Final project report

Hospitality in IOT

Introduction

The Internet of Things (IoT) is revolutionizing the hospitality industry by enhancing guest experiences and optimizing operational efficiency. This report presents an air quality monitoring system designed for hospitality environments, leveraging IoT technologies to ensure a comfortable and healthy atmosphere for guests.

Components and Libraries

- ESP32: A powerful microcontroller with built-in WiFi and Bluetooth capabilities.
- DHT11 Sensor: Measures temperature and humidity.
- MQ135 Gas Sensor: Detects air quality by measuring gas concentration.
- GP2Y1010AU0F Dust Sensor: Measures dust density in the air.
- LiquidCrystal_I2C: Library for controlling the LCD display.
- Blynk: Platform for IoT applications, enabling remote monitoring and control.
- Thing Speak: IoT analytics platform for data collection and visualization

System Overview

The system utilizes an ESP32 microcontroller, DHT11 sensor, MQ135 gas sensor, GP2Y1010AU0F dust sensor, and an LCD display to monitor and display air quality parameters such as temperature, humidity, gas levels, and dust density. The data is transmitted to the Blynk platform and Thing Speak for real-time monitoring and analysis.

Block Diagram:

- ESP32 connects to the sensors and LCD display.
- Data from sensors (temperature, humidity, gas levels, and dust density) is collected.
- The system communicates with a web server over WiFi.
- Real-time air quality data is accessible via computers and mobile devices.

2. **Data Collection**:
    - **Sensors (such as the DHT11, MQ135, and GP2Y1010AU0F) continuously measure air quality parameters (temperature, humidity, gas levels, and dust density).**
    - **The ESP32 microcontroller reads data from these sensors.**
3. **Data Aggregation:**
    - **The ESP32 processes the sensor data and prepares it for transmission.**
    - **It combines all relevant measurements into a single data package.**
4. **Data Transmission:**
    - **The ESP32 sends the aggregated data using the chosen communication mode.**
    - **The data travels over the selected network (cellular, WiFi, or other) to reach the cloud infrastructure.**
5. **Cloud Infrastructure:**
    - **The cloud receives the data from multiple ESP32 devices.**
    - **It stores the data securely and makes it accessible for further analysis.**
6. **Data Analysis and Visualization:**
    - **The cloud infrastructure processes the data:**
        1. **Identifies trends, anomalies, and patterns.**
        2. **Generates real-time visualizations (charts, graphs, etc.).**
    - **Users (researchers, administrators, or end-users) can access this information through web interfaces or mobile apps.**
7. **Alerts and Notifications:**
    - **If air quality falls below a certain threshold (e.g., high pollution levels), the system triggers alerts.**
    - **Notifications can be sent to relevant parties (environmental agencies, facility managers, or residents).**
8. **Maintenance and Optimization:**
    - **The system continuously monitors the health of sensors and communication channels.**
    - **If any issues arise (e.g., sensor malfunction or communication disruption), appropriate actions are taken (replacing sensors, improving network coverage,** etc.).

Testing and validation:

1. **Controlled Experiments:**

    - **Conduct controlled experiments in a controlled environment (e.g., a lab or test chamber).**

    - **Introduce known levels of pollutants (such as specific gases or particulate matter) to evaluate the system's response.**

    - **Measure the system's accuracy, precision, and response time under controlled conditions.**

2. **Field Testing:**
   - Deploy the system in real-world environments (both indoor and outdoor).
   - Collect data over an extended period, considering variations in weather, traffic, and other factors.
   - Validate the system's accuracy against ground truth data.
3. **Cross-Validation:**
   - Split the dataset into training and validation subsets.
   - Train the system using one subset and validate it using the other.
   - Evaluate the system's performance across different data subsets.

Results:

1. **Accuracy and Real-Time Monitoring:**
   - The system provides accurate and real-time air quality information.
   - It surpasses the limitations of traditional monitoring systems by offering continuous data updates.
2. **Cloud-Based Architecture:**
   - The system's cloud-based architecture enhances scalability and accessibility.
   - Stakeholders can access air quality data from anywhere, enabling informed decisions for environmental management[1].
3. **Performance Percentage:**
   - In relevant experiments, the performance percentage of IoT nodes used for air quality inference exceeded 90%.
   - Memory consumption was optimized (14 Kbytes in flash and 3 Kbytes in RAM), reducing power consumption and bandwidth requirements compared to traditional measuring stations[2].