VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi – 590014.

Internship Report

on

"Smart Air Pollution Monitoring System"

Submitted in partial fulfillment of the requirement for the award of degree of

BACHELOR OF ENGINEERING

By

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Under the guidance of:
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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

A P S COLLEGE OF ENGINEERING

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PROJECT COMPLETION CERTIFICATE

I, **TIPPALURI SRINU** (Roll No: 1AP21CS051), here by declare that the material presented in the Project Report titled **"SMART AIR POLLUTION MONITORING SYSTEM"** represents original work carried out by me in the **Department of Computer Science and Engineering** at the **APS college of Engineering, Bangalore** during the tenure **2 October, 2024 – 12, December, 2024**.

With My signature, I certify that:

- I have not manipulated any of the data or results.
- I have not committed any plagiarism of intellectual property and have clearly indicated and referenced the contributions of others.
- I have explicitly acknowledged all collaborative research and discussions.
- I understand that any false claim will result in severe disciplinary action.
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Date: **Student Signature**:

In my capacity as the supervisor of the above-mentioned work, I certify that the work presented in this report was carried out under my supervision and is worthy of consideration for the requirements of the B.Tech. Internship Work.

Advisor's Name: Dr. Shivamurthaiah **Guide Name:** Sai Charan Teja

Advisor's Signature **Guide Signature**

PROJECT COMPLETION CERTIFICATE

I, **ANUSHA C M** (Roll No: 1AP21IS050), here by declare that the material presented in the Project Report titled **"SMART AIR POLLUTION MONITORING SYSTEM"** represents original work carried out by me in the **Department of Information Science and Engineering** at the **APS college of Engineering, Bangalore** during the tenure **2 October, 2024 – 12, December, 2024**.

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Advisor's Name: Dr. Shivamurthaiah **Guide Name:** Sai Charan Teja

Advisor's Signature **Guide Signature**

PROJECT COMPLETION CERTIFICATE

I, **NITHIN M** (Roll No: 1AP21EC008), here by declare that the material presented in the Project Report titled **"SMART AIR POLLUTION MONITORING SYSTEM"** represents original work carried out by me in the **Department of Electronics and Communication Engineering** at the **APS college of Engineering, Bangalore** during the tenure **2 October, 2024 – 12, December, 2024**.

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Date: **Student Signature**:

In my capacity as the supervisor of the above-mentioned work, I certify that the work presented in this report was carried out under my supervision and is worthy of consideration for the requirements of the B.Tech. Internship Work.

Advisor's Name: Dr. Prakash Jadhav **Guide Name:** Sai Charan Teja

Advisor's Signature **Guide Signature**

Evaluation Sheet

Title of the Project: Smart Air Pollution Monitoring System

Name of the Students:

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Date:

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ABSTRACT

This project introduces a **Smart Air Pollution Monitoring System** that leverages Internet of Things (IoT) technologies for real-time environmental monitoring, visualization, and alerting. The system employs an MQ2 sensor to detect harmful gases and smoke levels, a DHT11 sensor to measure temperature and humidity, and a Raspberry Pi as the central processing and control unit. Sensor data is collected and transmitted to the Things peak cloud platform for secure storage and analysis. A custom-built user dashboard provides an interactive interface to display real-time environmental data, including air quality metrics and weather conditions.

To enhance functionality, the system features an alert mechanism that automatically sends notification messages when pollution levels exceed predefined thresholds. This ensures timely awareness and facilitates proactive responses to potential environmental hazards.

By integrating sensor technology, cloud-based analytics, real-time visualization, and automated alerting, this system offers a comprehensive, cost-effective, and scalable solution to address the challenges of air pollution monitoring. It demonstrates the potential of IoT to promote environmental sustainability, improve public awareness, and support data-driven decision-making for pollution control and urban planning.

