AI- BASED DYNAMIC RECIPE GENERATOR USING LANGUAGE MODELS

PROJECT REPORT – PHASE I

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering
with Specialization in Data Science

By

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AUGUST - 2025

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Harini Shree B (42733027)** who carried out the Project entitled "AI-BASED DYNAMIC RECIPE GENERATOR USING LANGUAGE MODELS" under my supervision from June 2025 to August 2025.

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DECLARATION

I, **Harini Shree B (Reg. No- 42733027),** hereby declare that the Project Report entitled **"AI-BASED DYANMIC RECIPE GENERATOR USING LANGUAGE MODELS"** done by me under the guidance of **Dr. B. SELVAPRIYA, M.Tech., Ph.D.,** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering with Specialization in Data Science.**

DATE:

PLACE: Chennai **SIGNATURE OF THE CANDIDATE**

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management** of **Sathyabama Institute of Science and Technology** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. Senduru Srinivasulu**, **M.TECH., Ph. D.**, **Head**, School of Computing, for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. B. SELVAPRIYA, M.Tech., Ph.D.,** for her valuable guidance, suggestions, and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering with Specialization in Data Science** who were helpful in many ways for the completion of the project.

ABSTRACT

Meal planning today is a challenging task due to diverse dietary preferences, nutritional requirements, allergies, and the increasing importance of sustainable living. Individuals often struggle to prepare meals that are healthy, practical, and aligned with their personal needs, while also making effective use of available ingredients. This often results in inefficiency, reliance on processed foods, and unnecessary food waste, which has significant social, economic, and environmental consequences.It addresses these challenges by developing an AI-driven Recipe Generator that provides personalized, safe, and practical recipe suggestions. The system uses advanced Natural Language Processing and machine learning techniques to analyze user inputs such as available groceries, dietary restrictions, allergies, and time constraints, and generates coherent, nutritious recipes tailored to those requirements. By incorporating allergy-aware decision-making, the system ensures that suggested meals are not only suitable but also safe for consumption. The project emphasizes sustainability by encouraging the use of available resources and reducing waste, while also promoting healthier eating habits. Additionally, the system provides users with accessible outputs through an intuitive interface and downloadable resources. By combining efficiency, personalization, and safety, this work highlights the potential of AI to transform everyday cooking into a more convenient, inclusive, and eco-conscious practice.

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INTRODUCTION

In the modern world, meal planning has become a complicated task influenced by diverse factors such as individual dietary preferences, nutritional requirements, allergies, and environmental concerns. People are becoming more health-conscious and aware of how their food choices affect not only their well-being but also the planet. At the same time, busy lifestyles and limited time often make it difficult for individuals to prepare meals that are both healthy and practical. In addition, a significant challenge faced by households is food wastage, where ingredients are purchased but never fully utilized. This issue not only increases economic costs but also contributes to environmental degradation. These challenges highlight the pressing need for intelligent systems that can assist people in making smarter choices when it comes to meal preparation.

Traditional methods of recipe discovery, such as cookbooks or online databases, are limited in their adaptability to users' real-life constraints. Most recipe platforms offer static results that fail to consider what ingredients users already have, their specific dietary restrictions, or allergies. For instance, a person with a nut allergy may find it difficult to identify safe recipes without carefully checking every detail. Similarly, individuals who follow specialized diets, such as vegan, gluten-free, or low-carb, often struggle to find recipes that align perfectly with their preferences. These inefficiencies lead to frustration and wasted effort, and in many cases, people resort to less healthy alternatives like processed foods or takeaway meals.

Artificial intelligence has emerged as a transformative technology in addressing these modern-day challenges. By integrating natural language processing and machine learning techniques, AI can interpret user requirements and generate tailored solutions. The Recipe Generator developed in this project harnesses the power of AI to provide personalized, safe, and practical meal suggestions. By analyzing user inputs such as available groceries, allergies, dietary restrictions, and time constraints, the system generates recipes that are not only coherent and creative but also aligned with individual needs. The inclusion of allergy-awareness is a critical advancement, as it ensures the safety of users and builds trust in the recommendations provided by the system.

