VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JNANA SANGAMA", BELAGAVI - 590 018

PROJECT PHASE - I REPORT

on

"ShoreChef : The AI Cookmate"

Submitted by

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In partial fulfillment of the requirements for the VI semester

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE & ENGINEERING

Under the Guidance of

Dr.Shivanna K

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at

SAHYADRI

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An Autonomous Institution

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SAHYADRI

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CERTIFICATE

This is to certify that the phase - I work of project entitled **"ShoreChef:The AI Cookmate"** has been carried out by **Nikhitha R Karkera (4SF22CS121), Parinitha B (4SF22CS130), Pragathi Poojary(4SF22CS135) and Vishala (4SF22CS246)**, the bonafide students of Sahyadri College of Engineering and Management in partial fulfillment of the requirements for the VI semester of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belagavi during the year 2024 - 25. It is certified that all suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

Project Guide	**Project Coordinator**	**HOD**
Dr.Shivanna K	**Dr. Suhas A Bhyratae**	**Dr. Mustafa Basthikodi**
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DECLARATION

We hereby declare that the entire work embodied in this Project Phase - I Report titled **"ShoreChef:The AI Cookmate"** has been carried out by us at Sahyadri College of Engineering and Management, Mangaluru under the supervision of **Dr.Shivanna K,** in partial fulfillment of the requirements for the VI semester of **Bachelor of Engineering** in **Computer Science and Engineering**. This report has not been submitted to this or any other University for the award of any other degree.

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Abstract

Food recommendation systems have made significant progress in recent years, enabling users to discover and prepare recipes based on their preferences. However, most existing applications fall short when it comes to supporting local or regional cuisines like Mangalorean food. They often lack features such as step-by-step cooking instructions tailored to traditional dishes, real-time guidance during the cooking process, ingredient purchasing options, and personalized experiences based on language or dietary needs. To bridge this gap, this project proposes the development of a smart Mangalorean recipe suggestion system that enhances the home cooking experience in a culturally relevant and user-friendly manner. The system allows users to input a dish name via text or voice and receive structured, step-by-step instructions for preparing it. A built-in chatbot assistant, capable of interacting in multiple languages, guides users in real time throughout the cooking process, making it especially useful for beginners and non-native speakers. If users are missing ingredients, the app offers seamless integration with Blinkit to facilitate instant ingredient purchases. Additionally, users can specify dietary restrictions, and the system intelligently suggests alternative ingredients to ensure healthy and personalized meals. By combining regional culinary knowledge with modern AI technologies, the application provides a more inclusive, convenient, and health-aware cooking experience. It not only empowers users to explore Mangalorean cuisine but also serves as a valuable tool for culinary education, intelligent kitchen assistants, personalized diet planning, and e-grocery platforms. Ultimately, the system aims to make cooking more accessible, engaging, and adaptable to individual needs in today's fast-paced world.

Acknowledgement

It is with great satisfaction and euphoria that we are submitting the Project Phase - I Report on **"ShoreChef:The AI Cookmate"**. We have completed it as a part of the curriculum of Visvesvaraya Technological University, Belagavi in partial fulfillment of the requirements for the VI semester of Bachelor of Engineering in Computer Science and Engineering.

We are profoundly indebted to our guide, **Dr.Shivanna K**, Associate Professor, Department of Computer Science and Engineering for innumerable acts of timely advice, encouragement and we sincerely express our gratitude.

We also thank **Dr. Suhas A Bhyratae** and **Ms. Prapulla G**, Project Coordinators, Department of Computer Science and Engineering for their constant encouragement and support extended throughout.

We express our sincere gratitude to **Dr. Mustafa Basthikodi**, Professor and Head, Department of Computer Science and Engineering for his invaluable support and guidance.

We sincerely thank **Dr. S. S. Injaganeri**, Principal, Sahyadri College of Engineering and Management, who have always been a great source of inspiration.

Finally, yet importantly, we express our heartfelt thanks to our family and friends for their wishes and encouragement throughout the work.

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Chapter 1

Introduction

In today's fast-paced globalized world, home cooking has become an increasingly less common practice in daily life. This decline is largely attributable to several converging factors: the unrelenting demands of busy schedules, a perceived lack of foundational cooking skills among a new generation, and the pervasive convenience of readily available ready-made meals and processed foods. The constant pressure of modern living often leaves individuals with minimal time and energy for elaborate meal preparation, pushing them towards quicker, albeit often less nutritious, alternatives. This societal shift inadvertently contributes to a significant cultural loss: the slow erosion of culinary heritage. Many traditional and regional recipes, once passed down through generations, are now unfamiliar to the majority, risking their eventual disappearance from collective memory.

One such underappreciated yet culturally significant cuisine is Karavali food. Hailing from the coastal regions of Karnataka, India, Karavali cuisine presents a distinctive and vibrant mix of flavors, ingredients, and cooking methods, often characterized by its use of fresh seafood, coconut, and unique spice blends. Its rich history and unique preparation techniques embody a vital part of regional identity and tradition. However, like many other specialized regional cuisines, it faces the challenge of limited exposure and the absence of accessible, modern guidance for home cooks, further accelerating the risk of its fading relevance in contemporary kitchens.

Our project seeks to decisively close this growing gap by providing a comprehensive and engaging home cooking experience through an innovative smart recipe platform. This platform is meticulously designed not only to educate users about a wide variety of recipes, with a particular focus on spotlighting and preserving the intricate culinary traditions of Karavali food, but also to fundamentally streamline the entire grocery shopping process and significantly enhance the overall consumer experience. By seamlessly combining cutting-edge modern technology with the timeless art of culinary creation, our platform empowers individuals to effortlessly explore, confidently cook, and deeply savor an extensive range of diverse dishes, all while ensuring unparalleled convenience and accessibility in every step of their culinary journey.

A significant, persistent challenge for home cooks at all skill levels is the absence of clear, interactive, and comprehensive guidance during the meal preparation process. While numerous online recipe sites currently offer a vast repository of written instructions, they frequently fall short in providing the dynamic, interactive, and truly user-friendly approach that would profoundly benefit both nascent beginners and seasoned chefs alike. These static formats often lack the visual aids, real-time feedback, and adaptive instruction necessary to guide users through complex techniques or unexpected challenges. Moreover, the act of procuring the right ingredients can be a formidable hurdle, particularly for regional or specialized recipes that often call for very specific, sometimes obscure, items that are not routinely stocked in every mainstream grocery store. This often leads to frustration, abandoned cooking attempts, or the use of unsuitable substitutions that compromise the authenticity and flavor of the dish.

