RV COLLEGE OF ENGINEERING®, BENGALURU-560059
(Autonomous Institution Affiliated to VTU, Belagavi)

EXPERENTIAL LEARNING 2024-25

Sustainable Development Goal 11(SDG 11)
5th SEMESTER
PROJECT REPORT

Automated LPG Usage and Safety Monitoring System Using Machine Learning & Smart Kitchen

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CERTIFICATE

Certified that the project work titled **'AUTOMATED LPG USAGE AND SAFETY MONITORING SYSTEM USING MACHINE LEARNING AND SMART KITCHEN'** is carried out by **JISHNU PRADEEP (1RV22EC073), PRAJWAL M S (1RV22EC114), SHREYASH ANANT MITHARE (1RV23EC411), NAGAPRASAD NAIK (1RV23CS410), MANOJ KUMAR B V (1RV23CS407),** who are bonafide students of RV College of Engineering®, Bengaluru, in partial fulfillment of the curriculum requirement of 5th Semester during the academic year **2024-2025**. It is certified that all corrections/suggestions indicated for the internal Assessment have been incorporated in the report. The report has been approved as it satisfies the academic requirements in all respect laboratory mini-project work prescribed by the institution.

Signature of Faculty In-charge

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Any achievement, be it scholastic or otherwise does not depend solely on the individual efforts but on the guidance, encouragement and cooperation of intellectuals, elders and friends. A number of personalities, in their own capacities have helped me in carrying out this project work. I would like to take this opportunity to thank them all.

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ABSTRACT

Liquefied Petroleum Gas (LPG) is a widely used fuel for domestic and commercial cooking, but its improper handling can lead to severe safety hazards such as gas leaks and fire accidents. This project presents an **Automated LPG Usage and Safety Monitoring System** that integrates **Machine Learning (ML) and Smart Kitchen technologies** to enhance safety, optimize gas consumption, and provide real-time monitoring.

The system employs **Internet of Things (IoT) sensors** to detect gas leakage, monitor LPG levels, and track usage patterns. In case of a gas leak, the system automatically triggers safety mechanisms, including **turning on exhaust fans, opening smart windows, and sending real-time alerts via mobile notifications** to users and emergency contacts. Additionally, an AI-powered assistant offers **personalized cooking recommendations** based on gas image uploaded.

Data collected from the sensors is stored and processed using **cloud-based analytics**, ensuring **remote monitoring and control** via a dedicated mobile application. The integration of **smart kitchen appliances** with the LPG system enhances convenience while maintaining safety standards. This **intelligent and automated approach** significantly reduces the risk of LPG-related accidents, promotes energy efficiency, and improves user experience in modern kitchens.

Keywords: LPG Monitoring, Gas Leakage Detection, Smart Kitchen, Machine Learning, IoT, Safety Automation.

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Chapter 1

INTRODUCTION

In modern households, Liquefied Petroleum Gas (LPG) is a widely used fuel for cooking. However, its improper handling or leakage can pose serious safety hazards, including fire accidents and health risks. To address these concerns, we propose an "Automated LPG Usage and Safety Monitoring System & Smart Kitchen", a comprehensive system designed to enhance both convenience and safety in kitchens. Our system focuses on automated LPG usage monitoring, gas leakage detection, and smart kitchen integration using IoT-based technologies. A load cell continuously monitors the LPG cylinder's weight, and when it drops below a predefined threshold, an automated notification is sent to family members, ensuring timely refilling and uninterrupted usage.

For safety monitoring, a gas sensor detects any leakage and triggers an alert through the Blynk platform, notifying users in real time. To further enhance safety, if a leakage is detected, the system automatically opens windows to prevent gas accumulation and potential hazards.

The Recipe-Lens project further complements this system by utilizing computer vision and Natural Language Processing (NLP) to transform food images into personalized recipes. By simply capturing a photo of a dish, users can instantly receive detailed, step-by-step cooking instructions tailored to their preferences. Whether you're an experienced chef looking for inspiration or an amateur cook seeking easy guidance, Recipe-Lens provides an intuitive, interactive way to create meals based on ingredients you already have.

