VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi – 590014.

Internship Report

On

"FIRE and SMOKE Detection 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:
Sai Charan Teja

2023 - 2024

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

A P S COLLEGE OF ENGINEERING

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PROJECT COMPLETION CERTIFICATE

I, **MUCHUMARI VEERA VASANTH REDDY** (Roll No: 1AP21CS029), here by declare that the material presented in the Project Report titled **"FIRE AND SMOKE DETECTION 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.
- I understand that the work may be screened for any form of academic misconduct.

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, **Chandana S** (Roll No:1AP21IS005), here by declare that the material presented in the Project Report titled **"FIRE AND SMOKE DETECTION 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, **Varun M** (Roll No: 1AP22EC407), hereby declare that the material presented in the Project Report titled **"FIRE AND SMOKE DETECTION 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 Jhadav **Guide Name:** Sai Charan Teja

Advisor's Signature **Guide Signature**

Evaluation Sheet

Title of the Project: Fire and Smoke Detection System

Name of the Students:

1.Muchumari Veera Vasanth Reddy

2.Chandana S

3.Varum M

External Supervisor:

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Internal Supervisor:

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Date:

Place:

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ABSTRACT

The Fire and Smoke Detection System aims to create a robust and intelligent safety solution for monitoring fire and smoke hazards in real-time. The system uses a DHT11 temperature sensor and an MQ2 gas sensor to collect environmental data, which is then processed by a Raspberry Pi 4. The collected data is transmitted to the ThingSpeak cloud for visualization and further analysis. Additionally, the system integrates with the Hugging Face API to provide AI-driven suggestions based on the sensor readings.

The system includes signup and login functionality for secure access. User credentials are stored in an SQLite3 database to enable authentication and user-specific interactions. When the DHT11 temperature sensor crosses a predefined threshold, the system activates a buzzer to alert users. Similarly, if the MQ2 gas sensor detects hazardous gas levels, an LED is triggered. If either threshold is exceeded, an SMS alert is sent via Twilio to notify relevant parties, and an MP4 danger alert is played to provide an audible warning. A user-friendly web interface offers a Fahrenheit conversion option, a CSV file download for historical data, and real-time monitoring.

This project integrates IoT, AI, and cloud technologies to provide a comprehensive and user-configurable safety system.

CHAPTER-1

INTRODUCTION

Fire and smoke incidents are among the most significant safety hazards, leading to severe consequences such as environmental damage in extreme cases and loss of life. Despite the availability of conventional fire alarm systems, many lack the ability to provide real-time data visualization, remote alerts, and actionable intelligence. This shortcoming underscores the need for an advanced system that not only detects fire and smoke hazards promptly but also provides enhanced functionality for user convenience and immediate action.

The Fire and Smoke Detection System is a state-of-the-art solution designed to address these limitations by leveraging IoT, AI, and cloud-based technologies. At its core, the system uses two primary sensors: the DHT11 for monitoring temperature and the MQ2 for detecting the presence of combustible gases and smoke. The collected data is processed through a Raspberry Pi 4, which acts as the central controller, and sent to the ThingSpeak cloud for visualization and trend analysis. Additionally, the system incorporates AI-driven recommendations through the Hugging Face API, enabling users to receive intelligent insights and suggestions for mitigating potential risks.

The system ensures comprehensive safety through multiple alert mechanisms. When the temperature crosses a predefined threshold, the system sounds a buzzer to warn users. Similarly, when the gas sensor detects dangerous levels of combustible gases, an LED is activated as a visual indicator. For more robust notifications, SMS alerts are sent via the Twilio API to designated recipients, ensuring timely awareness of hazardous situations. Furthermore, an MP4 danger alert plays to provide audible warnings, enhancing user responsiveness.

The project prioritizes user convenience by incorporating features such as a Fahrenheit conversion option for temperature readings and the ability to download historical data in CSV format for offline analysis. To enhance security and user management, the system includes a signup and login functionality, where user data (such as credentials and personal information) is securely stored in an SQLite3 database. This ensures that only authorized users have access to the system, safeguarding the privacy and integrity of the information.

