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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

Submitted by,

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Chapter 1: Introduction to the project

1.1 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.

1.2 Literature Survey

The increasing use of Liquefied Petroleum Gas (LPG) in households, industries, and commercial establishments necessitates advanced safety measures and efficient monitoring systems. Traditional methods of gas level checking and leakage detection rely on manual inspection, which is prone to errors and delays. Smart LPG monitoring systems integrate sensors, microcontrollers, communication modules, and IoT technologies to enhance safety, automate gas level tracking, and facilitate automatic booking when gas levels are low.

This literature survey explores various research works on LPG monitoring systems, focusing on gas leakage detection, real-time level monitoring, automated refill booking, and IoT-based enhancements. By analysing existing studies, we aim to understand the strengths, limitations, and advancements in this field to develop an improved smart LPG monitoring solution.

1.2.1 Gas Level Detection and Automatic Booking System

Authors: Tamizharasan V, Ravichandran T, Sowndariya M, Sandeep R, Saravanavel K

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:

1. LPG Leakage Detection: Gas sensors detect LPG leaks, triggering alarms and sending SMS alerts to users, ensuring immediate awareness and response to potential hazards.
2. 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.
3. Automated SMS Notifications: When gas levels drop below a critical threshold, users receive SMS alerts for timely refill bookings.
4. 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.

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

Authors: Sachin Chawla, Hunny Chawla

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

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

This comparative study highlights different approaches to LPG monitoring and safety mechanisms while addressing potential improvements for existing systems.

1.2.3 IoT-Based Automatic Gas Booking and Leakage Detection System

Authors**:** Kodali R.K, Rajanarayanan S.C

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

1. Leakage Detection and Gas Level Monitoring: The MQ2 gas sensor and a Wheatstone Bridge circuit measure LPG concentration and cylinder weight.
2. IoT-Based Automation**:** The system is integrated with a web interface for real-time user interaction, enabling automatic cylinder booking.
3. 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.

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

Authors**:** Tamizharasan V, Ravichandran T, Sowndariya M, Sandeep R, Saravanavel K

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

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

1.3 Problem statements

- 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.

1.4 Objectives

Automated LPG Level Monitoring:

- Implement a load cell-based system to continuously monitor the LPG cylinder weight.
- Send automated alerts to family members when the gas level drops below a predefined threshold.

Gas Leakage Detection and Prevention:

- Use a gas sensor to detect leakage and send instant notifications through the Blynk platform.
- Trigger an automated response by opening windows for ventilation to reduce gas accumulation.

Integration with Smart Home Systems:

- Connect the system with Sinric Pro for voice-controlled operations using Amazon Alexa and Google Home.
- Enable remote monitoring and control of gas-related activities in the kitchen.

Enhanced Safety Measures:

- Implement an emergency alert system to notify users via SMS or mobile notifications in case of gas leaks.
- Integrate a buzzer and LED indicators to provide immediate local alerts.

Fire and Human Presence Detection:

- Integrate a fire sensor to detect accidental kitchen fires and send safety alerts.
- Implement a human presence sensor to allow gas usage only when an adult is present, preventing unauthorized use by children.

Cost-Effective and Scalable Solution:

- Design a low-cost, efficient, and scalable system that can be deployed in households and commercial kitchens.
- Ensure easy installation and user-friendly operation for widespread adoption.

Energy-Efficient and IoT-Based Monitoring:

- Develop a power-efficient IoT solution that can operate with minimal energy consumption.
- Enable real-time monitoring and data logging for future analytics and improvements.

Food Image Analysis:

- Leverage deep learning and image processing algorithms to analyze food images and identify ingredients with high accuracy.

Ingredient Estimation and Recipe Generation:

- Estimate the quantity of each ingredient from the image and generate personalized step-by-step cooking instructions tailored to the user's skill level and available ingredients.

Personalized Recipe Recommendations:

- Use machine learning models to recommend recipes based on the user's preferences, dietary restrictions, and cooking history.

1.5 Link to SDG – 11

1.5.1 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.

1.5.2. 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.

1.5.3. 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.

1.5.4. 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.

