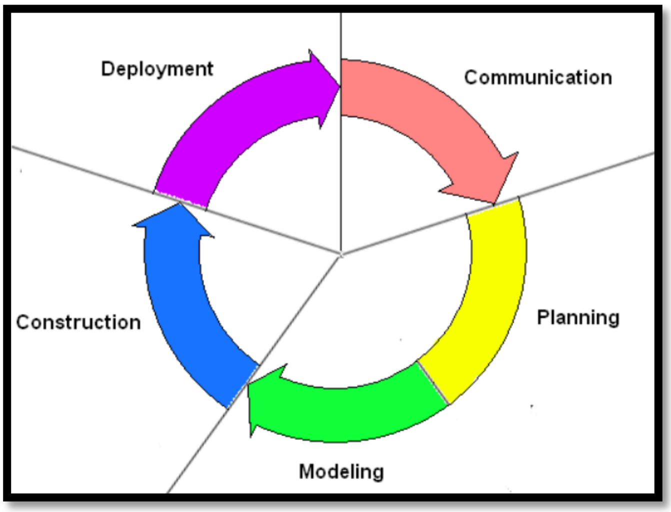

Figure 1. System development methods

Each phase in the prototype method for an Internet of Things (IoT)-based air quality monitoring system:

1. Planning
   Identify Needs: Define the parameters to be monitored (gas, temperature, humidity). Specifications and Budget: Establish technical specifications and cost estimates.
2. Modeling
   System Design: Create a flow chart and initial design of the system. Verification: Ensure the design meets the user's needs.
3. Construction
   Hardware Manufacturing: Hardware component assembly. Programming: Write code for data collection and delivery.
4. Deployment
   Installation: Install the system on-site. Trials: Test the system in the field and analyze the data.
5. Communication
   Visualizations and Notifications: Display data on the IoT platform and send notifications. Reports: Create reports and present results to stakeholders.

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Air monitoring architecture

This figure describes a block of diagrams that show the correlation between parts of air quality monitoring and is described as follows(Hasanuddin & Herdianto, 2023; Islam et al., 2021):

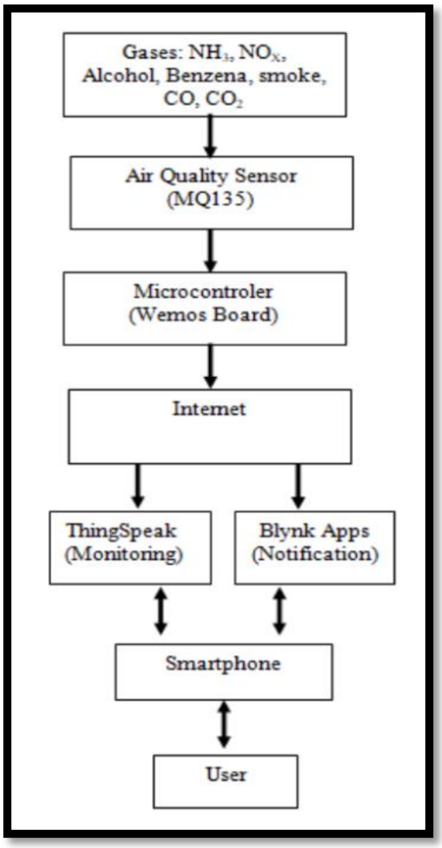

Figure 2 . Air Monitoring Architecture

1. The input detected by the sensor is Ammonia gas (NH3), Nitrogen Oxcide (NOX), Alcohol, Benzene, Carbon Monoxide (CO), and Carbon Dioxcide (CO2).
2. MQ135 type air quality sensor is the sensor used and connected with Wemos board microcontroller
3. The input read from the sensor is processed inside the microcontroller and wifi module contained on the Wemos board sends information to the internet.
4. Thingspeak as an IoT platform records data from sensors in the channel that has and provides an output in the form of a graph.
5. Blynk Apps provides notifications to users via smartphones if the quality air has increased at a significant level

RESULT

Once all the parts are assembled correctly and the program has been uploaded to the ESP8266 then the next step is to test the DHT11 and MQ 135 sensors, whether they work or not. The assembled circuit test and test send the sensor reading results to the LCD first, as shown in the picture below(Hakim & Susanto, 2020; *Jm_informatika,+34212-76624-2-ED+-+Copy*, n.d.; Waworundeng & Lengkong, n.d.):