Additionally, our system incorporates smart kitchen functionalities using Sinric Pro, a cloud-based platform that enables voice-controlled operation via Amazon Alexa and Google Home. This integration allows users to control kitchen appliances efficiently, adding convenience and modern automation to their cooking environment. By combining real-time monitoring, automated safety mechanisms, and IoT-based smart controls, our project aims to enhance kitchen safety, prevent gas-related accidents, and improve user convenience. This system is particularly beneficial for households, ensuring a seamless and secure cooking experience

1.1 Literature Survey

1.1.1 Gas Level Detection and Automatic Booking System

This study presents a smart LPG monitoring system that focuses on real-time gas level detection and automatic refill booking. The key components and functionalities of the system include: LPG Leakage Detection: Gas sensors detect LPG leaks, triggering alarms and sending SMS alerts to users, ensuring immediate awareness and response to potential hazards.

Load Cell-based Gas Monitoring: The system uses a load cell to measure the weight of the LPG cylinder, providing real-time gas level updates displayed on an LCD screen. Automated SMS Notifications: When gas levels drop below a critical threshold, users receive SMS alerts for timely refill bookings. Pipeline Gas Flow Monitoring: The system extends its application to pipeline monitoring, enabling accurate billing and potential integration into smart city infrastructure. This system enhances both safety and user convenience by automating the detection and booking process. However, limitations include dependency on Wi-Fi stability, sensor calibration issues, and specific gas detection challenges.

1.1.2 A Comparative Study on Monitoring of LPG Gas Cylinders to Prevent Hazards (2023)

This study focuses on LPG hazard prevention by comparing different monitoring techniques for gas cylinder safety. The proposed system integrates:

Gas Sensors for Leakage Detection**:** MQ-series sensors detect gas leaks and activate an audible alarm for immediate hazard alerts. Load Cell for Gas Level Measurement**:** The weight of the LPG cylinder is continuously tracked to determine gas consumption. GSM Module for Alert Notifications**:** In case of leakage or low gas levels, SMS notifications are sent to users, ensuring timely intervention. LCD Display for Live Monitoring**:** The system provides real-time updates on gas levels and alerts through an LCD screen.

1.1.3 IoT-Based Automatic Gas Booking and Leakage Detection System

This research explores the use of IoT in automating gas booking and leakage detection. The proposed system consists of:

Leakage Detection and Gas Level Monitoring: The MQ2 gas sensor and a Wheatstone Bridge circuit measure LPG concentration and cylinder weight. IoT-Based Automation**:** The system is integrated with a web interface for real-time user interaction, enabling automatic cylinder booking. Limitations: The study identifies challenges such as network dependency, sensor accuracy issues, and power consumption constraints, which impact system performance in real-world applications.

By leveraging IoT, this system enhances safety and convenience but requires optimization in terms of connectivity and reliability.

1.1.4 Gas Level Detection and Automatic Booking System (IoT-Based)

This study presents an IoT-based LPG monitoring system designed for real-time tracking and automated gas refill booking. The key features include:

LPG Detection and Notification: The system uses gas sensors to detect leaks and alerts both users and gas agencies. IoT Integration with NodeMCU-12E and Ubidots: This enables real-time gas level monitoring and online data tracking for enhanced user experience. System Limitations: The system faces challenges related to Wi-Fi stability, sensor calibration, and specific gas detection accuracy, which impact overall performance.

1.2 Problem Statement

Unmonitored LPG Consumption: Users are often unaware of how much gas remains in the cylinder, leading to unexpected depletion and disruption in cooking activities. Manual checking methods are inconvenient and unreliable.

Gas Leakage Risks: Undetected gas leaks can lead to fire hazards, explosions, and health issues due to inhalation of harmful gases. Traditional gas sensors only trigger audible alarms, which may go unnoticed if no one is present in the kitchen.

Lack of Automated Safety Measures: Existing systems do not take corrective actions, such as opening windows for ventilation, in case of a gas leak. Immediate response mechanisms are essential to prevent accidents.

Limited Smart Home Integration: Most LPG monitoring systems are not integrated with IoT-based platforms for remote alerts and smart home control. Users lack the convenience of voice-controlled kitchen operations through platforms like Amazon Alexa and Google Home.

Need for a Smart and Automated Solution: A system is required that can automatically monitor LPG levels, detect leaks, send alerts, and take preventive measures. The solution should be cost-effective, scalable, and easy to integrate into modern kitchens.