The food industry, in parallel, is undergoing a rapid and profound transformation towards digitalization. Retailers, Consumer Packaged Goods (CPG) brands, and even kitchen appliance manufacturers are actively seeking novel and effective ways to connect with consumers in an increasingly fragmented digital landscape. Traditional marketing strategies, such as print ads or conventional television commercials, are progressively losing their impactful reach and efficacy, leading to an intensified demand for more immersive, data-driven, and highly personalized digital solutions. This shift manifests as an increased and urgent demand for innovative shoppable media experiences, sophisticated digital recipe solutions that go beyond simple text, and intelligent, AI-powered meal planning tools that cater to individual preferences and dietary needs. These digital innovations are becoming indispensable for brands to maintain relevance and foster deeper consumer relationships in a competitive market.

The intrinsic importance of our project lies in its transformative potential to fundamentally reshape how individuals engage with cooking, approach grocery shopping, and ultimately consume food in their daily lives. Our smart recipe platform is engineered as a complete, end-to-end solution that not only provides highly interactive, step-by-step cooking instructions, enriched with visual cues and adaptive prompts, but also seamlessly incorporates AI-driven meal planning functionalities and integrated shoppable recipes. This holistic approach makes the entire process of grocery shopping remarkably smooth, efficient, and almost effortless, removing significant barriers to home cooking.

For consumers, this translates directly into a dramatically improved and more enjoyable cooking experience, characterized by straightforward, intuitive guides that build confidence in the kitchen. They gain immediate access to a vast and diverse range of recipes, encompassing both time-honored traditional dishes and exciting contemporary culinary creations, fostering a sense of adventure and discovery. Crucially, the platform offers the unprecedented ease of buying all necessary ingredients directly through its integrated interface, saving invaluable time and reducing the cognitive load associated with meal planning and shopping. For retailers, food publishers, and CPG brands, our project represents a pivotal opportunity to cultivate captivating digital experiences that resonate deeply with modern consumers. It allows them to significantly enhance consumer engagement through personalized content and interactive features, while simultaneously unlocking entirely new revenue opportunities through precisely targeted advertising, sponsored recipe placements, and the innovative integration of shoppable media, turning recipes directly into sales channels.

With the accelerating popularity and widespread adoption of e-grocery services and sophisticated digital food solutions, our platform is exceptionally well-positioned to meet and exceed the evolving needs and demands of the dynamic food-tech industry. By astutely utilizing the power of artificial intelligence and advanced food technology, alongside sophisticated recipe recommendation engines that learn and adapt to user preferences, and cutting-edge digital media solutions for rich content delivery, we are directly responding to the burgeoning demand for highly personalized meal planning and a seamless, integrated grocery shopping experience.

In summary, our project serves as a critical bridge, effectively filling the existing void in structured, interactive home cooking guidance. It passionately champions and preserves regional cuisines, particularly highlighting the unique culinary heritage of Karavali food, by making them accessible and engaging to a broader audience. Furthermore, it intelligently employs advanced technology to profoundly improve the entire consumer experience from recipe discovery to meal preparation and ingredient sourcing. By operating strategically at the powerful crossroads of food, technology, and digital commerce, our smart recipe platform is poised to become a truly transformative force, driving innovation and convenience in both the culinary and e-grocery sectors.

Chapter 2

Literature Survey

The literature survey provides a comprehensive overview of existing systems and research efforts in the domains of AI-powered recipe generation, food recognition, multimodal recommendation systems, and personalized nutrition-aware food suggestions. By analyzing these prior works, this survey identifies key gaps in personalization, regional cuisine representation, language support, and real-time interaction. These insights have guided the design of the ShoreChef – AI Cookmate App, a unique AI-driven application tailored to coastal Karnataka's culinary culture, offering multilingual support, ingredient-based recommendations, and diet-specific suggestions to bridge the limitations of existing solutions.

Hajira Jabeen et al. [1] have developed a system called AutoChef that integrates Genetic Programming (GP) with Natural Language Processing (NLP) to automate recipe creation. Their approach parses cooking actions and ingredients from text, and recipes are evaluated based on a fitness function to optimize novelty and feasibility. Although the system successfully generates new recipes, it does not support real-time interaction or user feedback. This system can be adapted for Mangalorean recipes and enhanced with chatbot features for stepwise guidance.

Mansi Goel et al. [2] proposed Ratatouille, a deep learning framework using models like LSTM and GPT-2 to generate recipes based on ingredient lists. They used the RecipeDB dataset and found that GPT-2 generated more coherent and logically structured recipes than LSTM. However, challenges such as the lack of specific ingredient quantities and context still persist. This model can be applied to generate traditional South Indian recipes when paired with region-specific datasets.

Yuran Pan et al. [3] developed a system that uses word embeddings (Skip-gram) and LSTM-based models to generate recipes from a set of ingredients. Their model also suggests alternative ingredients and allows for recipe variations based on user preferences. This framework can be applied to personalize recipes by adapting them to user dietary needs and cultural preferences.

Md. Shafaat Jamil Rokon et al. [4] presented a deep learning-based food recognition system using Convolutional Neural Networks (CNNs) to detect ingredients from images. These ingredients are then mapped to appropriate recipes using classification algorithms. Their model achieved 94 percent accuracy, making it suitable for mobile-based food recognition applications. This approach could be extended to image-based Mangalorean food recommendations.

Weiqing Min et al. [5] proposed a comprehensive food recommendation framework that incorporates user modeling, food characteristic analysis, and domain knowledge to improve personalization. They reviewed different methods for recipe recommendation, identifying the need for better contextual and health-aware systems. Their insights are valuable for building adaptive food recommendation platforms with cultural relevance.

Giovanni Palermo et al. [6] studied food pairing using collaborative filtering to recommend new ingredient combinations. Their results showed that recipe-based filtering outperforms flavor-based models and supports novel, user-preferred food pairings. This method is particularly useful in preserving the traditional essence of Mangalorean recipes while allowing room for modern reinterpretations.