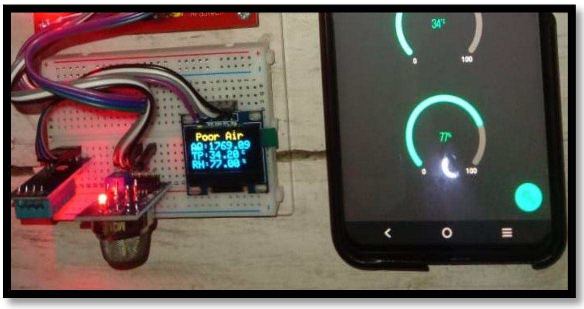

Figure 3 . Tool Display When Testing

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DHT 11 sensor testing

Table 1. DHT 11 sensor testing

No	Test Conditions / PPM Levels
1	Indoor - 734 PPM
2	Outdoor - 1282 PPM
3	Lighter Gas - 4563 PPM
4	Smoke - 8083 PPM

a) Indoor Test:
The test was carried out to measure indoor temperature and humidity. The results showed that the indoor temperature reached 34°C with a humidity of 77%. This shows that the DHT11 sensor is able to detect stable environmental conditions in the room.

b) Outdoor Test:
When the test was carried out outdoors, the detected temperature was 38°C and humidity 64%. The temperature outdoors is higher than indoors, indicating that the DHT11 sensor is quite responsive to changes in the environment.

c) Testing with API Heat
When the sensor is exposed to a heat source from a fire, the measured temperature reaches 43°C and humidity 53%. This shows that the sen-sor is able to detect a significant increase in temperature, but the humidity decreases due to high heating.

MQ135 Sensor Testing

Table 2. MQ135 sensor testing

No	Test Conditions	Temperature(°C)/Humidity(%)
1	Indoor	34°C / 77%
2	Outdoor	38°C / 64%
3	Heat from Fire	43°C / 53%

a) Indoor Test:
The MQ135 sensor detected a PPM level of 734 in the room, which indicates that the indoor air is still classified as healthy (Fresh Air).

b) Outdoor Test:
Outdoors, the detected PPM level increased to 1282, which is close to the unhealthy air limit. This shows the effect of outdoor air pollution on air quality.

c) Testing with Lighter Gas and Fumes:
Tests with lighter gas produced a PPM level of 4563, and tests with smoke showed a PPM of 8083, which is already classified as Danger.

DISCUSSION

Testing shows that IoT-based air quality monitoring systems are working as expected. The DHT11 sensor is capable of providing accurate temperature and humidity readings, while the MQ135 sensor can detect pollutant gas levels well,The Blynk platform is used to send real-time data to smartphones. Notifications sent through the application work according to the parameters that have been set. Air quality can be monitored through an app with an easy-to-understand data display

a. Sensor Accuracy: The DHT11 and MQ135 sensors provide results that match the expectations, although there is a slight decrease in accuracy in environmental conditions that extreme. Overall, though, the sensor works quite well for monitoring applications room.

b. Responsive to the Environment: Sensors are able to respond to changes in temperature and humidity rapidly, especially at sudden changes such as when tested with fire heat and smoke.

c. Effectiveness of IoT Platform: The use of the Blynk platform facilitates remote monitoring remote, allowing users to get notifications directly through their smartphones when the air condition enters an unhealthy or dangerous level.

CONCLUSION

From the tests carried out on the two sensors, namely DHT11 and MQ135, it can be concluded that both sensors show good performance in air quality monitoring.he DHT11 sensor, tested indoors, recorded a temperature of 34°C and a humidity of 77%, reflecting stable environmental conditions. When tested outdoors, the temperature increased to 38°C with a humidity of 64%, indicating the sensor's responsiveness to environmental changes. When exposed to a heat

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source, the sensor recorded a temperature of 43°C with humidity decreasing to 53%, indicating its ability to detect temperature spikes.Meanwhile, the MQ135 sensor detected a PPM level of 734 in the room, indicating that the air in the room is relatively healthy. However, when tested outdoors, the PPM level increased to 1282, close to the limit considered unhealthy, thus indicating the effects of outdoor air pollution. In tests with match gas and smoke, the sensor recorded very high PPM levels

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