The project also emphasizes sustainability, which is a growing global concern. With nearly

one-third of food produced worldwide being wasted, there is an urgent need to encourage more efficient use of available ingredients. The Recipe Generator directly addresses this issue by designing recipes based on the groceries users already have at home.
This reduces the tendency to purchase unnecessary items and helps households minimize wastage. Encouraging people to use what is already available in their kitchens not only saves money but also supports environmentally conscious cooking practices.

Another important dimension of this project is accessibility. Many existing recipe platforms are designed primarily for English-speaking users, which excludes a large segment of the global population. By incorporating multi-language support, this system ensures inclusivity and enables individuals from different linguistic backgrounds to benefit equally. In addition, the integration of modern input methods such as voice-to-text and image-based ingredient detection makes the system more user-friendly. For example, instead of typing out long lists of groceries, a user can simply speak their inputs or upload a picture of ingredients to detect what they have. These features lower barriers to usage and make the system accessible even to individuals who may not be technologically adept.

The importance of safety in food preparation cannot be overstated, especially for individuals with allergies. This project's allergy-aware mechanism ensures that harmful ingredients are avoided in recipe generation. Beyond simple exclusion, the system also suggests safe substitutions, enabling users to enjoy recipes without compromising on taste or nutrition. This feature distinguishes the project from many existing platforms, making it not just a convenience tool but also a reliable support system for healthy and safe cooking.

Beyond solving individual challenges, the project carries broader implications for society. By promoting healthier eating, it encourages individuals to adopt balanced diets that align with their nutritional goals. By reducing food wastage, it contributes to sustainability efforts at both household and global levels. By providing inclusive and accessible solutions, it bridges cultural and linguistic gaps, allowing users worldwide to explore diverse cuisines. The system also has an educational dimension, as it introduces users to cooking methods, ingredient substitutions, and nutritional insights, helping them build confidence in the kitchen.

Technological innovation forms the foundation of this project. The system integrates large

language models for recipe generation, optical character recognition for ingredient detection, and user-friendly interfaces for seamless interaction. It also allows users to download recipes and additional information as PDF files, ensuring convenience and portability. By combining these technologies in a unified platform, the project creates an intelligent assistant that simplifies one of the most essential aspects of daily life—meal preparation.

In conclusion, the Recipe Generator represents a significant step toward reshaping how people approach cooking in the modern era. It addresses the challenges of dietary diversity, allergies, time constraints, and sustainability through intelligent, AI-driven solutions. By promoting healthier eating, reducing waste, and ensuring safety, the project highlights how technology can positively impact everyday practices. Furthermore, its accessibility and inclusivity demonstrate the potential of AI applications to reach and benefit a wide audience. Ultimately, this work illustrates the role of artificial intelligence in transforming cooking from a stressful routine into an enjoyable, efficient, and sustainable experience.

CHAPTER 2

LITERATURE SURVEY

2.1 SURVEY

The development of intelligent recipe generation systems has attracted significant research interest, combining artificial intelligence, nutrition science, and sustainability studies. Existing literature highlights the importance of personalization, health-awareness, and eco-friendly practices in meal planning. Researchers have explored diverse approaches, including natural language processing, ingredient substitution, allergy detection, and sustainable cooking strategies. This survey reviews key contributions across these areas, providing the foundation for the design of an AI-driven recipe generator.

2.1.1. Personalized Nutrition and Meal Planning

Researchers have highlighted the importance of tailoring meal plans to individual needs. Personalized nutrition systems improve adherence to healthy eating habits by considering dietary goals, available ingredients, and user preferences. Bianchi et al. (2020) demonstrated that technology-assisted personalized meal planning helps individuals stick to diets more effectively compared to generic plans. These studies show that personalization increases user satisfaction and practicality. Such insights directly influence the design of modern recipe generators that aim to deliver flexible, user-centered outputs.

2.1.2. Natural Language Processing (NLP) in Recipe Generation

Natural Language Processing has become a vital tool for extracting and generating recipe information. Koo et al. (2019) showed how NLP models can analyze large datasets of culinary texts to create coherent and novel recipes. NLP also enables systems to interpret user queries in conversational form, enhancing accessibility. This ensures users can communicate naturally without needing technical knowledge. The integration of NLP makes recipe generation more interactive, adaptive, and user-friendly.