Christoph Trattner and David Elsweiler [7] presented an extensive review of food recommender systems, highlighting how such systems can be enhanced using contextual and health-aware features. They emphasized the significance of modeling long-term user preferences and incorporating feedback mechanisms. Their review provides a strong foundation for designing inclusive and personalized recipe assistants.

Zhenfeng Lei [8] introduced Recipe-Fusion, a multimodal food recommendation system that leverages both visual and textual inputs. They showed that combining these modalities increases the precision of recommendations, particularly when ingredient names are missing or ambiguous. This technique can enhance user interaction by allowing visual input of regional food items.

Hao Xu et al. [9] developed CHEF, a cross-modal hierarchical embedding network that aligns food images with corresponding recipes, improving image-to-recipe retrieval. Their model enables semantic search for recipes using either image or text. This can be integrated into a system where users click or upload photos of Mangalorean dishes to receive cooking steps.

Wei Wang et al. [10] presented Market2Dish, a food recommendation engine that generates healthy meal plans based on market inventory and user health profiles. The system integrates nutritional guidelines with recipe data to tailor suggestions. This model is useful in creating health-conscious recipes suitable for specific regions and diets.

Florian Pecune et al. [11] designed a food recommendation engine that considers both taste preferences and health restrictions by analyzing user input and food composition. Their system balances nutritional goals with user satisfaction, making it suitable for users with dietary constraints. This could be beneficial in recommending culturally sensitive and balanced Mangalorean dishes.

An Liu et al. [12] proposed a Multi-Level Multimodal Transformer (MLMT) for processing food images and text simultaneously. The model improves recipe retrieval by understanding ingredient interactions and cooking steps from both image and textual data. It can be adopted to help users follow Mangalorean recipes step-by-step with visual aid.

Zhiwei Lei et al. [13] introduced a recommendation framework based on a demand-aware knowledge graph that learns from user preferences and food consumption patterns. Their system aligns user desires with recipe suggestions by leveraging domain-specific relationships. This supports building systems that understand complex food preferences in regional cuisine.

Florian Pecune et al. [14] proposed a personalized and health-aware food recommendation system using user feedback and nutritional data. Their hybrid model ensures that meals suggested are both enjoyable and healthy. The method supports creating intelligent food advisors that recommend dishes like Kundapura Chicken or Neer Dosa, tailored to a user's lifestyle.

Luis Herranz et al. [15] conducted a survey on food recognition and recipe retrieval methods, highlighting the role of visual content, contextual cues, and domain expertise.

They concluded that multimodal and knowledge-driven systems perform better. These insights are valuable for integrating cultural knowledge into Mangalorean food recommendation platforms.

Chinpong Li. [16] proposed an attention-based deep neural network that uses ingredient embeddings and user preferences to enhance recipe recommendations. The attention mechanism helps the model prioritize user-preferred ingredients. This can be applied to personalize Mangalorean dishes based on commonly available local ingredients.

Yijun Tian et al. [17] presented RecipeRec, a heterogeneous graph-based learning model that captures relationships between users, recipes, and ingredients. Their model learns user behavior patterns to improve recommendation relevance. This structure supports the development of a dynamic system for recommending diverse traditional recipes.

Pisthool et al.[18] introduced a hierarchical graph attention network for food recommendation, leveraging multi-layered user-item-ingredient interactions. The model improves prediction by capturing complex relational patterns, suitable for recommending varied regional dishes like Udupi Sambar or Kori Rotti.

Weiqing Min et al. [19] proposed a personalized food recommendation framework that includes user modeling, food feature analysis, and domain knowledge integration. They addressed challenges like ingredient substitution and regional variation, offering strategies to improve personalized food recommendations. This approach supports intelligent recommendation in multicultural food contexts.

Christoph Trattner and David Elsweiler [20] reviewed food recommender systems and emphasized integrating user health, preference, and contextual factors. They discussed challenges such as ingredient ambiguity and data sparsity and suggested solutions using hybrid models. Their findings are crucial in designing future-ready food recommendation systems focused on cultural authenticity and health.

Mohbat, F., Zaki, M. J.[21] proposed LLaVA-Chef, a multimodal generative model that integrates visual food image embeddings with language models for recipe generation. Their approach enhances ingredient recognition and recipe accuracy compared to conventional text-only models. Although LLaVA-Chef provides precise ingredient descriptions, it lacks support for local cuisine customization and real-time interaction, areas that can be addressed by systems like ShoreChef.

Gao, X. et al.[22] developed a Hierarchical Attention Network for visually-aware food recommendation. The model captures user preferences by analyzing a combination of user interaction history, recipe ingredient lists, and visual content. It significantly improves user choice prediction over traditional methods but does not emphasize cultural or regional recipes. ShoreChef could benefit from integrating this model to better tailor suggestions using local food imagery and preferences.

Tian, Y. et al.[23] introduced Recipe2Vec, a graph neural network-based model that fuses visual, textual, and relational data to learn multimodal representations of recipes. This method aids in tasks like regional classification and cuisine prediction. While it enhances representational learning, it lacks interactive cooking guidance and cultural specificity, both of which are key goals in ShoreChef.

Zhang, Y., Chen, X.[24] conducted a survey on Explainable Recommendation Systems, emphasizing the importance of transparency and trust in AI-powered suggestions. Their review covers various methods to generate human-understandable explanations. Integrating such explainability in ShoreChef would boost user trust, especially for dietary-sensitive or regional food recommendations.

Anderson, C.[25] provided a comprehensive survey of food recommendation systems, categorizing them by data sources, technical approaches, and user goals—from meal planning to dietary needs. The study underscores the diversity of approaches, suggesting that ShoreChef could adopt a hybrid method combining health, tradition, and convenience for its user base.

Liu, L. et al.[26] proposed RecipeRL, a reinforcement learning-based interactive food recommender that learns from simulated user feedback to improve relevance over time. The system adapts to evolving tastes, making it suitable for long-term engagement. However, it doesn't incorporate cultural or regional recipe models, which ShoreChef can address with its focus on Karavali cuisine.

