MINOR PROJECT

Air Quality Monitoring using IoT

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Introduction

- Air quality refers to the condition of the air in our environment, indicating how clean or polluted it is.
- It is determined by the presence and concentration of pollutants, including gases like carbon monoxide (CO), carbon dioxide (CO2), nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), and particulate matter (PM2.5 and PM10).
- Good air quality is crucial for human health, the environment, and overall quality of life, while poor air quality can lead to respiratory issues, environmental damage, and other serious health problems.
- Air quality monitoring helps us by providing real-time data on pollution levels, enabling timely health alerts, guiding policy decisions, and promoting environmental awareness.
- It helps identify pollution sources, track trends, and implement corrective actions, ultimately protecting public health and the environment.

Objectives

1. **Real-time Monitoring:** Continuously measure air quality to detect pollutants like VOCs, carbon monoxide, and harmful gases.
2. **Data Logging:** Collect and store air quality data for analysis and identifying trends over time.
3. **IoT Integration:** Use IoT to transmit air quality data to a cloud platform, enabling remote access and monitoring.
4. **Data Visualization:** Offer a user-friendly interface to visualize air quality data and gain insights.

Literature Review

Title: IoT based Air Quality Index Monitoring using ESP32
Authors: Shreya Mahetaliya, Dipansh Makwana, Anchal Pujara, Prof. Sandeep Hanumante

- This paper discusses an air quality monitoring system designed to measure and analyze air pollution in real-time using the ESP32 microcontroller.
- The system monitors parameters such as PM2.5, carbon monoxide (CO), carbon dioxide (CO2), temperature, and humidity. Data from various sensors (MQ135, MQ7, GP2Y1010AU0F, DHT11) are transmitted to the ThingSpeak IoT platform, where it is displayed graphically and numerically.
- The system includes a buzzer that activates when CO2 levels exceed a certain threshold, alerting users of poor air quality.
- This approach offers a cost-effective solution to continuously monitor and manage air pollution, potentially mitigating its adverse health effects and environmental impact.

Title: Development of an Internet of Things solution to monitor and analyse indoor air quality

Authors: Dylan Wall, Paul McCullagh *, Ian Cleland, Raymond Bond

- The paper explains about an Internet of Things (IoT) system designed to monitor indoor air quality. The system uses inexpensive sensors to measure temperature, humidity, and volatile organic compounds (VOCs). The data is then transmitted to a server and displayed on a web dashboard.
- The study monitored indoor air quality over two weeks in summer and autumn.
- Results showed that kitchen air quality was generally better due to overnight ventilation.
- Air quality dipped in the evenings, likely due to cooking and less ventilation to maintain warmth.
- Humidity had a strong negative correlation with air quality, meaning higher humidity led to poorer air quality.
- Interestingly, temperature had little impact on air quality in either room.
- Finally, the study found that air quality worsened in the autumn likely due to increased time spent indoors, less ventilation for heating and use of cleaning products can significantly reduce air quality.

Title: An IoT-based Air Quality Monitoring Platform
Authors: Helton Pierre Lucena de Medeiros, Gustavo Girão

- The paper discusses an IoT-based air quality monitoring platform designed to address the environmental and health challenges posed by air pollution, exacerbated by the COVID-19 pandemic.
- The system employs low-cost sensors (PMSA003, MICS-6814, and MQ-131) to measure concentrations of PM2.5, PM10, ozone, carbon monoxide, nitrogen dioxide, and ammonia. The device, powered by an ESP-WROOM-32 microcontroller, utilizes Wi-Fi and Bluetooth for data transmission to a cloud server.
- A key feature of the platform is its capability to send periodic notifications and alerts when pollutant levels exceed safe limits, enhancing public awareness and enabling timely interventions.
- The study emphasizes the importance of monitoring air quality for mitigating COVID-19 impacts and highlights the limitations of existing commercial solutions due to high costs.
- The proposed solution aims to offer a scalable, affordable option for real-time air quality monitoring, suitable for widespread deployment in smart cities.

Title: Arduino-Based Real Time Air Quality and Pollution Monitoring System
Authors: Md. Abdullah Al Ahasan, Saumendu Roy, A. H. M. Saim, Rozina Akter, Md. Zakir Hossain

- This research paper proposes an Arduino-based air quality monitoring system designed to be affordable, portable, and user-friendly. The system addresses the growing concern of air pollution and its detrimental effects on human health.
- The key components are Arduino microcontroller, MQ-135 sensor, Computer connection.
- The authors tested the system's effectiveness by measuring pollution levels from cigarette smoke, mosquito coil burning, and vehicle exhaust.
- The results demonstrated the system's ability to detect and differentiate between various pollution sources.
- The paper highlights the system's potential applications in various settings, including:

1. Indoor air quality monitoring in homes and offices.
2. Outdoor air quality monitoring in urban and industrial areas.
3. Personal air quality monitoring for individuals concerned about their exposure to pollutants.