2.1.3. Ingredient Substitution and Waste Reduction

Ingredient substitution is central to sustainability and usability in recipe systems. Studies by Garrone et al. (2019) emphasize that unused ingredients are a major source of food waste, and intelligent substitution mechanisms can significantly reduce this. By suggesting alternatives based on flavor compatibility and nutritional value, AI systems not only minimize

waste but also ensure users can cook effectively with what they already have. Substitution also helps users adapt recipes to cultural preferences.

2.1.4. Allergy Detection and Food Safety

Food safety has received growing attention, particularly with the rise in food allergies. Research has proposed methods to automatically identify allergens in recipes and flag unsafe dishes. Recent works go further by suggesting safe substitutions, making recipes accessible to people with dietary restrictions. This ensures inclusivity for users with serious medical conditions. Integrating allergy detection in recipe generators builds trust and positions them as reliable health-supportive tools.

2.1.5. Sustainability and Eco-Friendly Cooking Practices

Poore and Nemecek (2018) conducted a large-scale study on the environmental impact of food consumption, showing that plant-based diets are significantly more sustainable. Integrating these principles into recipe recommendation systems ensures not only personal health but also environmental benefits. Sustainable recipe systems can encourage users to utilize perishable items and reduce waste. They also foster awareness of eco-friendly.

2.1.6. User Experience and Community Engagement

The effectiveness of recipe generation systems depends not only on technical accuracy but also on usability and engagement. Gollnisch et al. (2021) emphasized that intuitive design, customization, and social features significantly influence adoption of meal-planning technologies. Systems that allow users to share experiences, rate recipes, and exchange tips create a sense of community and trust. This engagement motivates healthier eating habits while encouraging collaborative learning. Integrating user feedback loops also helps the system improve continuously, making it more adaptive and user- centered.

2.2 CHALLENGES IN EXISTING SYSTEM

2.2.1. Lack of Personalization: Most traditional recipe platforms provide generic suggestions without adapting to individual dietary preferences, nutritional goals, or available ingredients. This makes it difficult for users to find recipes that truly fit their personal lifestyle and needs.

2.2.2.Inadequate Allergy Awareness: Existing systems rarely filter recipes based on allergens, posing serious health risks for users with conditions such as nut, dairy, or gluten intolerance. In many cases, users must manually scan ingredient lists, which is both time-consuming and unreliable. This lack of automation limits the usability of such systems for vulnerable individuals who rely on safe meal recommendations.

2.2.3.High Food Waste: Many systems ignore the groceries users already have, forcing them to buy new ingredients unnecessarily. This often results in unused perishables and contributes to household food waste, an important environmental issue. By not encouraging the use of available resources, traditional systems miss an opportunity to promote eco-friendly cooking practices.

2.2.4.Limited Accessibility and Usability: Recipe applications are often text-heavy, language-restricted, and require manual input. This creates barriers for non-English speakers, busy individuals, or those with limited technical or culinary expertise.

2.2.5.Static and Rigid Recipe Suggestions: Traditional systems lack flexibility in ingredient substitution or dynamic customization. Users cannot easily replace missing or unwanted items, leading to frustration and reducing the practicality of suggested recipes.

2.2.6.Multi-language Support: Most recipe applications are restricted to English or a single language, excluding non-English speakers and reducing inclusivity. Additionally, systems often require manual text input, creating barriers for users who would benefit from voice or image-based interaction.

CHAPTER 3

ANALYSIS AND DESIGN OF PROPOSED SYSTEM

3.1. OBJECTIVE:

The primary objective of this project is to develop an intelligent AI-driven recipe generator that simplifies meal planning by providing personalized, safe, and sustainable meal suggestions. The system is designed to analyse multiple user inputs such as available groceries, dietary preferences, allergies, serving size, cuisine type, and cooking time to generate coherent and practical recipes tailored to individual needs. It emphasizes food safety through allergy awareness, reduces food waste by encouraging efficient use of available ingredients, and promotes healthier eating habits. By incorporating multi-language support, voice and image-based inputs, and a user-friendly interface, the project ensures inclusivity, accessibility, and convenience for diverse users in everyday cooking.