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Chapter 1

INTRODUCTION

1.1 Objective :

- **Real-Time Monitoring:** To continuously monitor air quality parameters, including harmful gas levels, smoke, temperature, and humidity, using MQ2 and DHT11 sensors.
- **Data Collection and Storage:** To collect environmental data from the sensors and store it securely on the ThingSpeak cloud platform for analysis and historical reference.
- **User Dashboard:** To develop a user-friendly dashboard that provides real-time visualization of pollution and environmental data, ensuring easy access and interpretation.
- **Alert Mechanism:** To implement an alert system that sends notification messages when pollution levels exceed predefined safety thresholds, enabling timely action.
- **Scalability and Cost-Effectiveness:** To design a scalable and affordable system that can be deployed in various urban and industrial areas for broader environmental monitoring applications.
- **Promote Environmental Awareness:** To increase public awareness about air quality and environmental conditions through accessible data visualization and alert notifications.
- **Support Decision-Making:** To provide actionable insights and data that can be used by authorities, organizations, and individuals to implement measures for pollution control and environmental protection.
- **Integration with IoT Technology:** To showcase the potential of IoT in environmental monitoring by integrating sensor networks, cloud computing, and user interfaces into a cohesive system.
- **Customizable Thresholds:** To enable users to set custom thresholds for alerts based on specific environmental requirements or standards.

1.2 Problem Statement:

Air pollution is a growing concern in urban and industrial areas, significantly impacting human health, the environment, and overall quality of life. Traditional pollution monitoring systems often lack real-time data, are cost-prohibitive, or require significant manual effort to operate. Additionally, the absence of user-friendly platforms for data visualization and proactive alert mechanisms limits public awareness and timely interventions.

This project addresses these challenges by developing a Smart Pollution Monitoring System that integrates low-cost sensors, IoT technologies, and cloud computing. The system provides real-time monitoring of key environmental parameters, such as harmful gases, smoke levels, temperature, and humidity, while also enabling data visualization through an interactive dashboard. Furthermore, an automated alert mechanism ensures immediate notifications when pollution levels exceed safety thresholds.

Chapter 2

APPLICATIONS

- **Urban Air Quality Monitoring:**

  Description: Urban areas often experience high levels of air pollution due to industrial activities, traffic congestion, and energy production. This system can be deployed across cities to monitor pollution levels in real time.

  Benefit: Authorities can identify pollution hotspots and implement targeted strategies, such as rerouting traffic, planting greenery, or regulating emissions from factories.

- **Industrial Pollution Control:**

  Description: Industrial zones are significant contributors to air pollution. By deploying this system, factories can monitor emissions and ensure they comply with environmental standards.

  Benefit: Prevents legal penalties for non-compliance and helps industries adopt cleaner practices. The data can also support audits and environmental certifications.

- **Traffic Pollution Analysis:**

  Description: The system can be installed along highways, intersections, and busy roads to measure emissions from vehicles.

  Benefit: Helps in assessing the impact of vehicular emissions on air quality and planning eco-friendly initiatives such as car-free zones, improved public transportation, and electric vehicle incentives.

- **Residential Air Quality Management:**

  Description: Individuals can use the system in residential areas to monitor and improve air quality around their homes.

  Benefit: Helps families, particularly those with children or elderly members, to create a healthier living environment by addressing sources of pollution like burning waste or using inefficient stoves.

- **Educational and Research Purposes:**

Description: Schools, colleges, and research institutions can use the system to study air pollution trends and their effects.

Benefit: Enables students and researchers to learn about environmental science, experiment with solutions, and contribute to pollution mitigation strategies.

- **Agriculture and Rural Monitoring:**

  Description: The system can monitor air quality, temperature, and humidity in rural areas, assisting farmers in protecting crops and livestock from adverse environmental conditions.

  Benefit: Helps in early detection of conditions like frost or high ozone levels that can damage crops, ensuring better yields and resource management.

- **Disaster Management:**

  Description: Used in regions prone to industrial accidents, chemical spills, or natural disasters to provide real-time updates on air quality and gas levels.

  Benefit: Enhances the efficiency of emergency response teams by providing accurate data for evacuation plans and containment measures.