Limited Recipe Discovery and Personalization: Many home cooks struggle to find recipes that match their available ingredients or skill level. Current solutions often require manually searching through extensive databases, which can be time-consuming and overwhelming. There is a need for an intelligent, easy-to-use system that provides personalized cooking instructions based on the ingredients available and the user’s preferences.

1.3 Objectives

Automated LPG Level Monitoring: A load cell-based system continuously monitors the LPG cylinder's weight and sends automated alerts to family members when gas levels drop below a predefined threshold, ensuring timely refills

Gas Leakage Detection and Prevention**:** A gas sensor detects leaks and sends instant notifications via the Blynk platform. To prevent gas accumulation, the system automatically opens windows for ventilation.

Integration with Smart Home Systems**:** The system connects with **Sinric Pro**, enabling voice-controlled operations through **Amazon Alexa and Google Home**. Users can remotely monitor and control gas-related activities in the kitchen.

Enhanced Safety Measures**:** In case of a gas leak, an emergency alert system notifies users via **SMS or mobile notifications**. Additionally, a buzzer and LED indicators provide immediate local alerts for enhanced safety.

Fire and Human Presence Detection**:** A fire sensor detects accidental kitchen fires and triggers safety alerts. A human presence sensor ensures gas usage is allowed only when an adult is present, preventing unauthorized access by children.

Cost-Effective and Scalable Solution: The system is designed to be low-cost, efficient, and scalable for both household and commercial kitchens. It ensures easy installation and a user-friendly experience for widespread adoption.

Energy-Efficient and IoT-Based Monitoring: A power-efficient **IoT-based** solution enables real-time monitoring, minimal energy consumption, and data logging for future analytics and system improvements.

Food Image Analysis: Deep learning and image processing algorithms analyze food images with high accuracy, identifying ingredients to assist users in meal preparation.

Ingredient Estimation and Recipe Generation: Using image analysis, the system estimates ingredient quantities and generates personalized, step-by-step cooking instructions based on user skill level and available ingredients.

Personalized Recipe Recommendations: Machine learning models recommend recipes tailored to the user's preferences, dietary restrictions, and cooking history, enhancing the smart kitchen experience.

1.4 Link to SDG-11

1.4.1 Promoting Safety in Urban Homes

SDG 11.5: This target focuses on reducing the number of deaths and people affected by disasters, including those caused by hazards like gas leaks and fires in urban areas.

Automated LPG Monitoring System: The system addresses safety risks in urban homes by detecting LPG gas leaks and sending real-time alerts to users. This reduces the chances of accidents, creating safer living environments and minimizing the impact of gas-related disasters in households.

Recipe-Lens: By providing real-time, accurate recipe suggestions based on available ingredients, Recipe-Lens ensures that home cooks follow safe cooking practices. It can help users avoid potential hazards by providing step-by-step guidance that minimizes errors in cooking, thus contributing to kitchen safety.

1.4.2 Improving Environmental Sustainability and Resource Efficiency

SDG 11.6: This target aims to reduce the environmental impact of cities, especially in terms of air quality and waste management.

Automated LPG Monitoring System: By efficiently monitoring LPG usage and ensuring timely refills, the system helps optimize fuel consumption and minimize waste. This promotes sustainable energy use in urban kitchens, contributing to the broader goal of reducing the environmental footprint of cities.

Recipe-Lens: Recipe-Lens promotes sustainability by encouraging users to make the most of the ingredients they already have, reducing food waste. The system can suggest recipes based on leftover ingredients, minimizing the environmental impact of food waste in urban homes and supporting more sustainable resource consumption

1.4.3 Enhancing Smart and Sustainable Urban Infrastructure

SDG 11.2: Focuses on making transport systems more sustainable, but also addresses the need for smarter urban infrastructure.

Automated LPG Monitoring System: The project uses IoT-based technologies and cloud integration (such as Blynk and Sinric Pro) to create a "smart kitchen." This integration not only enhances safety but also improves the overall efficiency and convenience of urban living, aligning with the broader goals of building smart, sustainable cities.

Recipe-Lens: Recipe-Lens also contributes to the concept of smart urban infrastructure by utilizing deep learning and image processing to create an intelligent recipe-generation system. By seamlessly integrating this with IoT-enabled kitchen devices, the project helps make urban kitchens more efficient, reducing manual effort and optimizing resource usage in cooking.