3.1.1 Personalize Meal Planning

A core objective of the Recipe Generator is to provide personalized recipes that match users' available groceries, dietary preferences, and cultural cuisine choices. By leveraging generative AI and natural language processing, the system ensures that users receive tailored suggestions that align with their health goals, food habits, and time availability. It also supports diverse cuisines, encouraging culinary exploration and variety in everyday meals. By doing so, the system enhances user satisfaction and makes cooking both practical and enjoyable.

3.1.2 Ensure Allergy Safety and Ingredient Substitution

Another major objective is to make recipe generation allergy-aware by detecting unsafe ingredients and excluding them from suggestions. The system also provides substitution options for allergenic or unavailable ingredients, ensuring that recipes remain practical, inclusive, and safe for all users. This functionality builds trust among users who face health risks due to allergies. By prioritizing safety, the system positions itself as more than just a convenience tool—it becomes a reliable kitchen assistant.

3.1.3 Reduce Food Waste through Smart Utilization

The project emphasizes sustainability by encouraging the use of available ingredients. Recipes are generated with a focus on minimizing waste and maximizing efficiency, enabling users to create meals from what they already have in their kitchens. This helps households save costs while supporting eco-friendly cooking practices. By promoting mindful consumption, the system addresses both environmental and economic concerns. It also contributes to global sustainability goals by reducing the carbon footprint associated with food waste.

3.1.4 Provide an Accessible and User-Friendly Interface

The interface, built with Gradio, is designed to be intuitive and engaging for users of all technical levels. Features such as multi-language support, voice-to-text input, and ingredient detection from uploaded images make the system widely accessible. This ensures inclusivity and ease of use for diverse user groups. By integrating modern interaction methods, the system lowers barriers for non-technical users. It also enhances convenience, making recipe planning quicker and more interactive.

3.1.5 Promote Healthy and Sustainable Eating Habits

Beyond convenience, the broader goal is to encourage healthier and more sustainable lifestyles. By providing nutritious recipe suggestions, cultural diversity in cuisines, and environmentally conscious cooking practices, the system contributes to both personal well-being and global sustainability.The platform motivates users to make smarter dietary choices that align with long-term health goals. In doing so, it bridges technology with lifestyle transformation, creating a lasting positive impact.

3.2 HARDWARE REQUIREMENTS AND SOFTWARE REQUIREMENTS:

3.2.1 Hardware Requirements :

To support the effective functioning of this Recipe Generator project, the following hardware requirements are necessary:

3.2.1.1 Processor (CPU)

The system should be equipped with a modern multi-core processor, such as an Intel i5/i7 or AMD Ryzen 5/7, to ensure smooth execution of AI-driven tasks, including natural language processing, OCR-based ingredient detection, and image processing. A strong CPU ensures efficient handling of real-time recipe generation and API calls without delays.

3.2.1.2 Memory (RAM)

A minimum of 8 GB RAM is required for development and smooth functioning. For better performance, particularly when running concurrent processes like OCR, voice-to-text, and AI model interactions, 16 GB or higher is recommended. Adequate RAM ensures the system remains responsive during multitasking operations.

3.2.1.3 Storage Capacity

At least 256 GB of SSD storage is recommended for saving uploaded ingredient images, user logs, generated recipes, and PDF reports. SSD storage is preferred over HDD for faster read/write operations and quicker application response times. Larger storage (512 GB or above) is advisable for extended datasets and multilingual support files.

3.2.1.4 Network Infrastructure

A stable high-speed internet connection is essential to interact with cloud-based AI models (e.g., LLaMA 3, GPT APIs). The system relies on real-time API calls for recipe suggestions, allergy detection, and translation, so a broadband network with low latency ensures seamless user experience and fast results.

3.2.2 Software Requirements

The Recipe Generator requires the following software components for smooth development and deployment:

3.2.2.1 Operating System

The application should be compatible with major operating systems such as Windows 10 or later, Linux (Ubuntu preferred), or macOS. A development environment on Windows or Linux is recommended, ensuring compatibility with machine learning libraries, OCR tools, and Gradio for the frontend.

3.2.2.2 Programming Languages

The primary language used is **Python**, as it provides powerful libraries for AI integration, text generation, OCR, and PDF generation. Python's versatility makes it suitable for both backend (API calls, AI processing, OCR with Tesseract) and frontend (via Gradio) implementation.