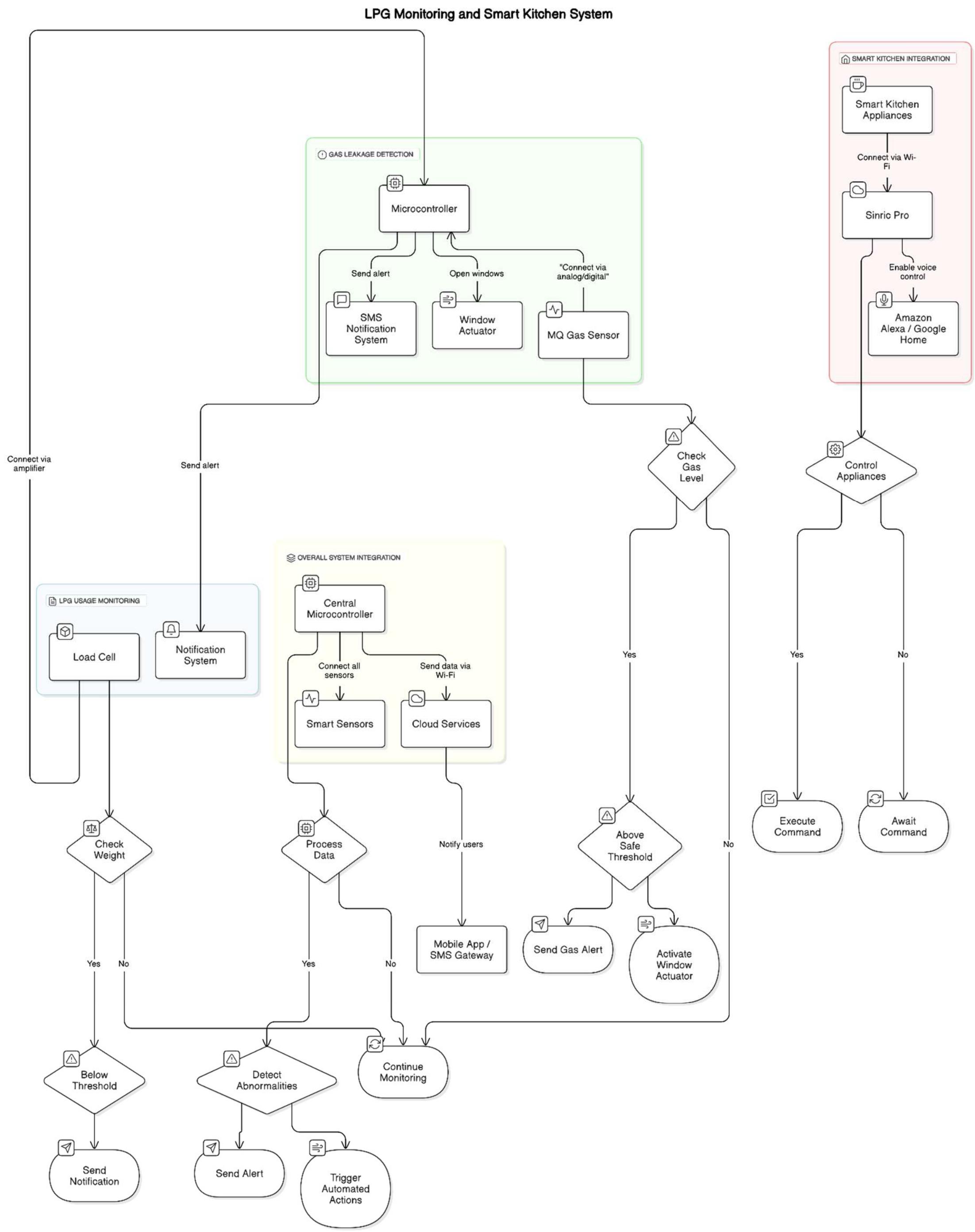
Both Recipe-Lens and the Automated LPG Monitoring System contribute to SDG 11 by improving urban safety, resource efficiency, and smart living. The LPG monitoring system ensures a safe cooking environment while optimizing fuel usage, and Recipe-Lens fosters sustainable practices by reducing food waste and encouraging creative meal planning. Together, these projects support the transition to smarter, safer, and more sustainable urban homes, enhancing both resilience and quality of life in cities.