This system is adaptable for a variety of use cases, from residential and commercial environments to industrial settings. By integrating advanced technologies with practical safety measures, the Fire and Smoke Detection System represents a significant step forward in fire

and smoke detection. Its capability to provide real-time monitoring, AI-driven recommendations, and multi-channel alerts, along with secure user access, positions it as a cutting-edge solution for proactive hazard management.

1.1 OBJECTIVE

The primary objectives of the **Fire and Smoke Detection System** are:

1. **Environmental Monitoring**:
    - Use high-precision sensors (DHT11 and MQ2) to monitor temperature and gas levels in real-time.
    - Ensure accurate and reliable readings to detect potential hazards promptly.
2. **Data Visualization**:
    - Transmit sensor data to the ThingSpeak cloud platform.
    - Enable users to visualize real-time data and trends through intuitive dashboards and graphs.
3. **Multi-Channel Alerts**:
    - Activate a buzzer for audible alerts when the temperature exceeds a predefined threshold.
    - Trigger an LED to provide a visual warning if gas levels reach hazardous limits.
    - Send SMS notifications via Twilio API to designated contacts for immediate awareness.
    - Play an MP4 danger alert to ensure comprehensive and effective communication during emergencies.
4. **AI-Driven Insights**:
    - Integrate the Hugging Face API to offer recommendations and insights for mitigating potential risks.
    - Utilize AI to provide actionable suggestions for preventive actions.
5. **User-Friendly Features**:

- Include a Fahrenheit conversion option for temperature readings, enhancing usability for diverse users.
- Enable CSV file downloads for historical data analysis and offline usage.

6. **Secure Authentication**:
   - Implement signup and login functionalities with data stored securely in an SQLite3 database.
   - Restrict system access to authenticated users, ensuring data integrity and privacy.

1.2 PROBLEM STATEMENT

Fire and smoke detection systems play a critical role in safety, yet existing systems often lack the ability to integrate data visualization, advanced notifications, and intelligent suggestions. Most traditional systems are limited to local alerts, such as sounding an alarm, which may not suffice in situations requiring immediate remote notifications or insights. This project aims to fill these gaps by offering a multi-faceted detection and alert system that combines IoT, AI, and user-centric features, ensuring timely intervention and enhanced safety.

CHAPTER-2

APPLICATIONS

1. Residential Safety

- **Home Fire Detection**: Monitors temperature and gas levels in households, alerting residents to potential fire or smoke hazards before they escalate.
- **Kitchen Safety**: Detects smoke or gas leaks, especially in areas prone to cooking-related incidents.

2. Commercial Establishments

- **Small Offices and Workspaces**: Ensures employee safety by providing early warnings of fire or smoke, reducing downtime and property damage.
- **Small Retail Stores**: Prevents panic during emergencies by alerting staff and management to take immediate action.

3. Educational Institutions

- **Schools and Colleges**: Enhances safety by monitoring classrooms, labs, and auditoriums for fire or smoke risks, ensuring a secure environment for students and staff.

4. Data Analytics and Research

- **Trend Analysis**: Enables data collection and analysis to understand patterns in fire and smoke incidents, helping improve future safety systems.

CHAPTER-3

COMPONENTS

3.1 Hardware Components:

1. **DHT11 Temperature and Humidity Sensor**

The DHT11 is a compact and cost-effective sensor that monitors temperature and humidity levels in real-time. It provides precise readings with an accuracy of ±3°C for temperature and ±5% for humidity, making it suitable for environmental monitoring applications. The sensor supports both Celsius and Fahrenheit outputs, ensuring compatibility with diverse user preferences. Its low power consumption and ease of integration with microcontrollers like the Raspberry Pi make it an ideal choice for continuous monitoring in fire and smoke detection systems.

FIG 4.1: DHT11 Sensor

2. **MQ2 Gas Sensor**

The MQ2 is a versatile gas sensor capable of detecting a wide range of combustible gases, including LPG, methane, carbon monoxide, and smoke. It provides analog and digital outputs that represent the concentration of gases in the environment. The sensor is highly sensitive and responds quickly to changes in gas levels, making it suitable for detecting potential hazards early. Its simple design and compatibility with Raspberry Pi allow seamless integration into the system, enhancing its capability to monitor air quality and prevent accidents.