3.2.2.3 Frameworks and Libraries

- **Frontend:** Gradio for creating an interactive and user-friendly interface.
- **Core Libraries:** OpenAI API (or Groq client), FPDF (for PDF exports), pytesseract & PIL (for OCR image processing), and speech-to-text libraries for voice input.
- **Data Handling:** Pandas and NumPy for structuring outputs. These frameworks collectively enable multilingual support, recipe generation, allergy-safe suggestions, and image-based ingredient detection.

3.2.2.4 Cloud-Based AI Service

The project integrates with cloud-based generative AI models (e.g., LLaMA 3 or GPT APIs) for natural language recipe generation and translations. These services process user inputs (text, voice, and images) and return personalized recipe outputs in real time. An active API key and stable internet connection are required for secure and efficient communication with these models.

CHAPTER 4

IMPLEMENTATION OF PROPOSED METHODOLOGY

4.1 PROPOSED METHODOLGY:

The proposed methodology for the Recipe Generator project outlines the step-by-step approach used to design and implement the system. It integrates AI-powered techniques, OCR, voice recognition, and multi-language processing to ensure personalized, safe, and user-friendly recipe generation. The methodology is structured into the following phases:

4.1.1 User Input Acquisition

Users provide inputs such as available groceries, cuisine preference, recipe type (Vegetarian, Non-Vegetarian, Vegan), allergy details, cooking time, and serving size. Inputs can be given manually through textboxes, through voice commands, or by uploading images of ingredients. This multi-modal input approach ensures inclusivity and convenience for diverse users.

4.1.2 Ingredient Detection from Images

For users uploading ingredient photos, the system employs OCR (via Tesseract) and image processing techniques to detect text labels or identify visible ingredients. The extracted ingredient list is pre-processed to remove noise and duplicates, and then added to the available grocery list. This feature reduces manual effort and supports accessibility.

4.1.3 Allergy Detection and Filtering

The system cross-checks the provided ingredients and user-declared allergies to filter out unsafe recipes. If allergens are detected, the AI suggests safe substitutions or excludes unsafe dishes. This ensures food safety and inclusivity, especially for users with dietary restrictions. The allergy detection layer acts as a safeguard before final recipe generation.

4.1.4 AI-Powered Dish Suggestions

Using generative AI models (such as LLaMA 3 or GPT APIs), the system generates a list of suitable dish suggestions based on the groceries, cuisine style, time constraints, and servings. The AI also ensures diversity by including multiple cuisines and variations. Users can then

select a preferred dish for detailed recipe generation.

4.1.5 Recipe Generation and Customization

Once a dish is selected, the system generates a detailed recipe, including ingredients, step-by-step preparation instructions, cooking time, and nutritional details. It also suggests ingredient substitutions where necessary. Recipes are delivered in the user's chosen language, ensuring accessibility for global users. Additionally, the output can be exported as a PDF for offline use.

4.1.6 Additional Information and Clarifications

The system allows users to ask follow-up questions, such as "Can I replace cream with yogurt?" or "How do I make this spicier?". The AI provides instant clarifications, substitutions, or additional cooking tips. This feature enhances interactivity and ensures the application acts as a real-time cooking assistant.

4.1.7 Multi-Language Support and Accessibility

The final phase ensures inclusivity by providing recipe outputs in multiple languages (English, Hindi, Spanish, French, etc.). Combined with voice input and OCR-based ingredient detection, the system breaks language and technical barriers. This makes the project accessible to a wide range of users, promoting global adoption.