- **Environmental Policy Making:**

  Description: Governments can use the system to collect data over time, helping to formulate and enforce environmental laws and regulations.

  Benefit: Supports data-driven decision-making and ensures resources are allocated to areas with the most pressing needs.

- **Climate Change Research:**

  Description: Researchers can use the system to study how pollution contributes to climate change by analyzing emissions of greenhouse gases and other pollutants.

  Benefit: Supports global efforts to reduce emissions and implement strategies to combat climate change.

Chapter 3

COMPONENTS

3.1 Raspberry Pi:

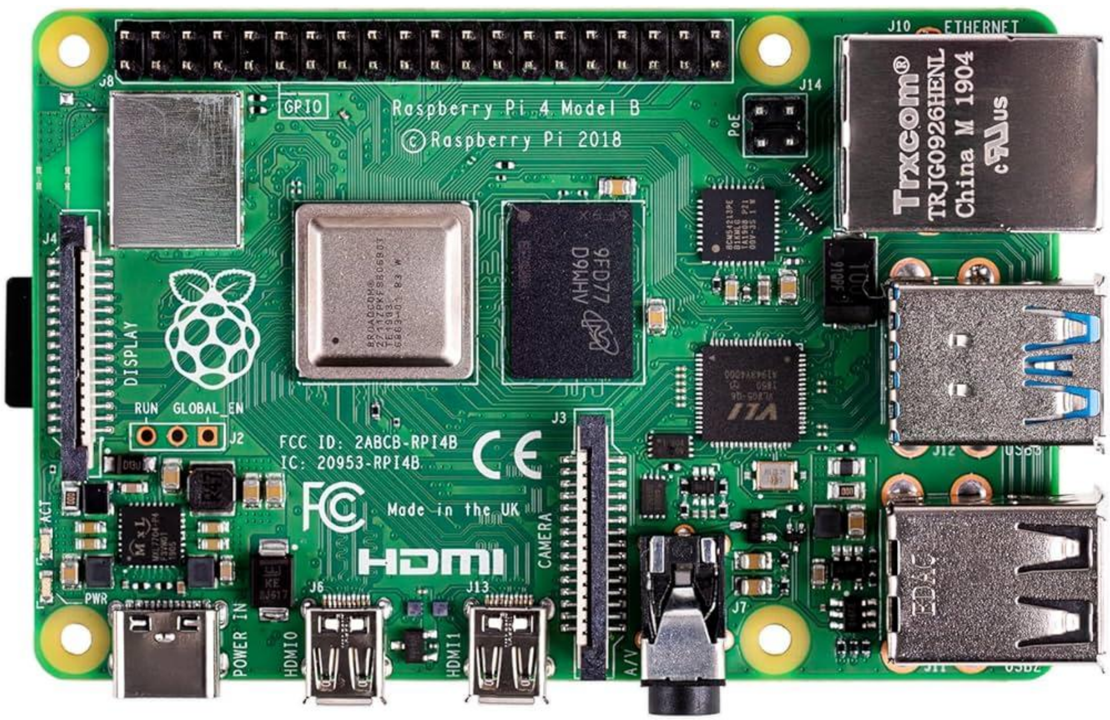

Figure 3.1 Raspberry Pi Processor

Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer.

Raspberry Pi is popularly used for real time Image/Video Processing, IoT based applications and Robotics applications.

Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at a low power consumption.

It has ARM based Broadcom Processor SoC along with on-chip GPU (Graphics Processing Unit).The CPU speed of Raspberry Pi varies from 700 MHz to 1.2 GHz. Also, it has on-board

SDRAM that ranges from 256 MB to 1 GB. Raspberry Pi also provides on-chip SPI, I2C, I2S and UART modules

Raspberry Pi is more than computer as it provides access to the on-chip hardware i.e. GPIOs for developing an application. By accessing GPIO, we can connect devices like LED, motors, sensors, etc and can control them too.