1.4.4 Reducing Vulnerability and Building Resilience

SDG 11.3: Encourages the adoption of policies and plans that make cities more resilient to disasters and hazards.

Automated LPG Monitoring System: By detecting gas leaks and automatically triggering safety responses (e.g., opening windows to disperse gas), your system contributes to the resilience of urban homes against the risks of gas-related accidents. This proactive approach helps prevent hazards before they escalate, strengthening community resilience.

Recipe-Lens: While not directly related to disaster management, Recipe-Lens can contribute to resilience by providing users with innovative, customizable meal options. This supports food security, allows people to make the most of available ingredients during crises (e.g., food shortages), and promotes the self-sufficiency of urban households.

1.5 Brief Methodology

The "Automated LPG Usage and Safety Monitoring System & Smart Kitchen" utilizes IoT technologies to improve safety and convenience in the kitchen. The LPG usage monitoring is achieved through a **load cell** that measures the weight of the LPG cylinder. The microcontroller processes this data, and when the gas level falls below a set threshold, it sends an SMS or app notification to alert users for a refill. For gas leak detection, an **MQ gas sensor** continuously monitors the air for harmful gases. When a leak is detected, the microcontroller triggers an SMS alert and activates an automated window-opening mechanism to ensure proper ventilation and prevent gas accumulation. Additionally, the system integrates **Sinric Pro**, enabling users to control kitchen appliances using **Amazon Alexa** or **Google Home** for voice commands, enhancing convenience. All modules are seamlessly connected through a central **microcontroller**, which processes sensor data, communicates with cloud services, and manages the overall system, providing real-time notifications and ensuring a safer, more efficient cooking environment.