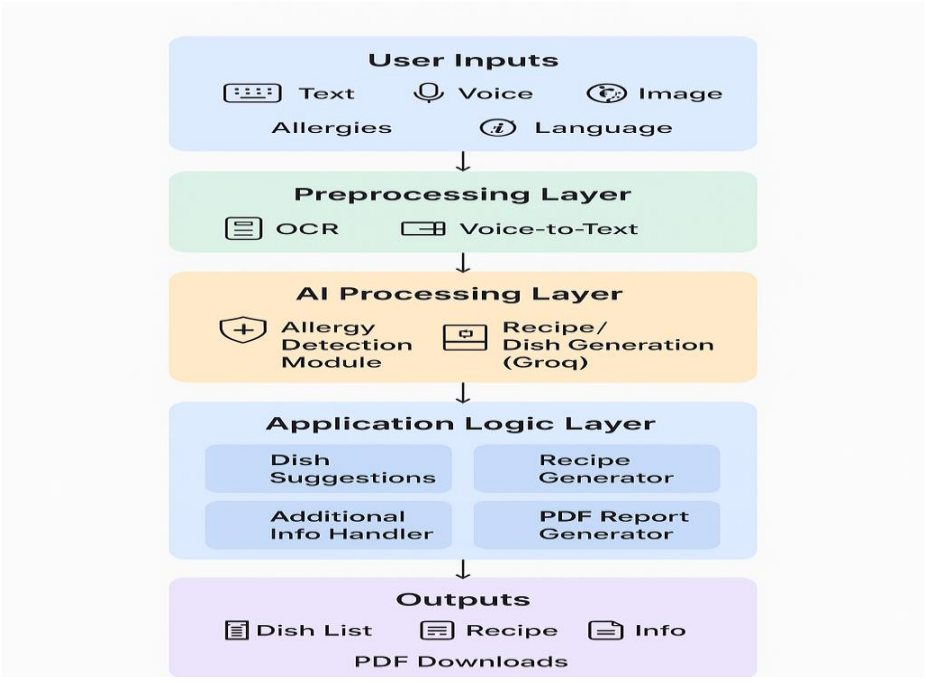

FIG 1.1 ARCHITECHTURE DIAGRAM

4.2 VARIOUS STAGES

4.2.1 Planning Stage

The project began with a comprehensive study of user needs, focusing on meal planning challenges, dietary restrictions, and the importance of accessibility. Key considerations included evaluating different AI models (LLaMA 3, GPT APIs, Groq), assessing libraries for OCR (Tesseract, PIL), and determining the most suitable frontend framework (Gradio) for user interaction. The planning stage finalized the core features—ingredient-based recipe generation, allergy safety, voice and image inputs, and multi-language support—while setting up the technical workflow from user input to recipe output. Initial environment setup, API key management, and documentation standards were also established.

4.2.2 Design & Prototyping Stage

In this stage, the architecture was designed with modular components for input handling, allergy detection, AI processing, and output generation. The user interface was mapped using Gradio elements like textboxes, buttons, and image upload modules. A prototype was developed to test OCR-based ingredient detection, voice-to-text functionality, and AI-generated recipe suggestions. Early prototypes also examined challenges such as handling noisy OCR outputs, ensuring correct allergy substitution logic, and managing AI-generated multi-language responses. These prototypes informed improvements in system flow before moving into full-scale implementation.

4.2.3 Implementation Stage

The core development phase focused on building all major functionalities. Python was used as the primary programming language, with modules for OCR (pytesseract), recipe generation (AI API integration), PDF export (FPDF), and voice-to-text input. The Gradio-based interface was fully developed to allow interactive grocery input, allergy specification, cuisine selection, and recipe display. AI prompts were carefully crafted to generate accurate and culturally relevant recipes, while ensuring allergy filtering and ingredient substitution. Error handling was added for unsupported inputs, incorrect image uploads, and invalid text entries.

4.2.4 Testing Stage

Extensive testing was performed to ensure functionality and reliability. Unit tests validated individual components such as OCR ingredient detection, allergy filtering, and AI recipe responses. Integration testing verified smooth communication between Gradio, Python functions, and AI APIs. User testing sessions provided feedback on usability, recipe quality, and interface design. The system was stress-tested with large grocery lists, multiple allergy inputs, and various cuisines to confirm accuracy and stability. Iterative refinements were made based on errors and user experience feedback, ensuring a smooth and accessible cooking assistant.

4.2.5 Deployment & Documentation Stage

During this stage, the system was deployed in a functional environment, configured for real-world use with cloud-based hosting. The AI model API keys and dependencies were securely managed, and the interface was optimized for performance. Comprehensive documentation was created, including user guides on how to input groceries, use voice/image features, and download PDF recipes. Technical documentation was also prepared for developers, covering AI integration, OCR processing, and troubleshooting. This stage also focused on ensuring accessibility across different devices and testing performance in varied network conditions.