1.6 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



2.2 Methodology & Implementation

1. LPG Usage Monitoring Module (Using Load Cell)

Components:

- **Load Cell**: A sensor that measures the weight of the LPG cylinder.
- **Microcontroller (e.g., Arduino or ESP32)**: The microcontroller reads and processes the data from the load cell.
- **Notification System (SMS or Mobile App)**: 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. Gas Leakage Detection Module (Using MQ Gas Sensor)

Components:

- **MQ Gas Sensor**: Detects the presence of combustible gases like LPG or methane.
- **Microcontroller (e.g., Arduino or ESP32)**: 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.

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.

4. Overall System Integration

Components:

- **Microcontroller (Central Unit)**: A central unit that processes data from all modules and coordinates communication between them.
- **Cloud Services (e.g., Sinric Pro, 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.

2.3 Results

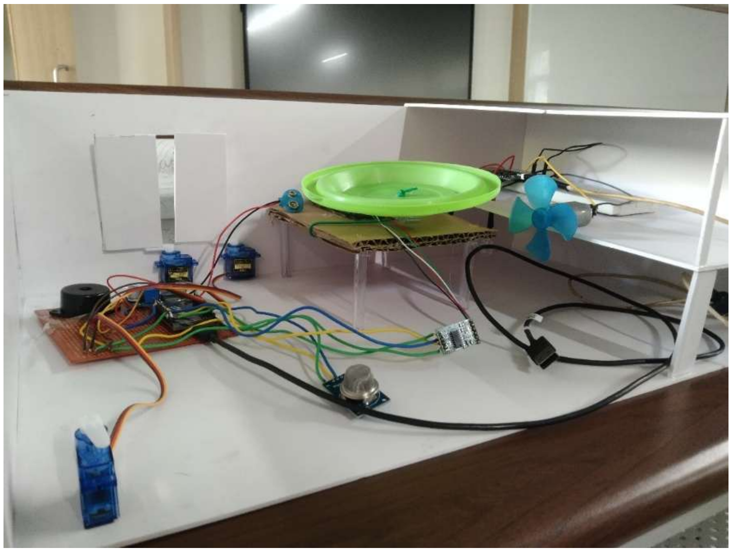


Figure 1 Image of the Hardware model

Figure 2 Image of the Hardware Model

Chapter 3: Software Implementation

3.1 Code

3.2 Methodology & Implementation

3.3 Results

3.3.1 Recipe-Lens Application Result

Chapter 4: Summary

4.1 Conclusion

The Automated LPG Usage and Safety Monitoring System & Smart Kitchen is designed to enhance safety, convenience, and efficiency in modern kitchens through real-time monitoring, automated safety mechanisms, and smart home integration. By leveraging 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**.**

Through the integration of Blynk and Sinric Pro, the system not only enhances safety but also introduces smart automation, allowing users to control appliances using voice commands via Amazon Alexa and Google Home. Additionally, features like fire detection, human presence monitoring, and automated gas refill notifications make this a comprehensive and intelligent solution for household and commercial kitchens. This project provides a cost-effective, scalable, and energy-efficient solution that ensures kitchen safety while improving user convenience**.** By addressing critical issues such as unmonitored LPG consumption and gas leak hazards, this system represents a significant step towards creating safer and smarter kitchens for the future**.**

The "Recipe-Lens" project represents a significant stride in the realm of culinary technology, marrying the visual allure of food with the precision of artificial intelligence. Through the amalgamation of state-of-the-art image recognition and natural language processing, this project has endeavoured to transform static images into dynamic, interactive cooking experiences. The journey from recognizing ingredients in a mere snapshot to generating coherent and personalized recipes is a testament to the potential of technology in reshaping our culinary adventures. As we reflect on the development process, it becomes evident that the project not only serves as a practical tool for meal planning but also as a source of inspiration for culinary enthusiasts across diverse skill levels.
In essence, the "Recipe Lens" project not only encapsulates the capabilities of modern technology but also embodies the spirit of culinary artistry, making every cooking endeavour an exciting and unique experience. It stands as a testament to the evolving intersection of technology and gastronomy, where the boundaries between the virtual and culinary worlds blur, paving the way for a more interactive and delightful cooking future.