Methodology

1. Sensor Selection:

- The MQ-3, MQ-9, and MQ-135 sensors were chosen for their specific capabilities in detecting key air quality parameters.
- The MQ-3 sensor is selected for its ability to detect alcohol vapor, making it suitable for applications such as industrial safety and breathalyzer systems.
- The MQ-9 sensor is chosen for its capability to detect carbon monoxide (CO), crucial for monitoring indoor air quality, automotive emissions, and industrial safety.
- The MQ-135 sensor is selected for its sensitivity to ammonia (NH3) gas, making it ideal for applications in agriculture, industrial processes, and environmental monitoring.
- By combining these sensors, the air quality monitoring system can provide comprehensive data on alcohol, CO, and NH3 levels, essential for ensuring human health and safety as well as environmental protection.

2. ESP32 Integration:

The ESP32 microcontroller connects to the sensors via I2C for digital communication, using dedicated pins for data exchange. The ESP32 sends commands and receives sensor data converting analog readings to digital values for processing. This setup enables accurate data collection from all sensors, crucial for comprehensive air quality monitoring.

3. Data Acquisition: The ESP32 sets sampling rates per sensor, storing data internally or on SD cards. Preprocessing involves noise filtering and averaging for improved data quality.

4. IoT Integration:

- ESP32 communicates with the IoT platform using protocols like MQTT for lightweight messaging, ensuring efficient data transmission.
- Data encryption methods like TLS/SSL secure data transfer to the cloud, enabling real-time monitoring and alerts based on predefined thresholds or patterns.
- The integration facilitates seamless data exchange between the ESP32 and the IoT platform, enabling remote monitoring and control of the air quality monitoring system.

5. Displaying data: The collected sensor data is visually presented using graphs or charts, showing real-time air quality measurements. This visualization aids in understanding current air quality conditions without performing detailed data analysis.