3.2 MQ-2 Gas Sensor:

Figure 3.2 MQ-2 Sensor

The MQ-2 is a smoke and Combustible gas Sensor. It can detect flammable gas in a range of 300 - 10000ppm. It's most common use is domestic gas leakage alarms and detectors with a high sensitivity to propane and smoke

The MQ-2 sensor is a versatile gas sensor capable of detecting a wide range of gases including alcohol, carbon monoxide, hydrogen, isobutene, liquefied petroleum gas, methane, propane, and smoke. It is popular among beginners due to its low cost and easy-to-use features.

3.3 DHT 11 Sensor:

Figure 3.3 DHT-11 Sensor

The DHT11 sensor is a digital temperature and humidity sensor that can be used in a variety of applications, including:

Home automation Can be used in smart thermostats or humidifiers to monitor and adjust temperature and humidity levels

Weather monitoring: Can be used in weather stations or weather balloons to monitor temperature and humidity levels, which can help weather forecasters make more accurate predictions

Agriculture: Can be used in greenhouses or crop fields to monitor temperature and humidity levels, which can help farmers adjust the growing environment for optimal conditions

Other applications: Can also be used in HVAC systems, industrial automation, food and beverage industry, medical and healthcare, energy efficiency systems, research and development, and educational projects .

3.4 Buzzer:

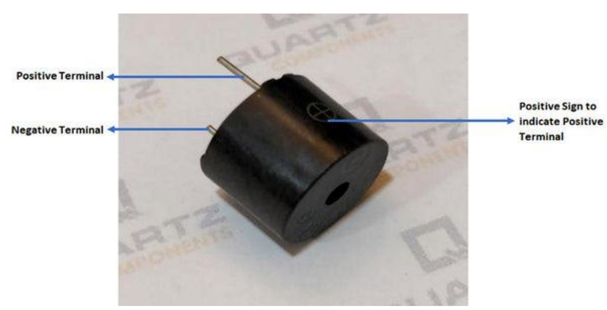

Figure 3.4 Buzzer

Buzzers are electronic components that generate sound to provide audible alerts or notifications. They are used in a variety of applications, including:

Alarm devices: Buzzers are used in fire alarms, security systems, and other alarm devices

Timers: Buzzers are used in timers

User input confirmation: Buzzers are used to confirm user input, such as a mouse click or keystroke.

Audio signaling devices: Buzzers are used as audio signaling devices.

Computers and printers: Buzzers are used as sound devices in computers and printers.

3.5 ThingSpeak:

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud. You can send data to ThingSpeak from your devices, create instant visualization of live data, and send alerts.

Data collection: You can send data from any device to ThingSpeak using a Rest API or MQTT.

Data visualization: ThingSpeak provides instant visualizations of data in the form of charts.

Data analysis: You can perform online analysis and process data as it comes in using MATLAB code.

Event-based alerts: You can create email alerts that trigger based on data coming in from your connected devices.

Plugins and apps: You can create plugins and apps for collaborating with web services, social networks, and other APIs.

Cloud-to-cloud integrations: You can integrate ThingSpeak with other services like The Things Network, Senet, the Libelium Meshlium gateway, and Particle.io.

3.6 Twilio:

Twilio provides products and services to help you innovative Internet of Things (IoT) applications, connect them to reliable cellular networks worldwide, and secure them for life. Our developer documentation will show you how to integrate our connectivity and device builder tools into your products and your cloud.

Twilio is a Software where its uses the user contact no. and Sends SMS alerts for critical conditions like high gas levels or hazardous AQI.