Chapter 2

HARDWARE IMPLEMENTATION

2.1 Block Diagram

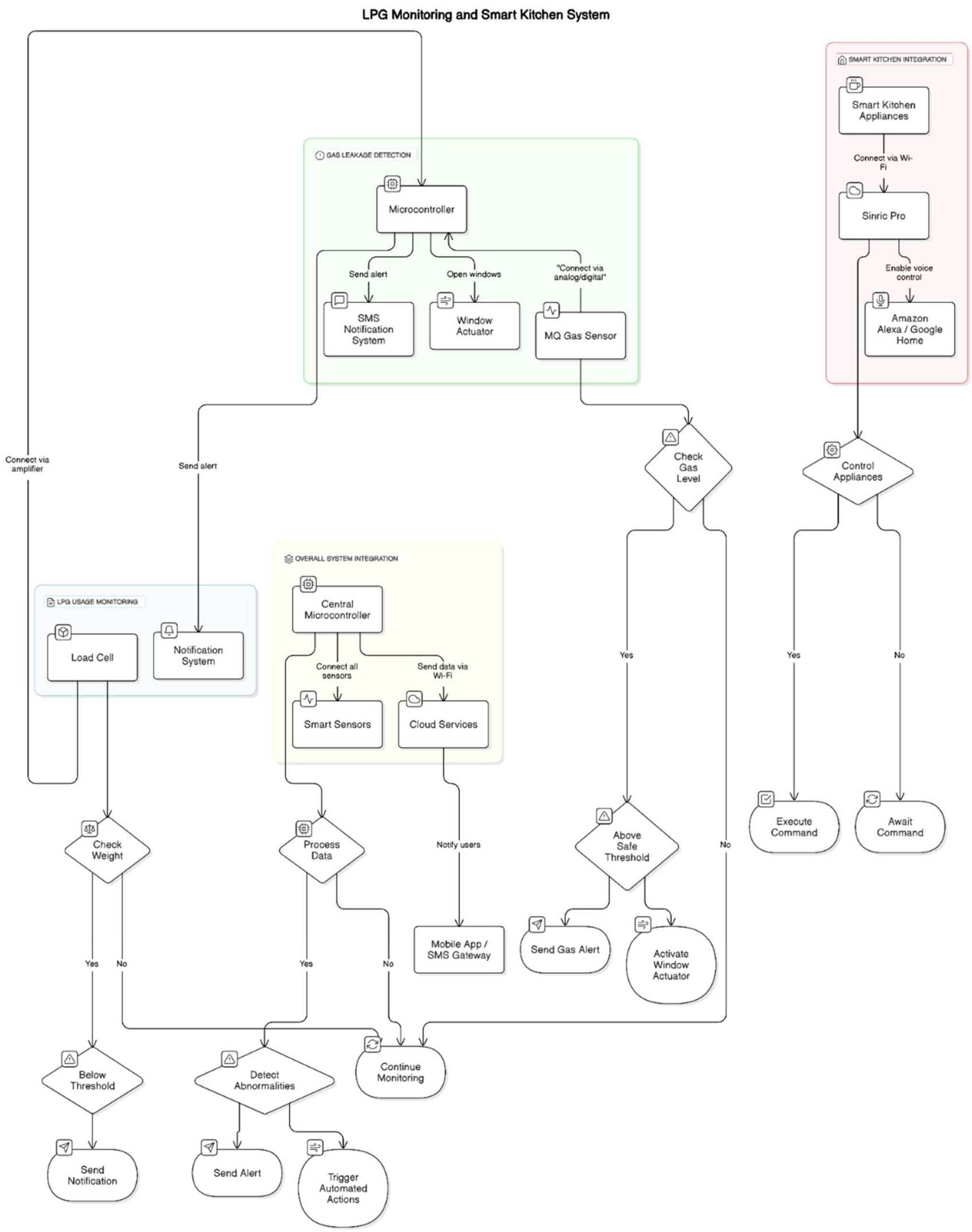

Figure 2.1Block Diagram of hardware connections

2.2 Methodology & Implementation

2.2.1 LPG Usage Monitoring Module (Using Load Cell)

Components:

Load Cell: A sensor that measures the weight of the LPG cylinder.

Microcontroller: The microcontroller reads and processes the data from the load cell.

Notification System: Sends alerts to users when the LPG cylinder weight drops below a predefined threshold, indicating that a refill is required.

Connections:

Load Cell to Microcontroller: The load cell is connected to the microcontroller via an amplifier module (like HX711) to convert the analog weight signals into readable digital data.

Microcontroller to Notification System: The microcontroller communicates with a mobile app or SMS gateway to send notifications. This can be achieved via Wi-Fi or Bluetooth, depending on the setup.

Working Principle:

The **load cell** measures the weight of the LPG cylinder. The microcontroller processes this data and compares it to a predefined threshold weight value, which corresponds to the gas consumption.

When the weight of the cylinder drops below the threshold, the system sends a **notification** to the user via SMS or a mobile app, alerting them that the LPG cylinder needs to be refilled.

2.2.2 Gas Leakage Detection Module (Using MQ Gas Sensor)

Components:

MQ Gas Sensor: Detects the presence of combustible gases like LPG or methane.

Microcontroller: Processes the data from the MQ gas sensor.

SMS Notification System: Sends an SMS or app notification if a gas leak is detected.

Automated Window Opening Mechanism: An actuator connected to the system opens windows automatically when a gas leak is detected.

Connections:

MQ Gas Sensor to Microcontroller: The MQ gas sensor is connected to the microcontroller through its analog or digital output, depending on the type of sensor used.

Microcontroller to Notification System: The microcontroller communicates with the mobile app or SMS gateway to send notifications when gas leakage is detected.

Microcontroller to Window Actuator: The microcontroller controls the window actuator, which opens the windows upon detecting a gas leak.

Working Principle:

The **MQ Gas Sensor** detects the concentration of combustible gases in the air. When the gas level exceeds a safe threshold, the microcontroller is triggered to send an **alert** to the user through an SMS or mobile app notification.

Simultaneously, the **automated window opening mechanism** is activated to open the windows and allow the gas to dissipate, reducing the risk of dangerous accumulation and potential explosions.

2.2.3 Smart Kitchen Integration (Using Sinric Pro and Voice Control)

Components:

Sinric Pro: A cloud-based platform that enables the connection of devices to voice assistants like Amazon Alexa and Google Home.

Amazon Alexa / Google Home: Voice-controlled platforms to interact with the kitchen appliances.

Smart Kitchen Appliances: Kitchen devices that can be controlled through Sinric Pro, such as lights, fans, and cooking appliances.

Connections:

Smart Kitchen Appliances to Sinric Pro: The appliances are connected to Sinric Pro via Wi-Fi, allowing them to be controlled by Alexa or Google Home.