4.2 Future Scope

The future scope of the "Automated LPG Usage and Safety Monitoring System & Smart Kitchen" offers exciting possibilities for enhancing its functionality and expanding its impact. One potential improvement is integrating the system with broader smart home ecosystems, allowing seamless interaction with other devices such as refrigerators, ovens, or air purifiers to create a fully connected and automated kitchen. Additionally, the system could incorporate advanced machine learning algorithms for predictive maintenance, allowing it to forecast LPG consumption patterns and detect potential issues with gas cylinders or components before they occur. The integration with renewable energy sources, like solar-powered cooking devices or sensors, would further promote sustainability by reducing reliance on non-renewable LPG. Furthermore, real-time remote monitoring through a mobile app could provide users with the ability to manage and monitor their kitchen's safety and energy usage even when away from home. Expanding the system's capabilities to detect a wider range of harmful gases, such as carbon monoxide or methane, would enhance air quality and overall safety within urban homes. Future collaborations with LPG providers could automate the refill process, ensuring that users never experience interruptions due to empty cylinders. Moreover, the system could provide educational features that guide users on safe LPG usage and energy-efficient cooking practices. Finally, the system could collect valuable data on consumption trends, leakages, and safety, which could be analyzed to help inform urban planning decisions, improve safety standards, and support resource management in smart cities. These advancements would not only improve safety and convenience but also align with broader goals of sustainability and smart urban living.

Future scope includes implementing a login feature to enhance user interaction, providing secure access to personalized cooking preferences and histories within the project.

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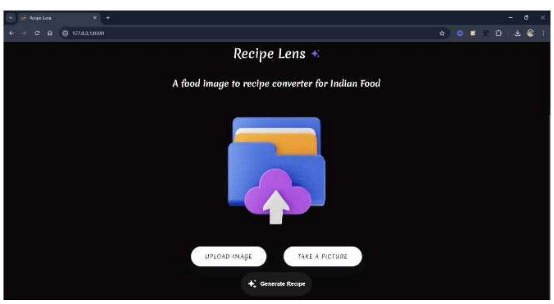