Chapter 4

FLOWCHART

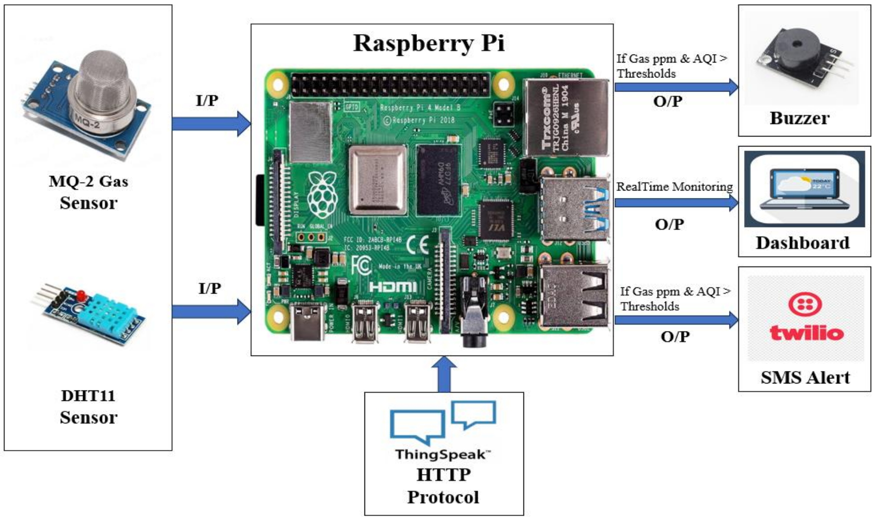

Figure 4.1 Flowchart

1. Initialization and Configuration

The system begins by initializing hardware and software components. Key configurations include setting up the MQ2 Gas Sensor for air quality measurement, DHT11 Sensor for temperature and humidity readings, GPIO pins for output devices like the buzzer, and external APIs such as Twilio for SMS notifications and ThingSpeak for data logging. The project also sets up a Flask web server to provide real-time data on a user-friendly dashboard.

2. Data Collection from Sensors

The system periodically collects data from the sensors:

- The MQ2 Sensor measures gas levels and converts raw sensor values into PPM (Parts Per Million).
- The DHT11 Sensor retrieves real-time temperature and humidity data.
- An Air Quality Index (AQI) is calculated from the gas concentration using predefined breakpoints.

This data is essential for determining environmental conditions and issuing recommendations or alerts.

3. Data Analysis and Decision Making

The collected data undergoes analysis to determine if any environmental parameter exceeds a predefined threshold:

- Gas Levels: If gas levels exceed 100 PPM, the system generates an alert and advises ventilation or using an air purifier.
- AQI: If the AQI is between 150 and 200, a warning SMS is sent, notifying the user that air quality is unhealthy. If the AQI exceeds 200, a critical alert is issued, advising the user to avoid outdoor activities.
- Temperature: High temperatures (>35°C) trigger a recommendation to use air conditioning.
- Humidity: Low humidity (<20%) prompts a recommendation to use a humidifier.

4. Triggering Alerts

When critical thresholds are crossed, the system:

- Sends an SMS alert to the recipient via Twilio's API.
- Activates a buzzer using the GPIO pins to provide an auditory warning.

5. Data Logging and Visualization

The analyzed data is logged to ThingSpeak, enabling long-term tracking and analysis. Simultaneously, it is sent to the Flask-powered web dashboard, where it is displayed in real-time. The dashboard includes:

- A combined chart visualizing gas levels, temperature, and humidity trends.
- Alerts and recommendations based on current sensor readings.

6. User Interaction

Users can interact with the system through the web dashboard, which is updated every 5 seconds. The dashboard displays real-time data, alerts, and actionable recommendations in an easily understandable format. Additionally, auditory feedback through the buzzer ensures immediate attention to critical conditions.

7. Continuous Monitoring

The system operates continuously, periodically collecting data, analyzing it, and updating the dashboard. Alerts are issued promptly when thresholds are breached, ensuring timely user intervention.

Chapter 5

CONCLUSION

The Smart Pollution Monitoring System successfully demonstrates the integration of IoT technologies to monitor, analyze, and respond to environmental conditions in real time. By utilizing sensors such as MQ2 and DHT11, coupled with a Raspberry Pi, the system efficiently collects data on gas concentration, temperature, and humidity. This data is processed and visualized on a user-friendly dashboard, with alerts sent via SMS for critical conditions. The use of the ThingSpeak cloud platform ensures reliable storage and accessibility of data for further analysis.