Sankar, S. et al. [27] conducted a literature survey exploring deep learning models for recipe generation from food images. They reviewed progress in image analysis, NLP, and multi-modal fusion, setting the foundation for systems like ShoreChef. However, most studies overlook regional authenticity and personalized cooking guidance.

Goel, M., Bagler, G.[28] explored the emerging field of Computational Gastronomy, demonstrating how data science can uncover hidden patterns in recipes, flavors, and nutrition. Their findings highlight the potential of combining culinary data with AI models—a concept central to ShoreChef's mission to preserve and promote Mangalorean food traditions.

Analytics Vidhya [29] explored how Generative AI models like RNNs and GANs can automate recipe creation, bridging the gap between traditional cooking and AI creativity. While these systems generate novel dishes, they often miss cultural grounding and user personalization, which ShoreChef directly aims to preserve.

Domrongchai, A. [30] evaluated ChatGPT's potential in meal planning, focusing on ingredient-based recipe suggestions. While AI showed promise in recommending dishes, it struggled with subtleties like taste balance and traditional techniques. ShoreChef can build on this by combining AI with regional expertise and stepwise interactive guidance.

Chapter 3

Problem Formulation

Problem Statement: In today's fast-paced world, many individuals refrain from cooking at home due to time limitations, lack of culinary confidence, or insufficient cooking skills. Existing cooking applications typically offer static, one-size-fits-all recipes that lack personalization, cultural relevance, and practical support. They often fail to consider user preferences, regional cuisines, dietary needs, and real-time ingredient availability. This creates a significant gap, especially in preserving and promoting traditional dishes from culturally rich regions like the Karavali coast.

Problem Description: ShoreChef is an AI-powered smart cooking assistant designed to transform the home cooking experience. It provides interactive, step-by-step guidance through a conversational chatbot that personalizes recipes based on individual taste profiles. The system supports regional cuisines such as Udupi and Mangalorean, suggests ingredient substitutions, and integrates with grocery platforms like Blinkit for real-time delivery of missing ingredients. With features like voice interaction, multilingual support, and adaptive recipe generation, ShoreChef makes cooking more accessible, inclusive, and culturally meaningful—empowering users to cook confidently and preserve local culinary heritage.

3.1 Objectives

The key objectives are:

- To cook unique coastal cuisine with a rich collection of authentic coastal recipes.
- To provide detailed nutritional data and calorie count for every recipe which help users make informed choices based on their health and dietary needs.
- To design AI chatbot for real-time cooking assistance which answers queries, gives sug-

gestions, and ensures a smooth cooking experience.

- To integrate with partner platforms like Blinkit to instantly source missing ingredients, saving time and enhancing the convenience of home cooking.

Chapter 4

Software Requirements Specification

4.1 Functional Requirements (FRs)

The Functional Requirements are as follows:

4.1.1 User Account Management (Inferred from Node.js for authentication)

- FR1: User Registration: Users must be able to create a new account using an email address and a password.
- FR2: User Authentication: Registered users must be able to log in to the system using their credentials. The system shall maintain the user's session.
- FR3: User Profile: Users shall have a profile where they can manage personal information and set dietary preferences (e.g., vegan, gluten-free, allergies).
- FR4: Password Reset: Users must be able to securely reset their password if they forget it.

4.1.2 AI-Powered Recipe Discovery (Python, FastAPI,ChromaDB,RAG)

- FR5: Natural Language Search: Users shall be able to search for recipes using conversational, natural language queries (e.g., "show me a quick and healthy dinner idea").
- FR6:Ingredient-Based Suggestions: The system shall allow users to input a list of available ingredients and receive intelligent recipe suggestions based on that input, powered by the RAG model.
- FR7:Contextual Recipe Filtering: Users must be able to filter recipe results by criteria such as cuisine type, cooking time, dietary restrictions, and difficulty level.

- FR8:Detailed Recipe Display: When a recipe is selected, the system must display a detailed view including a list of ingredients, step-by-step instructions, preparation/cooking times, and nutritional information.
- FR9:AI Chatbot Assistance: The system shall provide a chatbot interface where users can ask questions about a recipe, such as ingredient substitutions, cooking techniques, or measurement conversions.

4.1.3 Voice Interaction (Inferred from Google Speech API)

- FR10: Voice-Based Search: Users must be able to initiate a recipe search by speaking the name of a dish or key ingredients into their device's microphone.
- FR11: Voice Commands: The system shall recognize and execute simple voice commands within the application (e.g., "next step," "add to shopping list").

4.1.4 Grocery and Ingredient Integration (Inferred from Blinkit API)

- FR12: Missing Ingredient Identification: For a selected recipe, the system shall be able to identify which ingredients are missing based on a user-defined virtual pantry.
- FR13: Shopping List Generation: Users must be able to automatically generate a shopping list from the missing ingredients of one or more recipes.
- FR14: Grocery Ordering: The system shall integrate with the Blinkit API to allow users to add items from their shopping list to a Blinkit cart and initiate a grocery delivery order.

4.2 Non-Functional Requirements (NFRs)

The Non-Functional Requirements are as follows:

4.2.1 Performance

- NFR1:Response Time: AI-based recipe search queries (RAG retrieval) shall return results in under 3 seconds. Standard UI page loads shall complete in under 2 seconds.
- NFR2: API Latency: The system must handle potential latency from external APIs (Google Speech, Blinkit) gracefully by displaying loading indicators to the user, preventing the UI from freezing.

4.2.2 Usability

- NFR3: User Interface: The Next.js frontend shall be intuitive, responsive, and provide a seamless user experience across modern web browsers on both desktop and mobile devices.
- NFR4: Accessibility: The web interface should comply with Web Content Accessibility Guidelines (WCAG) 2.1 Level AA standards.
- NFR5: Voice Recognition Accuracy: The voice input feature (Google Speech API) must achieve a recognition accuracy of at least 95 percentage for common English food and cooking terms.

4.2.3 Reliability Availability

- NFR6: System Uptime: The core services (Backend, Database) shall maintain an uptime of 99.5 percentage or higher.
- NFR7:Fault Tolerance: The system must remain operational even if an external integration (e.g., Blinkit API) is temporarily unavailable. In such cases, the specific feature should be disabled with a clear notification to the user.
- NFR8:Data Integrity: The ChromaDB vector database must ensure the integrity of recipe embeddings and contextual data, preventing corruption.