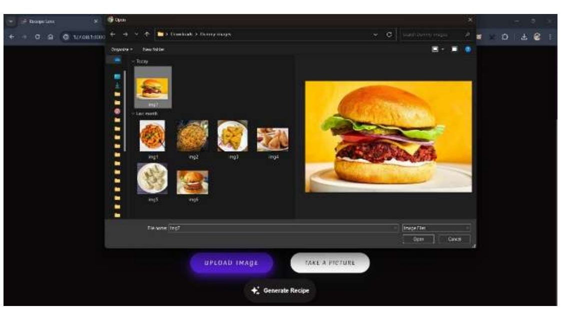

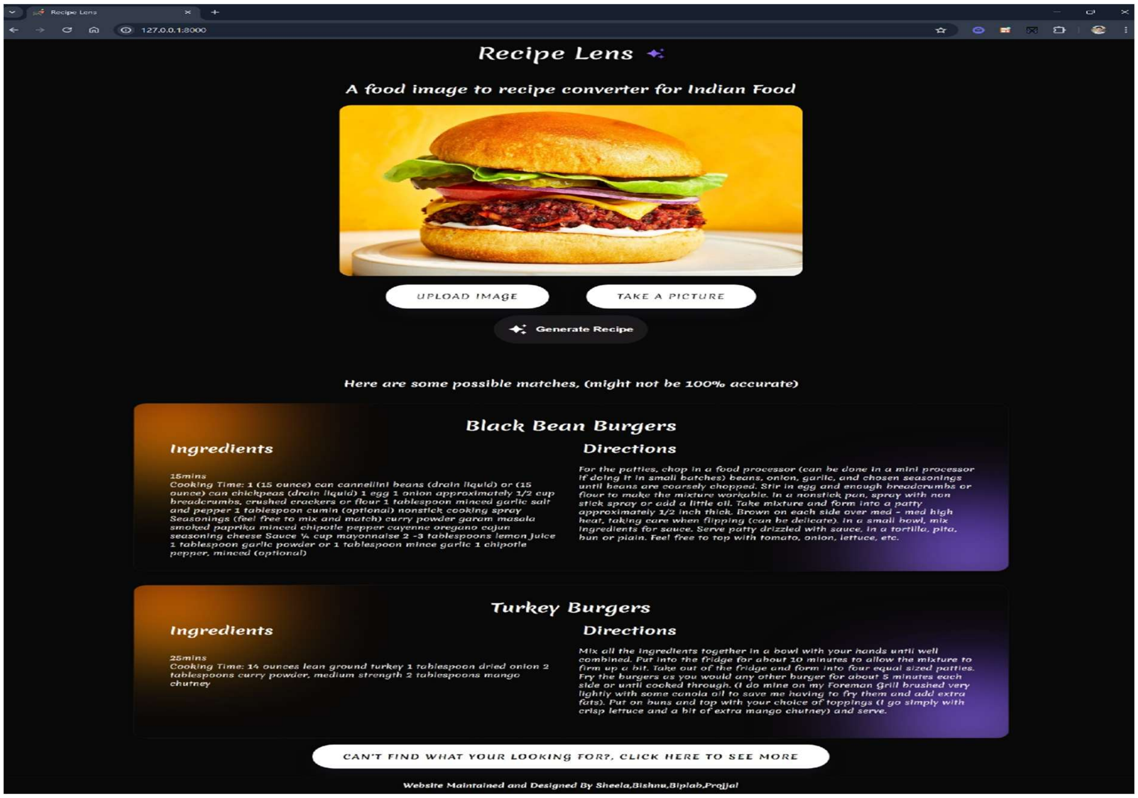
Recipe Lens
127.0.0.1:8000
Recipe Lens
A food image to recipe converter for Indian Food
UPLOAD IMAGE
TAKE A PICTURE
Generate Recipe
Here are some possible matches, (might not be 100% accurate)
Black Bean Burgers
Ingredients
15mins
Cooking Time: 1 (15 ounce) can cannellini beans (drain liquid) or (15 ounce) can chickpeas (drain liquid) 1 egg 1 onion approximately 1/2 cup breadcrumbs, crushed crackers or flour 1 tablespoon minced garlic salt and pepper 1 tablespoon cumin (optional) nonstick cooking spray Seasonings (feel free to mix and match) curry powder garam masala smoked paprika minced chipotle pepper cayenne oregano cajun seasoning cheese Sauce ¼ cup mayonnaise 2 -3 tablespoons lemon juice 1 tablespoon garlic powder or 1 tablespoon mince garlic 1 chipotle pepper, minced (optional)
Directions
For the patties, chop in a food processor (can be done in a mini processor if doing it in small batches) beans, onion, garlic, and chosen seasonings until beans are coarsely chopped. Stir in egg and enough breadcrumbs or flour to make the mixture workable. In a nonstick pan, spray with non stick spray or add a little oil. Take mixture and form into a patty approximately 1/2 inch thick. Brown on each side over med - med high heat, taking care when flipping (can be delicate). In a small bowl, mix ingredients for sauce. Serve patty drizzled with sauce, in a tortilla, pita, bun or plain. Feel free to top with tomato, onion, lettuce, etc.
Turkey Burgers
Ingredients
25mins
Cooking Time: 14 ounces lean ground turkey 1 tablespoon dried onion 2 tablespoons curry powder, medium strength 2 tablespoons mango chutney
Directions
Mix all the ingredients together in a bowl with your hands until well combined. Put into the fridge for about 10 minutes to allow the mixture to firm up a bit. Take out of the fridge and form into four equal sized patties. Fry the burgers as you would any other burger for about 5 minutes each side or until cooked through. (I do mine on my Foreman Grill brushed very lightly with some canola oil to save me having to fry them and add extra fats). Put on buns and top with your choice of toppings (I go simply with crisp lettuce and a bit of extra mango chutney) and serve.
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