The system’s ability to provide real-time insights, actionable recommendations, and timely alerts makes it an effective tool for addressing the growing challenges of air pollution in urban, industrial, and residential settings. Its scalability and flexibility allow for deployment in diverse scenarios, from individual homes to large-scale environmental monitoring projects.

This project highlights the potential of IoT in promoting environmental awareness and enabling data-driven decision-making. Future enhancements could include additional sensors for detecting other pollutants, machine learning for predictive analytics, and integration with other smart city systems. By continuing to innovate, this solution can significantly contribute to healthier and more sustainable environments.

Chapter 6

FUTURE WORK

To enhance and expand the capabilities of the Smart Pollution Monitoring System, the following improvements and additions can be considered:

Integration with Additional Sensors: Incorporate sensors for detecting other pollutants, such as NO_2, SO_2, O_3, and particulate matter (PM2.5 and PM10), to provide a more comprehensive air quality analysis.

Machine Learning for Predictive Analysis: Implement machine learning algorithms to predict pollution trends based on historical data, enabling proactive measures to mitigate pollution.

Mobile Application Development: Develop a mobile app for monitoring data, receiving alerts, and controlling the system remotely for greater user convenience and accessibility.

Geolocation Tracking: Include GPS modules to associate air quality data with specific locations, enabling geospatial analysis and mapping pollution hotspots.

Scalable Deployment for Smart Cities: Expand the system into a network of interconnected nodes for city-wide monitoring and integration with municipal smart city infrastructure.

Voice-Controlled Assistance: Integrate with virtual assistants like Alexa or Google Assistant for voice-based interaction, allowing users to query air quality and receive verbal updates.

Chapter 7

APPENDIX

Short Form	Abbreviation
IoT	Internet of Things
MQ2	A type of gas sensor
DHT11	Digital Humidity and Temperature Sensor
ARM	Advanced RISC Machine
SoC	System on a Chip
GPU	Graphics Processing Uni
CPU	Central Processing Unit
UART	Universal Asynchronous Receiver-Transmitter
SDRAM	Synchronous Dynamic Random Access Memor
GPIOs	General Purpose Input/Output pins
LED	Light Emitting Diode
HVAC	Heating, Ventilation, and Air Conditioning
API	Application Programming Interface
MQTT	Message Queuing Telemetry Transport (a messaging protocol
AQI	Air Quality Index
SMS	Short Message Service (commonly known as text messaging)
PPM	Parts Per Million (a unit of measurement for gas concentration)
GPS	Global Positioning System