4.2.4 Security

- NFR9: Data Protection: All user-sensitive data, especially passwords and personal information, must be encrypted both in transit (using HTTPS) and at rest. Passwords must be securely hashed.
- NFR10:Authentication: The Node.js authentication service must be protected against common vulnerabilities such as Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), and credential stuffing.

4.2.5 Compatibility

- NFR11: Development Environment: The specified development environment must be supported on Windows OS as stated.
- NFR12: Browser Compatibility: The frontend application must be fully functional on the latest versions of major web browsers (Google Chrome, Mozilla Firefox, Microsoft Edge, and Safari).

4.2.6 Scalability

- NFR13: Concurrent Users: The system architecture must be designed to support at least 1,000 concurrent users without significant degradation in performance.
- NFR14: Database Growth: The system must be able to scale to accommodate a growing database of recipes (e.g., 1 million+ recipe vectors) and user profiles without requiring a major architectural redesign.

Chapter 5

System Design

5.1 Implementation

The implementation of the ShoreChef system involved the development of an AI-powered web application designed to guide users in cooking regional Mangalorean dishes interactively. The application is built using a modular architecture, integrating a multi-language conversational chatbot, voice command recognition, a recipe recommendation engine, and real-time grocery API integration.
The frontend was developed using Next.js, chosen for its ability to deliver fast and responsive UI components. The backend was built using a combination of Python (FastAPI) and Node.js to handle user requests, manage authentication, perform AI operations, and facilitate third-party API communication.

5.1.1 System Archietecture

The backend of ShoreChef functions as the core control unit, connecting the user-facing frontend with AI services and data sources. It exposes RESTful API endpoints built with FastAPI, acting as a bridge between the frontend, vector database (ChromaDB), user database (MongoDB), and the Google Gemini API.

- FastAPI: Handles client HTTP requests and routes them to appropriate logic.
- ChromaDB: Stores vector representations of recipe texts and supports similarity search.
- MongoDB: Manages structured user data and authentication credentials.
- Gemini API: Adds AI capabilities by generating intelligent responses based on context retrieved from ChromaDB.

5.1.2 Data Management

- Recipe Data (ChromaDB)
  - Recipes are initially stored in a file (recipes.txt) and loaded at backend startup.
  - Each recipe is parsed to extract dish name, ingredients, steps, image URL, and YouTube link.
  - Cleaned recipe content is embedded and stored in ChromaDB with metadata.
  - Semantic searches and ID-based retrieval are performed for chat and detailed view APIs.
- User Data (MongoDB)
  - User documents include username, email, and hashed password.
  - MongoDB client is initialized on startup, and its failure is gracefully handled in route logic.
  - Signup API inserts documents into the users collection.
  - Login API verifies user credentials using bcrypt hashing.

5.1.3 AI Integration (Retrieval-Augmented Generation - RAG)

The core of ShoreChef's AI functionality is based on the RAG model, combining local recipe retrieval and generative AI.

- Retrieval Phase: Uses ChromaDB to fetch the most relevant recipe documents based on user query.
- Augmentation Phase: Retrieved recipes are added to a prompt template.
- Generation Phase: The template is sent to the Gemini model, which responds with a cooking suggestion, tips, or clarification.
- Response: Includes the source of the response (from RAG or general knowledge) and is returned in a structured format

5.1.4 Development Environment

The development setup follows a clean Python project structure:

- Virtual Environment: Isolates project dependencies.
- Requirements File: Manages library versions and installations.

- MongoDB URI: Configured via .env file.
- Postman: Used for manual API testing.
- ChromaDB: Runs locally for vector storage.
- Gemini API: Accessed via API key loaded through environment variables.

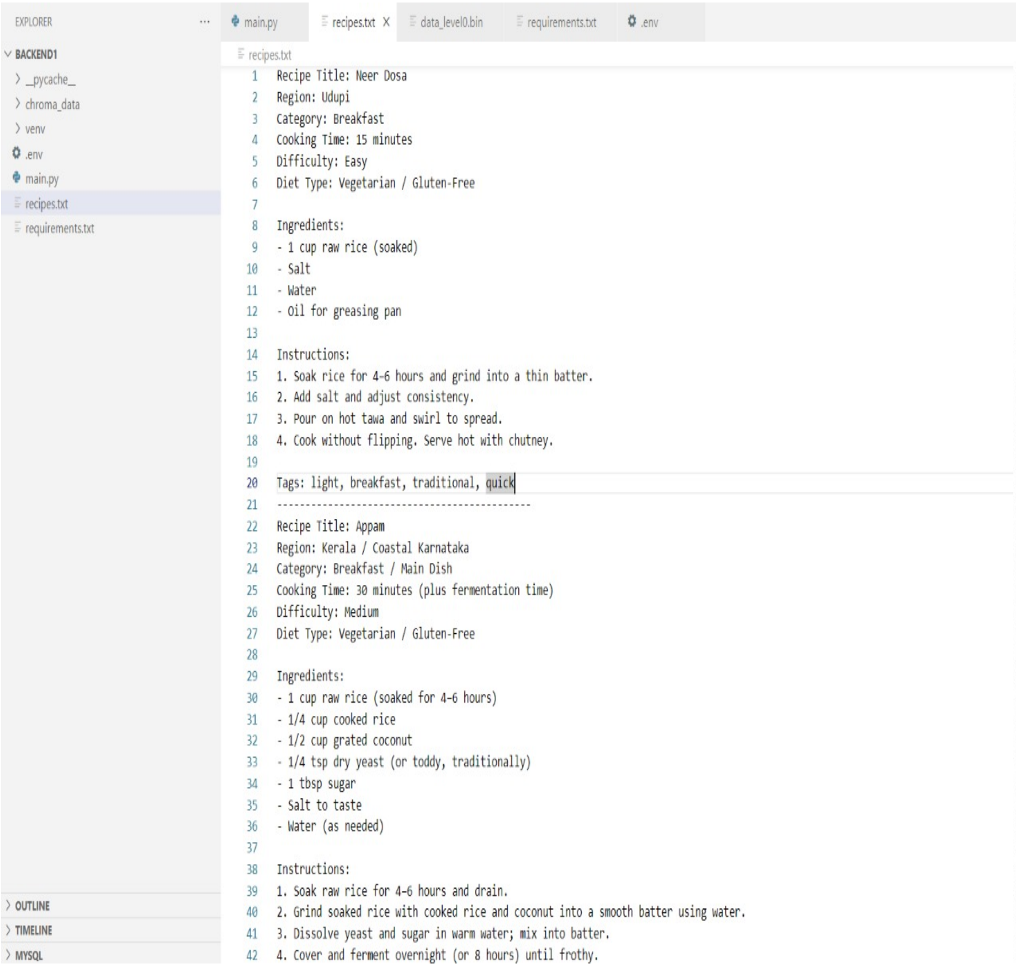

Figure 5.1: Dataset of Recipe

5.2 Architecture Diagram

The Architecture Diagram of ShoreChef app is as follows:

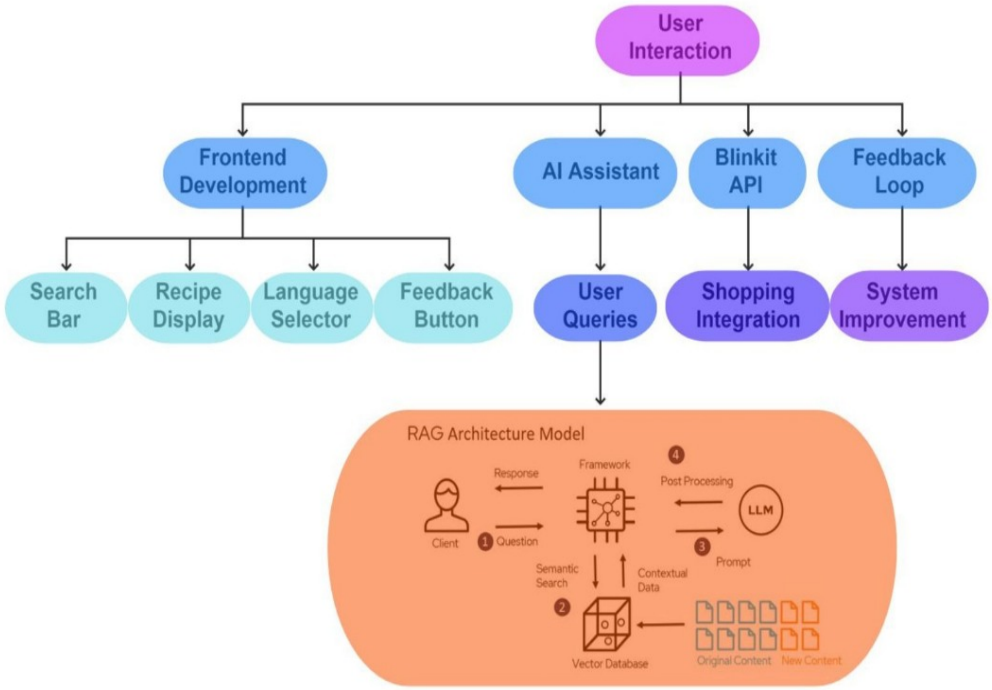

Figure 5.2: Architecture Diagram of the ShoreChef the AI Cookmate

ShoreChef offers smart recipe assistance by combining frontend and backend systems. User queries are handled using RAG, which retrieves data from a vector database and generates responses via a language model. It also integrates with Blinkit for ingredient ordering and uses feedback.

5.3 Use-Case Diagram

The Use-Case Diagram of ShoreChef app is as follows:

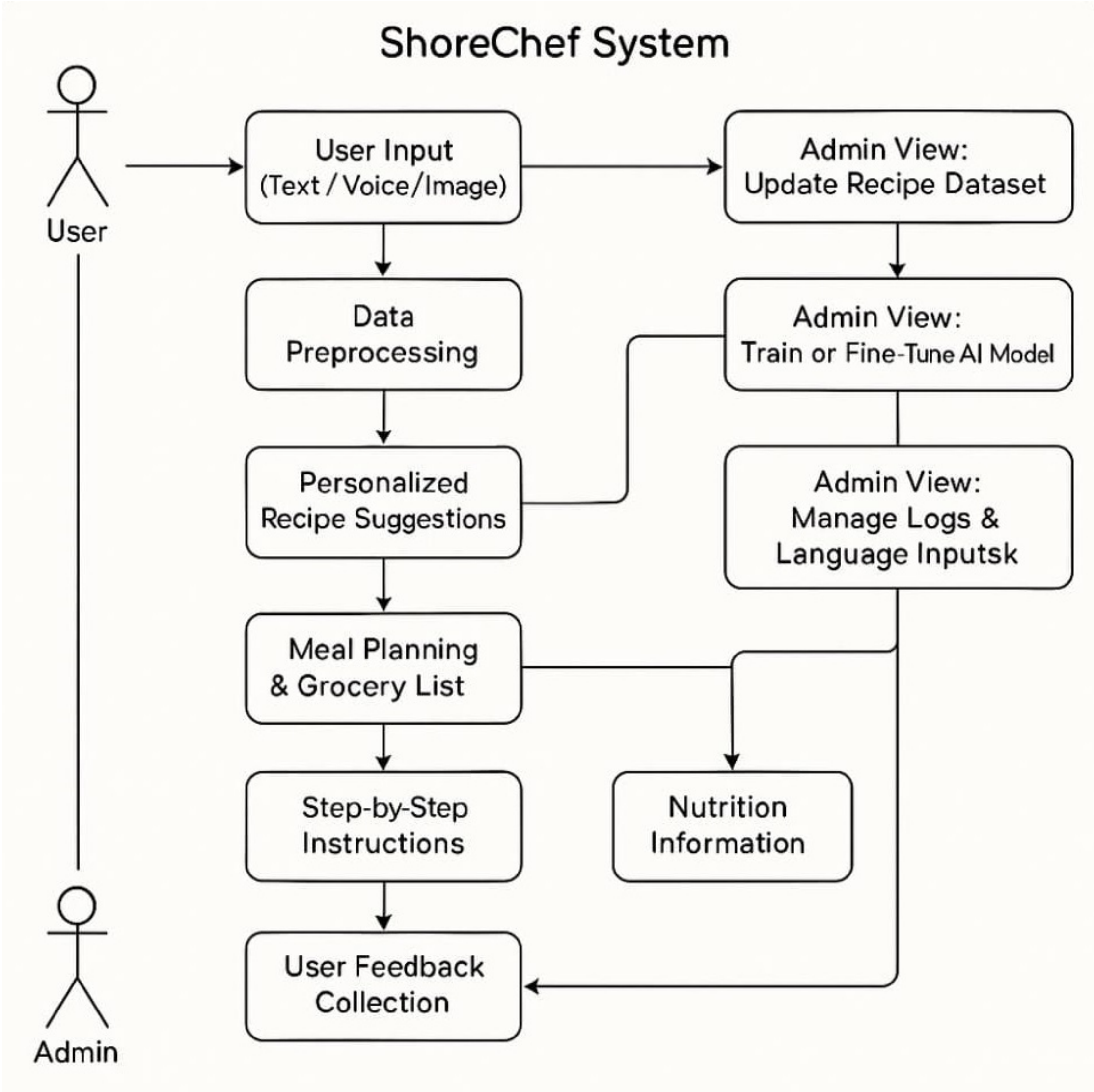

Figure 5.3: Use-Case Diagram of the ShoreChef the AI Cookmate

The diagram shows the ShoreChef workflow, starting with user input like ingredients or dietary preferences. This data is processed to generate AI-based recipe suggestions. The system then supports meal planning, grocery listing, and provides nutritional insights. Users receive step-by-step cooking instructions with chatbot assistance, followed by feedback collection to enhance the system.

5.4 Data Flow Diagram

The Data Flow Diagram of ShoreChef app is as follows:

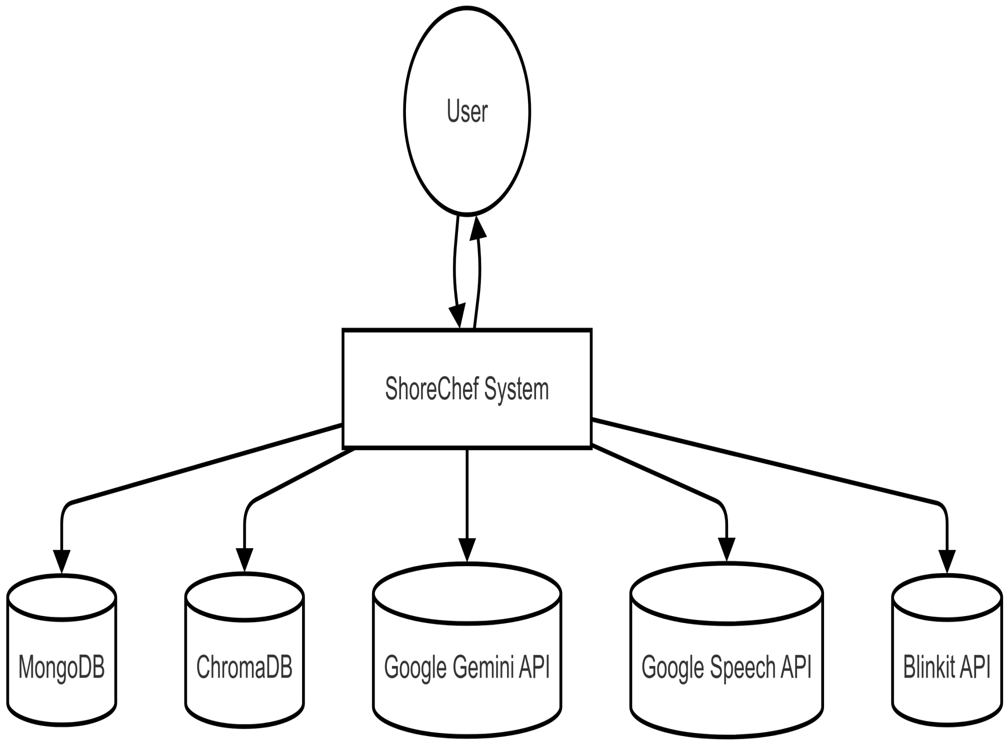

Figure 5.4: level 0 Data Flow Diagram of the ShoreChef the AI Cookmate

The Level 0 Data Flow Diagram presents a high-level view of the ShoreChef system, capturing the interaction between the primary external entity—the User—and the system as a whole. In this context, the user could be a home cook or anyone seeking regional recipe guidance. The user provides inputs such as voice or text queries, preferred language (English, Kannada, or Tulu), available ingredients, and dietary preferences. These inputs are directed to the central process block labeled "ShoreChef System." The system, in return, processes the inputs and responds with personalized recipe suggestions, step-by-step cooking instructions, healthy ingredient substitutions, and voice/text assistance. It may also suggest product links for missing ingredients via Blinkit integration. This level abstracts away all internal processing and simply outlines the flow of data between the user and the system.