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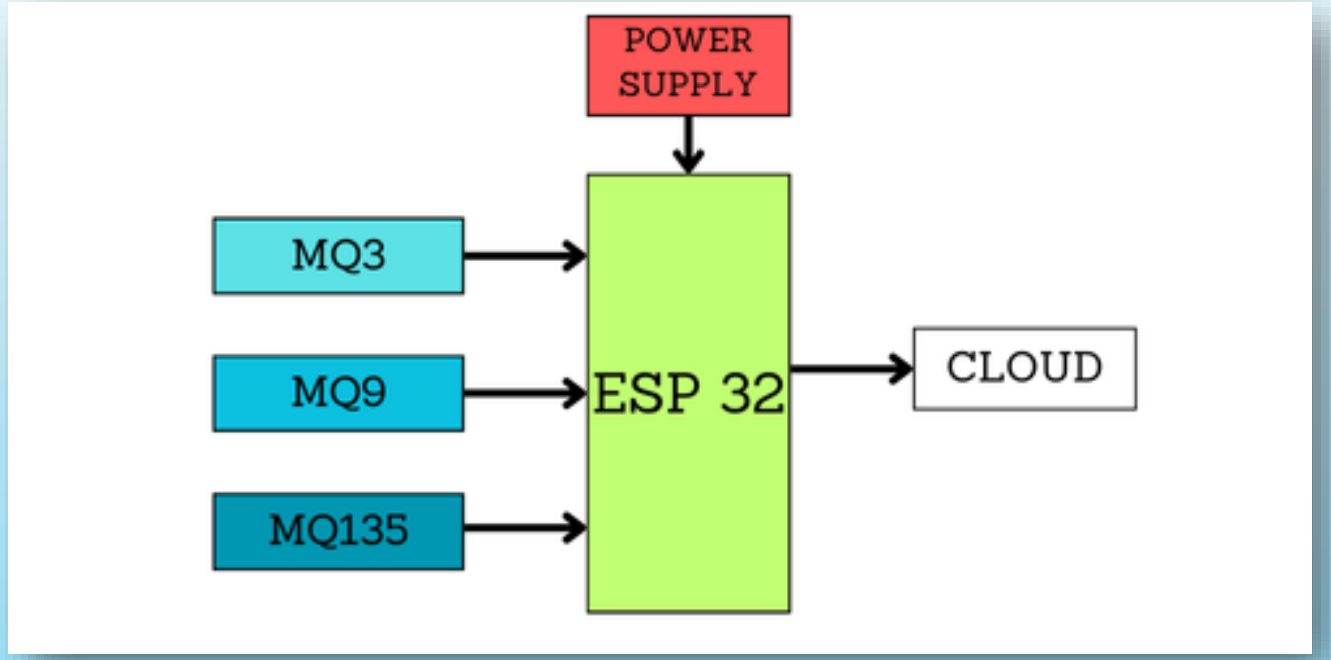
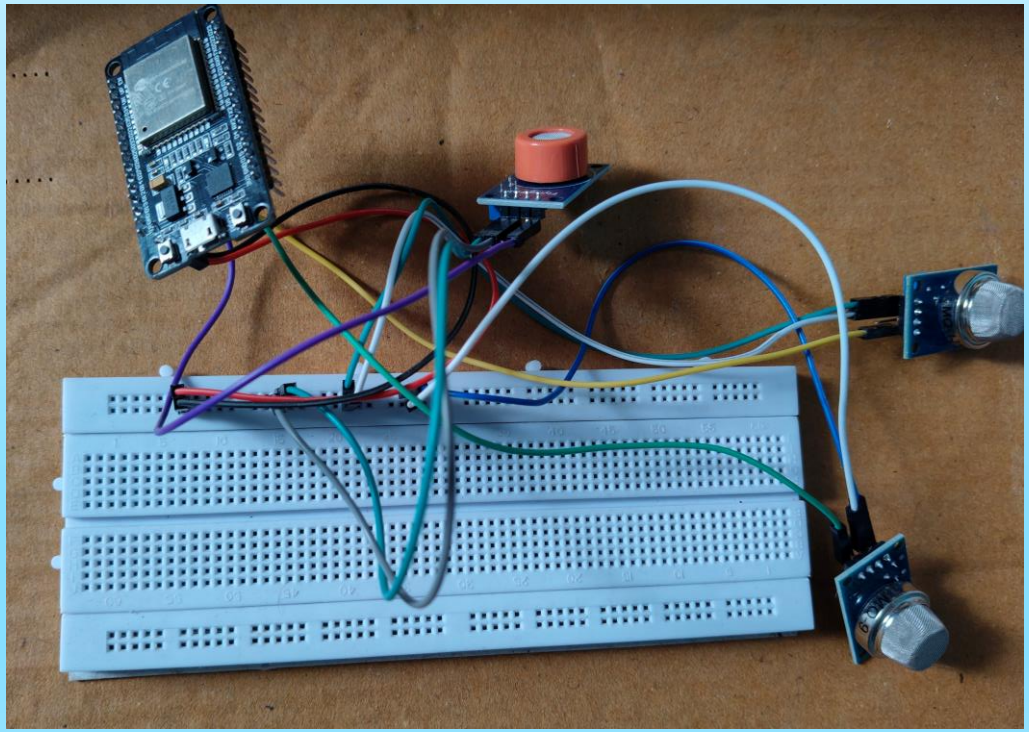


Basic Working:

- The MQ-135 sensor detects air pollutants in the surrounding environment.
- The sensor's resistance changes based on the level of pollution detected.
- This change in resistance is converted into an analog voltage signal by the Arduino.
- The Arduino processes the voltage signal and translates it into air quality data.
- The data is then transmitted to a connected computer for visualization and further analysis.

Initial Results

Physical Circuit is successfully completed containing esp32,mq3,mq9 and mq135 sensor.



Arduino code to collect data from sensors

```
// Define the pins where the sensors are connected
const int mq135Pin = 33; // MQ-135 sensor connected to pin D33
const int mq9Pin = 34;   // MQ-9 sensor connected to pin D34
const int mq3Pin = 35;   // MQ-3 sensor connected to pin D35

void setup() {
  // Initialize serial communication at 9600 baud rate
  Serial.begin(9600);

  // Configure the analog pins as input
  pinMode(mq135Pin, INPUT);
  pinMode(mq9Pin, INPUT);
  pinMode(mq3Pin, INPUT);
}

void loop() {
  // Read the analog values from the sensors
  int mq135Value = analogRead(mq135Pin);
  int mq9Value = analogRead(mq9Pin);
  int mq3Value = analogRead(mq3Pin);

  // Print the sensor values to the Serial Monitor
  Serial.print("MQ-135 Value: ");
  Serial.println(mq135Value);

  Serial.print("MQ-9 Value: ");
  Serial.println(mq9Value);

  Serial.print("MQ-3 Value: ");
  Serial.println(mq3Value);

  // Wait for a short period before the next reading
  delay(1000); // 1 second delay
}
```

References

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4.https://www.researchgate.net/publication/351052818_Development_of_an_Internet_of_Things_Solution_to_Monitor_and_Analyse_Indoor_Air_Quality

5.http://telkomnika.uad.ac.id/index.php/TELKOMNIKA/article/view/18990/10622

Thank You