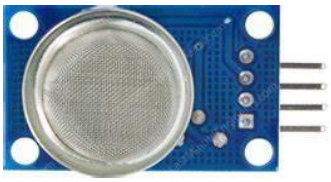


FIG 4.2 : MQ2 Sensor

3. **Raspberry Pi 4**

The Raspberry Pi 4 serves as the brain of the system, handling data acquisition, processing, and communication. Equipped with a quad-core processor and sufficient memory, it efficiently interfaces with sensors and executes Python scripts for data analysis and alert mechanisms. Its built-in GPIO pins enable easy sensor connections, while internet connectivity ensures seamless integration with APIs and cloud platforms. The Raspberry Pi 4's versatility makes it a powerful platform for building intelligent IoT applications like the Fire and Smoke Detection System.

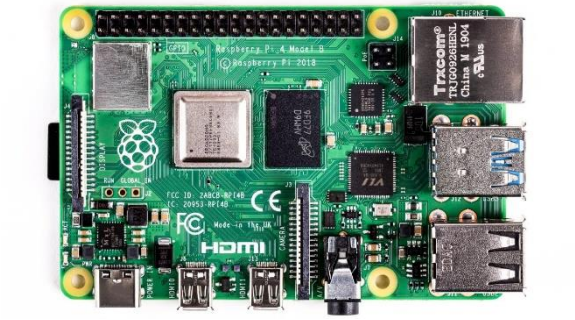


FIG 4.3: Raspberry pi 4

4. **Buzzer**

The buzzer acts as an audible alert mechanism in the system, producing a loud sound when the temperature sensor detects values exceeding the predefined threshold. It provides immediate feedback to nearby users, ensuring they are aware of potential fire hazards. The buzzer is small, energy-efficient, and highly effective in emergency scenarios, making it an indispensable component of the safety system.

FIG 4.4 : Buzzer Actuator

5. **LED**

The LED functions as a visual alert, lighting up when the MQ2 gas sensor detects hazardous gas levels. Its bright illumination ensures that the warning is easily noticeable even in noisy environments. The LED is a reliable and low-maintenance component that adds an extra layer of safety by providing a clear, non-intrusive visual indicator of danger.

FIG 4.5: Led Actuator

6. **Power Supply**

A stable and uninterrupted power supply is crucial for the reliable operation of the Raspberry Pi and connected sensors. The system utilizes an AC-to-DC adapter or battery pack to ensure consistent power delivery, even during power fluctuations. This guarantees that the system remains operational and responsive at all times, especially during emergencies when timely alerts are critical.

3.2 Software Components:

1. **ThingSpeak Cloud Platform**

ThingSpeak serves as the cloud-based data visualization and storage platform for the system. Sensor data is transmitted to ThingSpeak in real time, where it is displayed as interactive graphs and dashboards. The platform also allows users to analyze historical data, identify trends, and make informed decisions to improve safety measures. Its compatibility with IoT devices and ease of integration make it a cornerstone of the system's data visualization capabilities.

FIG 4.6 : ThingSpeak Cloud

2. **Hugging Face API**

The Hugging Face API adds an AI-driven layer to the system by providing intelligent insights and recommendations. Based on the sensor readings, the API suggests preventive actions or adjustments to thresholds to minimize risks. For instance, it might recommend adjusting ventilation in areas with rising gas levels or alerting nearby personnel when

temperatures approach critical levels. This AI-powered functionality enhances the system's ability to anticipate and mitigate hazards proactively.

FIG 4.7: Hugging Face Api for AI Suggestions

3. **Twilio API**

The Twilio API facilitates the system's remote notification capabilities by sending SMS alerts to designated contacts when thresholds for temperature or gas levels are crossed. This ensures that even users who are not physically near the system are promptly informed of potential dangers. Twilio's reliability and global reach make it an effective solution for delivering critical alerts in emergencies.

FIG 4.8 : Twilio for Notifications

4. **Web Interface**

The web interface acts as the user's gateway to the system, providing real-time monitoring and control features. Users can view live sensor data, toggle between Celsius and Fahrenheit for temperature readings, and download historical data in CSV format for offline analysis. The interface is designed to be intuitive and user-friendly, ensuring easy navigation and interaction for users of all technical levels.