Sinric Pro to Amazon Alexa / Google Home: Sinric Pro acts as an intermediary, allowing Alexa or Google Home to communicate with the connected kitchen appliances.

Working Principle:

Sinric Pro connects all smart kitchen devices to the cloud, allowing them to be accessed and controlled remotely via voice commands.

Users can issue voice commands to **Amazon Alexa or Google Home** to control appliances such as turning lights on/off, adjusting fan speeds, or even checking the status of the LPG gas usage.

The integration provides a convenient, hands-free way to interact with kitchen appliances, improving user experience and kitchen efficiency.

2.2.4 Overall System Integration

Components:

Microcontroller (Central Unit): A central unit that processes data from all modules and coordinates communication between them.

Cloud Services **(Blynk)**: Enables real-time data monitoring, remote control, and notifications.

Smart Sensors (Load Cell, MQ Gas Sensor): Provides real-time data on LPG levels and gas leaks.

Connections:

Microcontroller to All Sensors and Actuators: The microcontroller is the central hub that connects all sensors (load cell, MQ gas sensor) and actuators (window actuators) to ensure smooth communication and processing of data.

Microcontroller to Cloud Services: The microcontroller connects to cloud services via Wi-Fi to send real-time data, such as gas levels or notifications, to users through mobile apps or SMS.

Cloud to Mobile App / SMS Gateway: The cloud services interact with the mobile app or SMS gateway to notify users about gas levels, leaks, or other alerts.

Working Principle:

The **microcontroller** acts as the central processing unit, coordinating data from the sensors (load cell and MQ gas sensor) and sending alerts or control signals to the actuators (window opening mechanism).

Real-time data is sent to cloud services like **Sinric Pro** and **Blynk**, allowing users to monitor the system remotely and control appliances through mobile apps or voice assistants.

If the system detects any abnormalities (such as low LPG levels or a gas leak), it sends instant notifications to users via SMS or the mobile app. Additionally, automated actions like opening the windows are triggered to ensure safety.