4.2.6 Maintenance & Scaling Stage

Post-deployment, the system entered the maintenance phase, with continuous monitoring of AI API usage, OCR accuracy, and user interaction patterns. Updates are scheduled to maintain compatibility with new AI models, libraries, and security patches. Planned scaling includes expanding multi-language support to more regional languages, adding nutritional analysis features, and enhancing image recognition for direct food identification beyond text labels. Continuous user feedback collection helps refine features and prioritize future enhancements, ensuring the system evolves into a smarter and more inclusive recipe assistant.

4.3 WORKING PRINCIPLE:

The Recipe Generator project is founded on the integration of AI-powered natural language processing, image recognition, and user-centric design. By combining ingredient detection, allergy awareness, and generative AI, the system transforms everyday groceries into personalized meal suggestions. Each stage of the workflow—from acquiring user input through text, speech, or images to generating step-by-step recipes and providing multi-language support—is carefully structured to enhance usability. The project's working principle focuses on accessibility, adaptability, and personalization, ensuring that users receive safe, nutritious, and easy-to-understand recipes tailored to their preferences, allergies, and available cooking time.

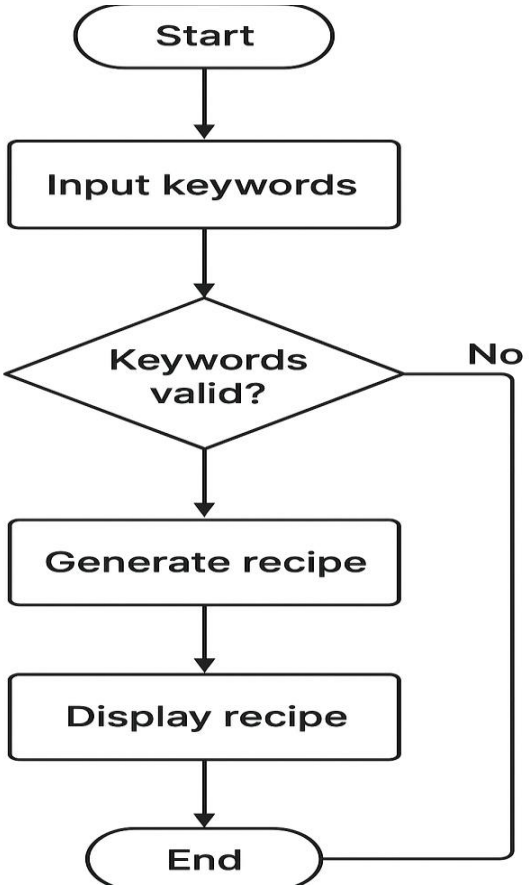

FIG 1.2 Activity Workflow.

4.3.1 User Input Acquisition

The system begins with collecting user input using multiple modalities. Users can type ingredients manually, speak them using the integrated voice-to-text feature, or upload an image of groceries to detect ingredients via OCR. Additional fields allow users to specify cuisine preference, dietary type (vegetarian, non-vegetarian, vegan), allergies, serving size, and cooking time limits. This multi-input design ensures accessibility for a wider range of users, including those with limited typing skills. By consolidating all forms of input into a unified structure, the system ensures accurate personalization right from the start of the process.

4.3.2 Allergy and Dietary Consideration Filtering

The next step is to filter user input against potential allergens and dietary restrictions. If an allergy is detected in the provided groceries or suggested recipes, the system eliminates unsafe options and proposes alternatives. This is particularly useful for users with common allergies such as nuts, gluten, or dairy. A rule-based engine and AI-driven substitutions ensure safer recipe outcomes without compromising taste or nutrition. The inclusion of this stage highlights the project's focus on user health and safety, enabling confident cooking decisions for individuals with dietary limitations.

4.3.3 Recipe Suggestion Generation

After filtering, the system generates a curated list of dish suggestions using generative AI models. The AI analyzes available groceries, chosen cuisine style, dietary restrictions, servings, and time constraints to propose 8–10 suitable dishes.