5. **SQLite3 Database**

The SQLite3 database is used to store user credentials for signup and login functionalities, ensuring secure access to the system. It is lightweight yet robust, providing reliable data storage without the need for complex configurations. By using SQLite3, the system ensures data integrity and privacy, restricting access to authorized users only.

6. **Python Scripts**

Python scripts form the backbone of the system's software functionality. They handle tasks such as acquiring sensor data, processing it, and triggering appropriate alerts. The scripts also manage communication with the ThingSpeak cloud, Hugging Face API, and Twilio API. Their modular design allows for easy updates and enhancements, making the system adaptable to evolving requirements.

CHAPTER-4

DESIGN

4.1 Architecture Diagram

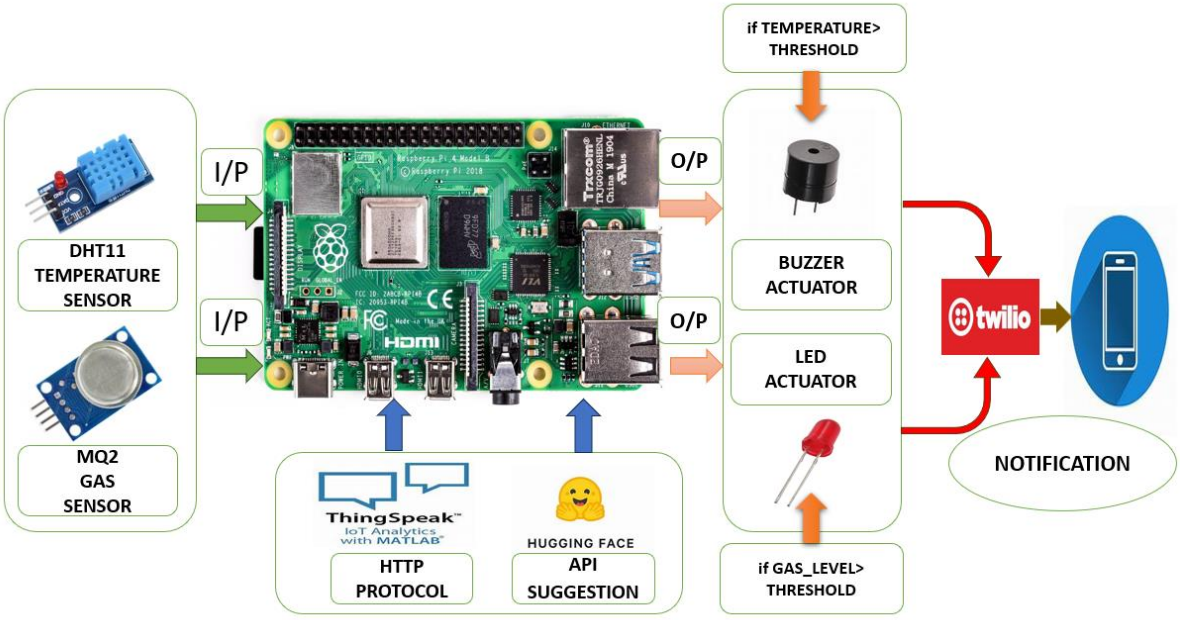


FIG 4.1:Fire and Smoke Detection System Circuit Diagram

The Fire and Smoke Detection System uses a **Raspberry Pi 4** as the central controller to monitor environmental conditions via input sensors like the **DHT11 Temperature Sensor** and **MQ2 Gas Sensor**. The DHT11 measures temperature and humidity, while the MQ2 detects combustible gases, sending real-time data to the Raspberry Pi for processing. When sensor values exceed predefined thresholds, the system activates output actuators, such as a **buzzer** for audible alerts and an **LED** for visual warnings. Additionally, the system sends **SMS notifications** via the **Twilio API** to inform designated contacts. The data is transmitted to the **ThingSpeak cloud** for visualization and stored for trend analysis. The system also integrates the **Hugging Face API** to provide AI-driven insights and recommendations for mitigating risks. The entire setup works through HTTP protocols, ensuring real-time monitoring and safety measures, with the Raspberry Pi serving as the core processor and communication hub for the sensors, actuators, cloud integration, and notifications.