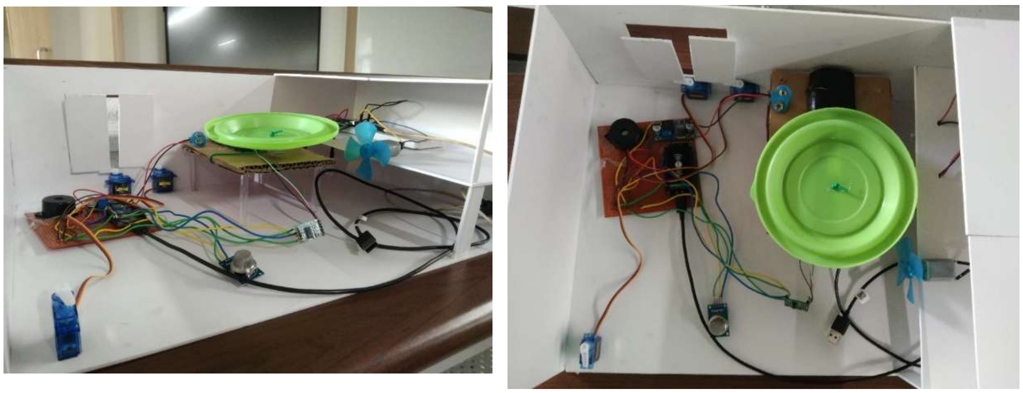

Figure 2.2 Image of Hardware Setup

Chapter 3

SOFTWARE IMPLEMENTATION

3.1Code

```
<div class="main_content">
<div class="image-upload-area">
  <center>
    <h2 style="width: 100%;">A food image to recipe converter for Indian Food</h2>
  </center>
  <div class="uploaded-image-display">
    <img id="up-image" src="data:image/png;base64,{{uploaded_image}}">
  </div>
  <div class="image_form">
    <form method="post" enctype="multipart/form-data"
      style="display:flex;flex-direction:column; justify-content:center;align-items:center; gap:1em">
      {% csrf_token %}
      <div style="display: flex;align-items:center; gap:1em; ">
        <label class="upload_button" style="width: fit-content;">
          Upload Image
          <input type="file" name="image" accept="image/*" id="id_image"
            onchange="document.getElementById('up-image').src =
window.URL.createObjectURL(this.files[0])">
        </label>   
        <label class="upload_button" style="width: fit-content;">
          Take a Picture
          <input type="file" name="image" accept="image/*" capture="environment" id="cap_image"
            onchange="document.getElementById('up-image').src =
window.URL.createObjectURL(this.files[0])">
        </label>
      </div>
      <button class="btn" type="submit">
        <svg height="24" width="24" fill="#FFFFFF" viewBox="0 0 24 24" data-name="Layer 1"
id="Layer_1"
          class="sparkle">
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            d="M10,21.236,6.755,14.745.264,11.5,6.755,8.255,10,1.764l3.245,6.491L19.736,11.5l-
6.491,3.245ZM18,21l1.5,3L21,21l3-1.5L21,18l-1.5-3L18,18l-3,1.5ZM19.333,4.667,20.5,7l1.167-
2.333L24,3.5,21.667,2.333,20.5,0,19.333,2.333,17,3.5Z">
          </path>
        </svg>
        <span class="text">Generate Recipe</span>
      </button>
    </form>
  </div>
</div>
```

3.2Methodology & Implementation

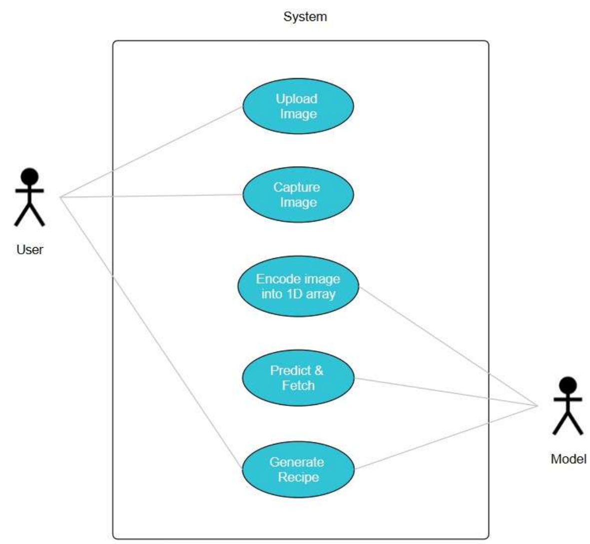

Figure 3.1 Use Case Diagram

The "Recipe Lens" application leverages Django for its robust, secure, and scalable framework, enabling efficient user login and project expansion. Its frontend features a user-friendly interface with options to upload or take pictures, generating recipes based on the images. Data scraping ensures a comprehensive image dataset for training, with tools to download images and extract recipe details from websites. Image encoding transforms images into numerical representations for efficient recognition and recipe generation, storing the results for seamless retrieval and display.