Each suggestion is contextually relevant, realistic, and easy to prepare within the specified parameters. This reduces the decision-making effort for users by presenting diverse yet practical meal options. The recipe suggestion stage emphasizes efficiency, personalization, and creativity, ensuring that users are never short of ideas regardless of limited ingredients or time.

4.3.4 Detailed Recipe Retrieval

Once the user selects a dish, the system generates a detailed recipe. The AI produces step-by-step instructions, including ingredient quantities, preparation

methods, and cooking steps. Special care is taken to present the recipe in simple, reader-friendly language so even beginners can follow it. Additional notes such as estimated cooking time, serving portions, and cooking tips may also be included.
To enhance usability, the recipe is exported into a downloadable PDF format for offline access. This step ensures that users not only receive suggestions but also actionable instructions to prepare their meals successfully.

4.3.5 Multi-Language Support

To make the system inclusive, the generated recipes and suggestions are translated into the user's preferred language, such as English, Spanish, Hindi, or French. Generative AI ensures that translations preserve cultural and culinary context—for example, ensuring that food terms like "paneer" or "tortilla" are not mistranslated. This feature makes the application globally usable, empowering users across different linguistic backgrounds. By providing clear cooking instructions in their native language, the system bridges communication gaps and promotes accessibility in the culinary space.

4.3.6 Additional Suggestions and Clarifications

The system also addresses users' follow-up queries, such as substituting unavailable ingredients, adjusting recipes for different serving sizes, or requesting nutritional information. Users can type or speak their questions, and the AI responds with contextual suggestions. This transforms the system into an interactive cooking assistant rather than a static recipe generator. It also allows for real-time adaptability, ensuring that users receive guidance tailored to changing conditions. This stage reflects the project's focus on enhancing engagement, problem-solving, and personalized support throughout the cooking process.

4.3.7 Continuous Learning and Improvement

Finally, the project incorporates feedback loops to continuously refine the system. User preferences, common ingredient substitutions, and frequently encountered allergies are analyzed to improve future outputs. Over time, the system can scale to support new cuisines, advanced nutritional analysis, and enhanced food image recognition. Maintenance also includes monitoring performance, updating AI models, and ensuring compatibility with evolving technologies. This ongoing refinement ensures that the recipe generator remains relevant, reliable, and adaptable, serving

both casual users and culinary enthusiasts alike.

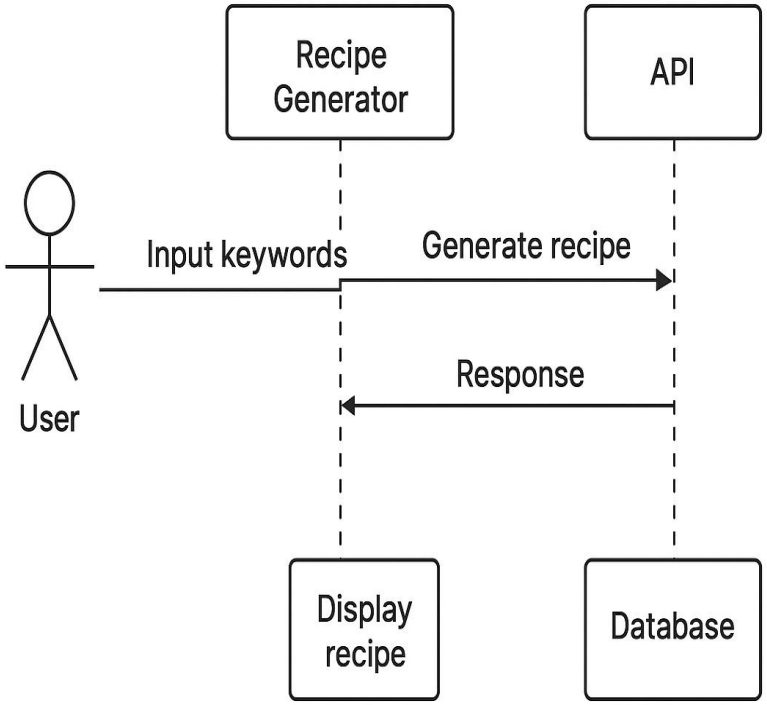

FIG 1.3 Sequence of Operations.

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