7.1 Pseudo Code:

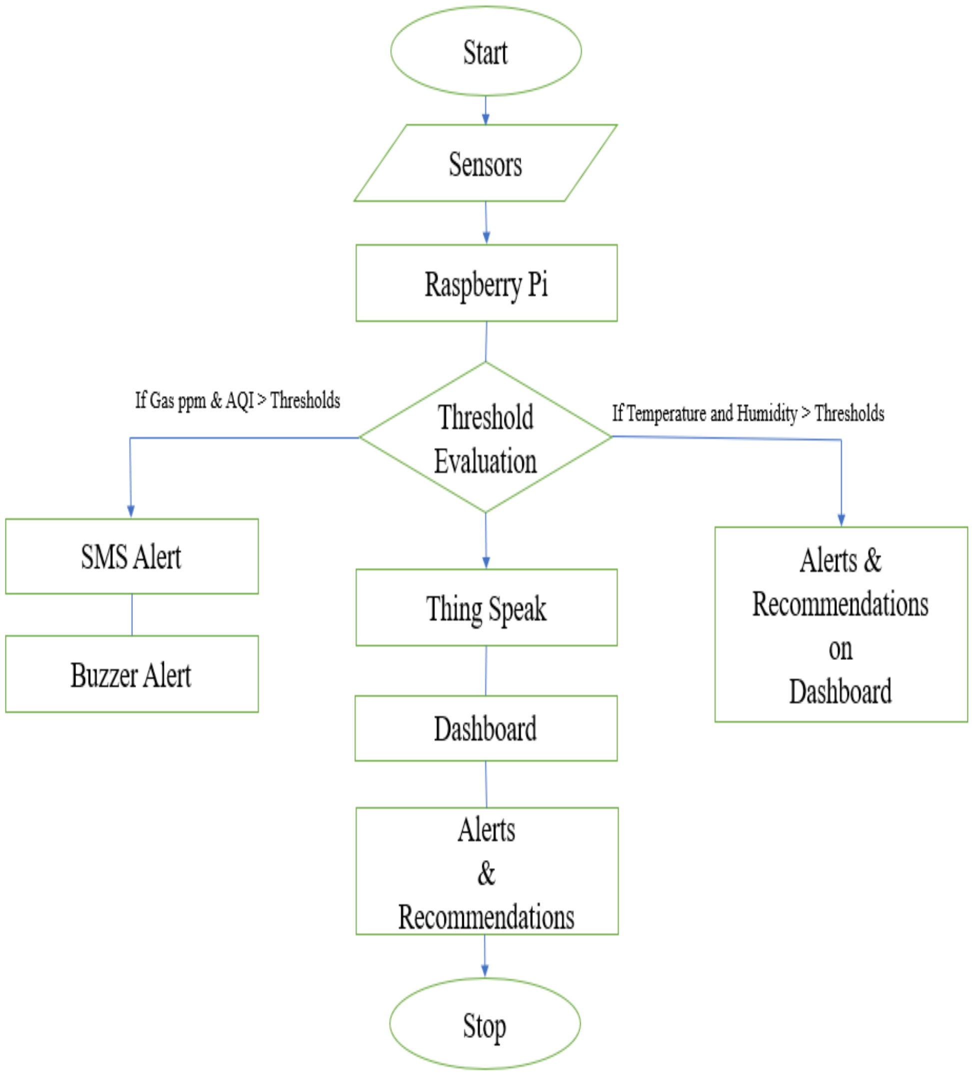

Figure 8.1.1 FlowChart

Pseudocode Flowchart Overview

1. Start:
    - The system starts by initializing necessary configurations (sensor, Twilio, ThingSpeak, GPIO pins).
2. Sensor Data Collection:

- **Gas Sensor (MQ2)**: Reads raw gas values and converts them to Parts Per Million (PPM).
- **Temperature & Humidity Sensor (DHT11)**: Measures temperature and humidity.
- **Air Quality Index (AQI)**: The concentration of gases (PPM) is used to calculate the AQI based on predefined breakpoints.

3. Alert and Recommendation Logic:
    - **Gas Level Check**: If gas levels exceed 100 PPM, an alert is triggered, and a recommendation to ventilate the room or use an air purifier is displayed.
    - **AQI Check**:
        - If AQI is between 150 and 200, a warning message is sent via SMS ("Air quality is unhealthy").
        - If AQI is above 200, a critical message is sent via SMS ("Avoid outdoor activities as the air quality is hazardous").
    - **Temperature Check**: If temperature exceeds 35°C, a recommendation to use air conditioning is triggered.
    - **Humidity Check**: If humidity is less than 20%, a recommendation to use a humidifier is triggered.
4. Sending SMS Alerts:
    - The system checks if any condition for alerts (gas, AQI, temperature, or humidity) is met and sends SMS using Twilio's API.
5. Trigger Buzzer:
    - If the AQI is unhealthy or if other critical conditions are detected (e.g., high gas levels), a buzzer is triggered for 2 seconds using GPIO.

6. Data Transmission to ThingSpeak:

    - Data related to gas levels, temperature, humidity, and AQI is sent to ThingSpeak for real-time monitoring.

7. Displaying Data on Web Dashboard:

    - Data is continuously sent to the dashboard where it's displayed in real-time, along with recommendations and alerts.
    - The dashboard visualizes the data through a combined chart and updates the sensor values every 5 seconds.

8. End:

    - The system continues to monitor the environment and update the dashboard, sending alerts and recommendations as needed.