3.3Results

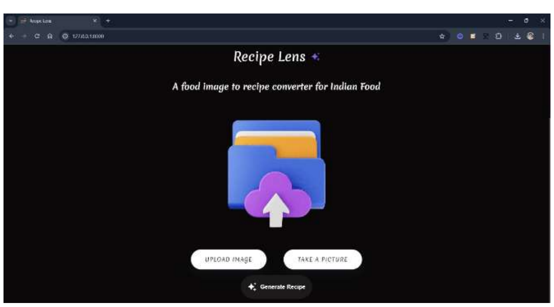

Figure 3.3 Home Page of Recipe-Lens

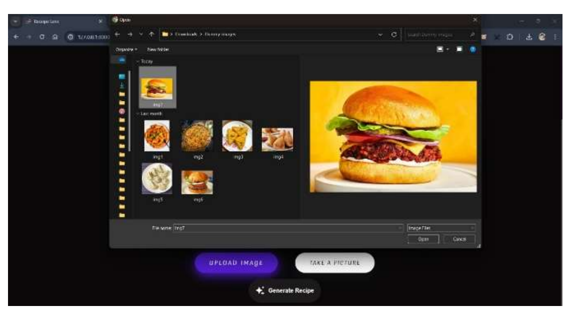

Figure 3.4 Uploading an image to the app

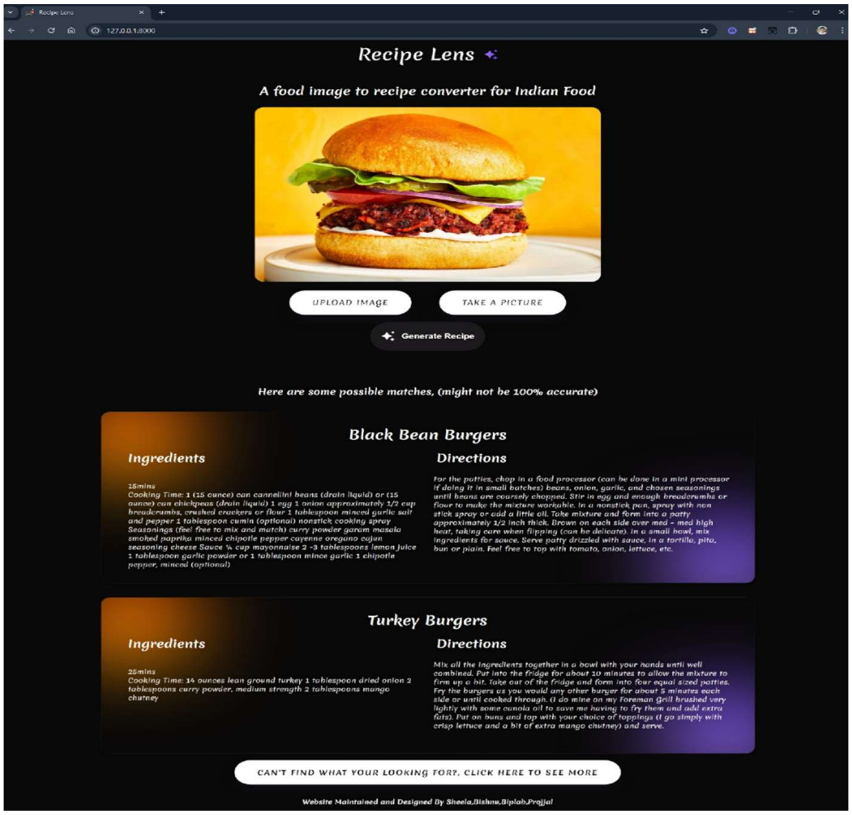

Figure 3.5Output Page

Chapter 4

CONCLUSION AND FUTURE ENHANCEMENTS

The Automated LPG Usage and Safety Monitoring System & Smart Kitchen enhances safety, convenience, and efficiency in modern kitchens through real-time monitoring, automated safety mechanisms, and smart home integration. Using IoT-based technologies, the system ensures continuous LPG level tracking, instant gas leakage detection, and proactive safety measures such as automatic window ventilation and emergency alerts.

By integrating Blynk and Sinric Pro, users can control appliances using voice commands via Amazon Alexa and Google Home, making the kitchen smarter and safer. Features like fire detection, human presence monitoring, and automated gas refill notifications create a comprehensive and intelligent solution for both households and commercial kitchens. This project is cost-effective, scalable, and energy-efficient, addressing key concerns such as unmonitored LPG consumption and gas leak hazards while ensuring a safer, smarter kitchen environment.

The Recipe-Lens project revolutionizes the culinary experience by combining image recognition and natural language processing to transform static food images into interactive cooking guides. From ingredient identification to generating personalized recipes, this technology enhances meal planning and culinary creativity.

Beyond practicality, Recipe-Lens embodies the fusion of modern AI and culinary artistry, making every cooking experience dynamic and engaging. By blending technology with gastronomy, it paves the way for a more interactive and enjoyable approach to cooking.

The future of the Automated LPG Usage and Safety Monitoring System & Smart Kitchen includes deeper integration with smart home ecosystems, enabling seamless interaction with refrigerators, ovens, and air purifiers for a fully automated kitchen. Advanced machine learning algorithms could predict LPG consumption patterns and detect potential gas system failures before they occur.

Additionally, integration with renewable energy sources like solar-powered cooking devices would support sustainability. A mobile app for remote monitoring would allow users to track kitchen safety and energy usage from anywhere. Enhancing gas detection to include carbon monoxide and methane would further improve air quality and safety. Collaborations with LPG providers could automate refills, ensuring uninterrupted gas supply. Educational features on safe LPG usage and energy-efficient cooking would further benefit users.

Expanding the system's data collection and analysis capabilities could support urban planning, safety improvements, and smart city initiatives, promoting sustainable and efficient resource management.

For Recipe-Lens, future improvements include user login features for personalized cooking experiences, allowing secure access to saved preferences and cooking histories.

Chapter 5

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