4.2 Flow Chart

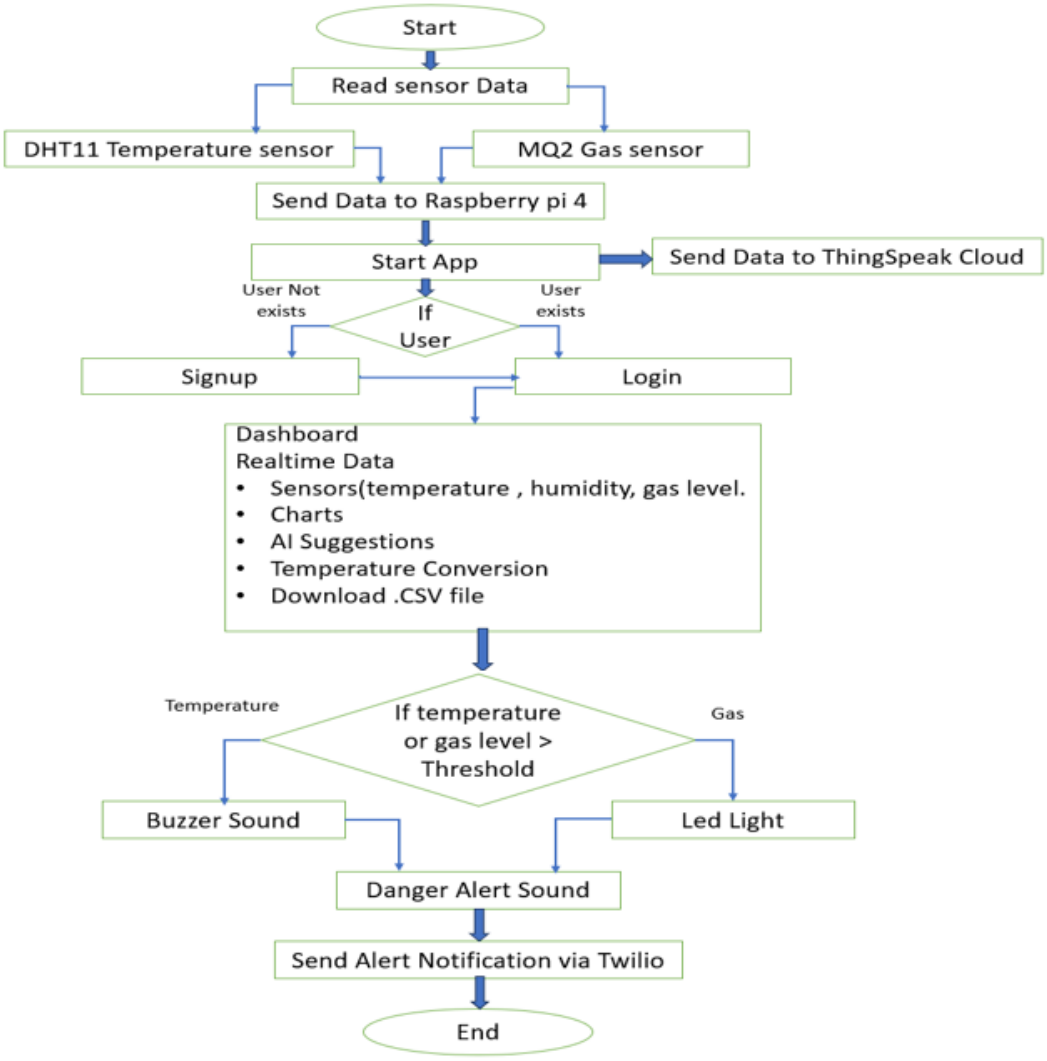


FIG 4.2: Fire and Smoke Detection Flow Chart

The system begins with the sensors (DHT11 for temperature and MQ2 for gas) reading values. These readings are then sent to the Raspberry Pi 4, which relays the data to the ThingSpeak Cloud. The application starts by either displaying a Signup or Login page. Once the user successfully logs in, the Dashboard opens, showing real-time sensor data, charts, a temperature conversion feature, AI suggestions, and an option to download the data as a CSV. If the temperature or gas level crosses a predefined threshold, a buzzer is triggered for temperature, and an LED turns on for the gas level. Simultaneously, a danger alert sound is played, and an SMS notification is sent via Twilio to alert the user.

CHAPTER-5

CONCLUSION

The Fire and Smoke Detection System successfully combines IoT, AI, and cloud-based technologies to create an intelligent and user-centric safety solution. By integrating secure user authentication through SQLite3, real-time monitoring, and multi-channel alerts, the system addresses critical safety needs. Features like temperature conversion and CSV downloads enhance its usability across various settings. This project demonstrates how modern technology can be leveraged effectively to mitigate risks and ensure safety.

CHAPTER-6

FUTURE WORK

Expanded Sensor Integration

- Incorporate additional sensors, such as carbon monoxide, particulate matter, and air quality sensors, to broaden the system's scope.

AI-Driven Edge Computing

- Develop local AI models for anomaly detection directly on the Raspberry Pi, reducing dependency on cloud APIs and improving response times.

Mobile Application Development

- Create an Android/iOS application for seamless monitoring, alerts, and control.

Battery Backup and Solar Power

- Integrate an uninterruptible power supply or solar panel support to ensure continuous operation during power outages.

Industrial Scalability

- Design the system for larger-scale applications, such as factories, warehouses, and residential complexes.

Data Analytics

- Provide deeper insights into historical trends and patterns using advanced analytics and AI models.

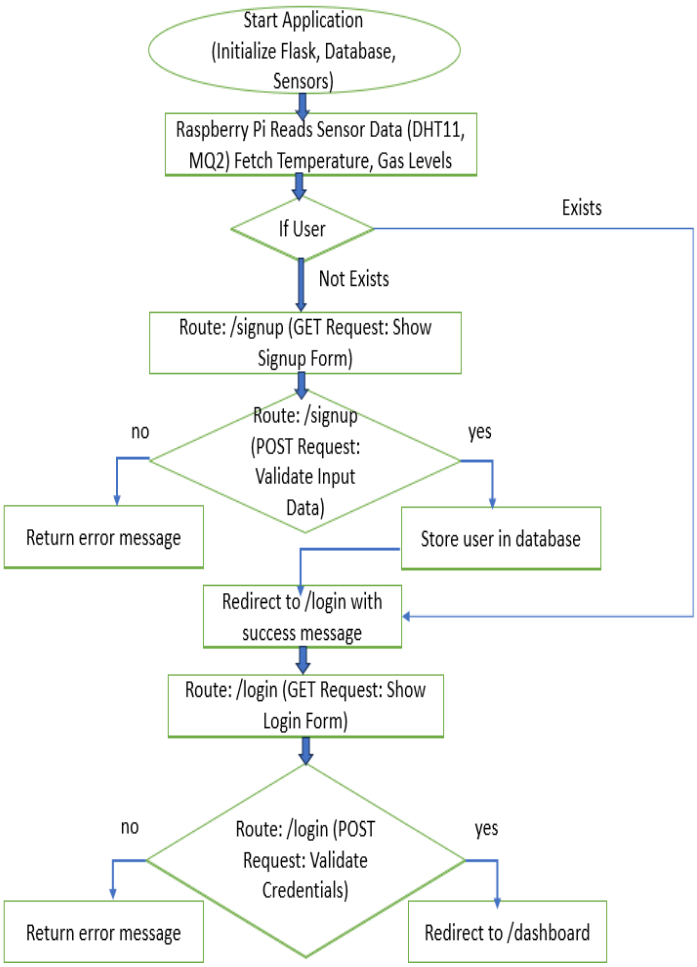
CHAPTER-7

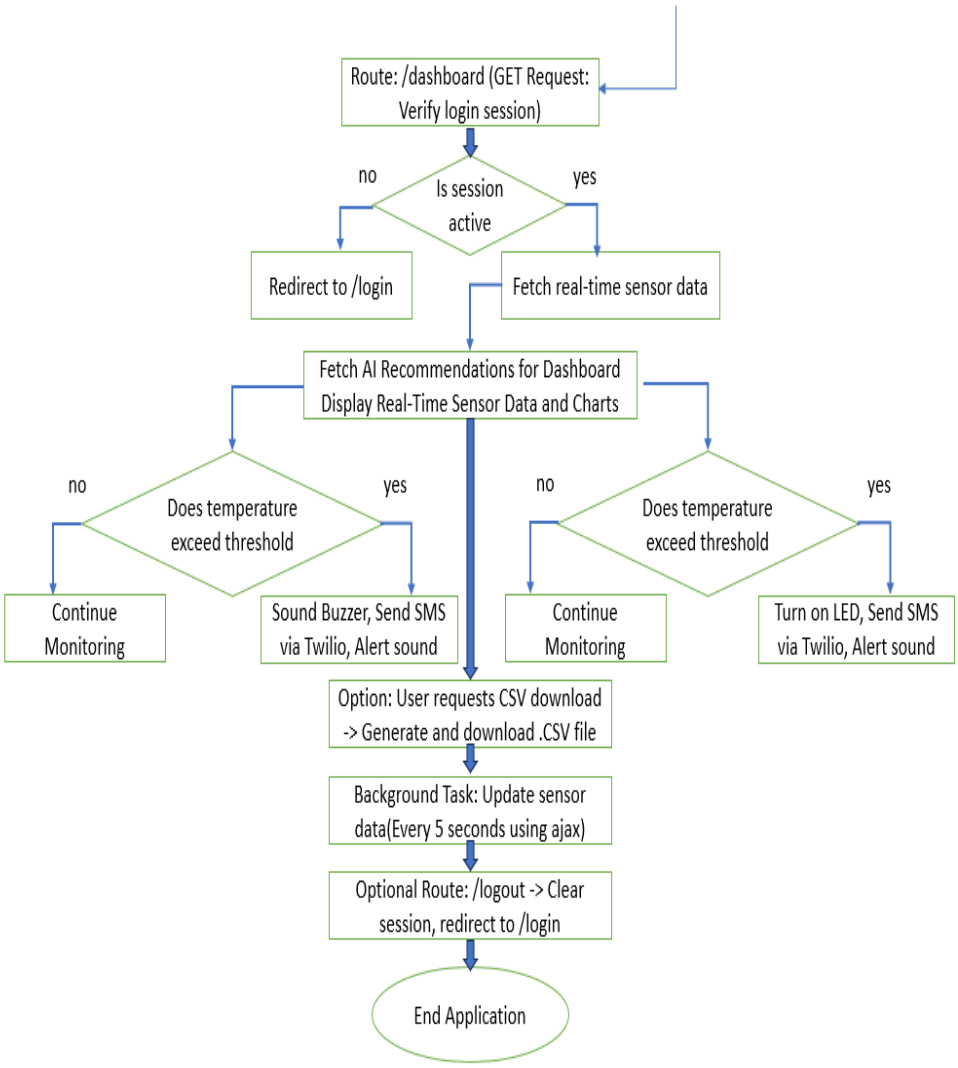
APPENDIX

Acronyms and Abbreviations:

- **API**: Application Programming Interface
- **CSV**: Comma-Separated Values
- **IoT**: Internet of Things
- **SMS**: Short Message Service
- **DHT11**: Digital Humidity and Temperature Sensor
- **MQ2**: Gas Sensor

7.1 PSEUDOCODE




Route: /dashboard (GET Request: Verify login session)
Is session active
no
yes
Redirect to /login
Fetch real-time sensor data
Fetch AI Recommendations for Dashboard Display Real-Time Sensor Data and Charts
Does temperature exceed threshold
no
yes
Continue Monitoring
Sound Buzzer, Send SMS via Twilio, Alert sound
Does temperature exceed threshold
no
yes
Continue Monitoring
Turn on LED, Send SMS via Twilio, Alert sound
Option: User requests CSV download -> Generate and download .CSV file
Background Task: Update sensor data(Every 5 seconds using ajax)
Optional Route: /logout -> Clear session, redirect to /login
End Application