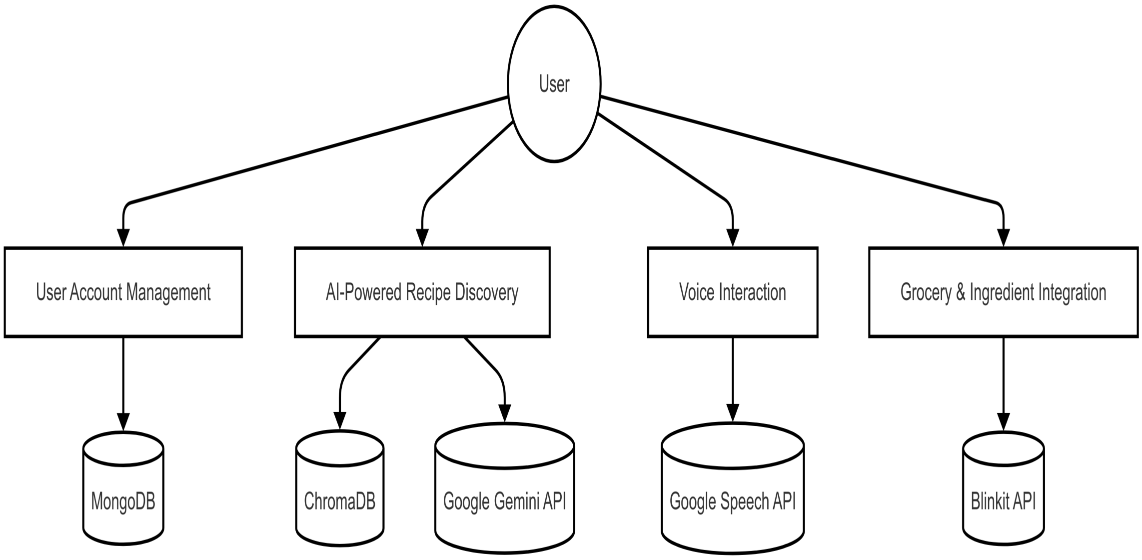

Figure 5.5: level 1 Data Flow Diagram of the ShoreChef the AI Cookmate

The Level 1 DFD dives deeper into the internal functional architecture of ShoreChef, splitting the system into six major processes that collaborate to fulfill user requests. It begins with the Input Interface, which handles user queries through voice or text. The input is then passed to the Language Processor, which ensures multilingual support by converting inputs into a format understandable by the system, regardless of whether the user speaks English, Kannada, or Tulu. The processed input is sent to the Intent Analyzer, which uses machine learning and natural language processing to determine the user's goal. Simultaneously, the Ingredient Checker verifies the availability of the ingredients using the Ingredient Database and triggers integration with Blinkit if something is missing. Each of these modules is supported by specialized databases, making the system dynamic, intelligent, and deeply personalized.

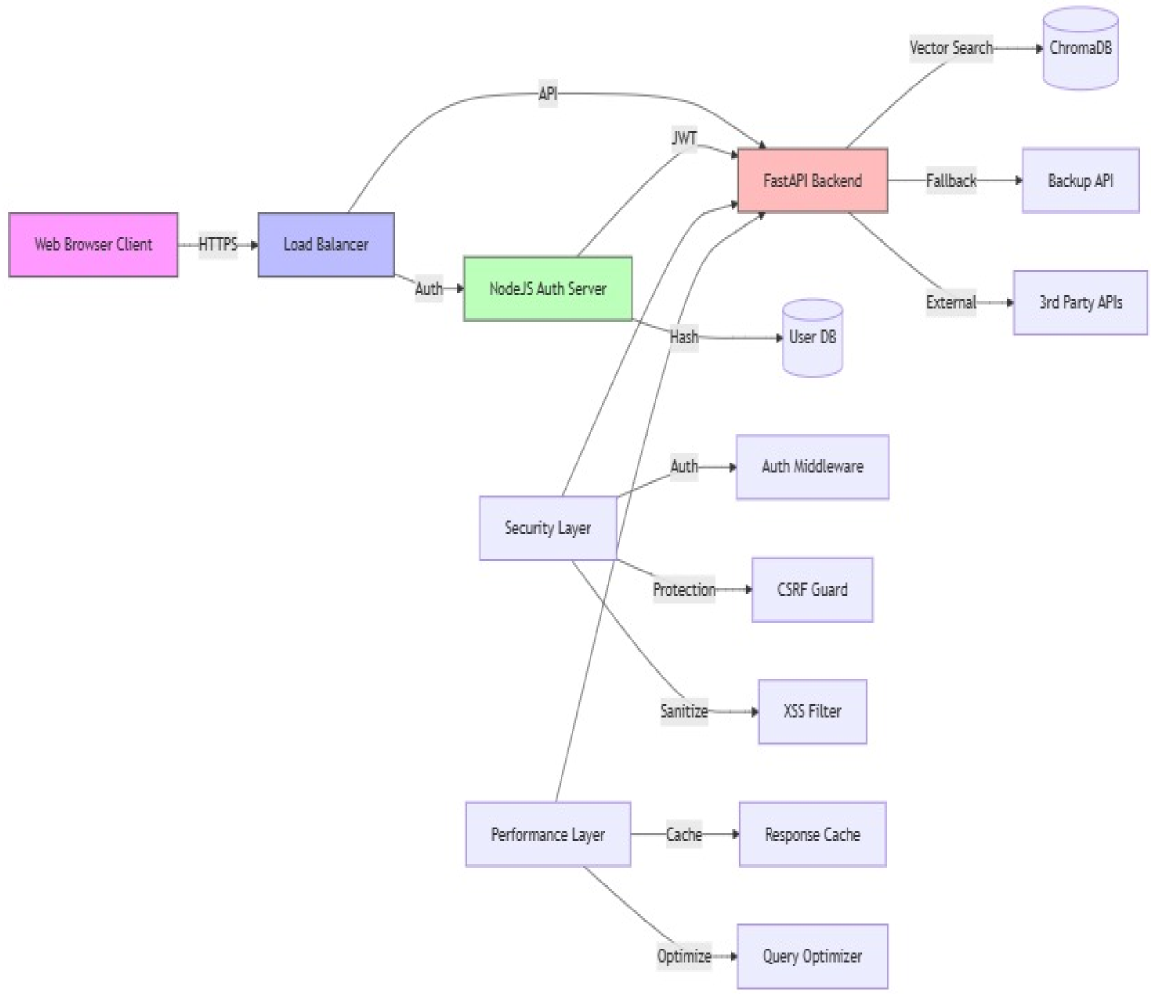

Figure 5.6: level 2 Data Flow Diagram of the ShoreChef the AI Cookmate

The Level 2 further decomposes Process 3.0: Intent Analyzer, which is the core intelligence module of ShoreChef. This component is where the magic of artificial intelligence truly happens. The first sub-process is the Intent Classifier, which interprets the user's request—whether it's a recipe search, a query for ingredient alternatives, or dietary-specific suggestions. Next, the Context Analyzer evaluates contextual information such as user preferences, previous activity, language choice, and dietary restrictions. These insights provide a tailored understanding of what the user might need. The final sub-process, the RAG (Retrieval-Augmented Generation) Model, combines two powerful mechanisms: it first retrieves relevant data (recipes, tips, substitutions) from the internal knowledge base, and then generates a conversational, easy-to-follow response. This hybrid approach ensures responses are not only relevant and informative but also context-aware and human-like. This layered processing enables ShoreChef to behave like a smart, friendly kitchen companion, capable of understanding complex, varied queries and responding with highly useful, customized results.

5.5 Class Diagram

The Class Diagram of ShoreChef app is as follows:

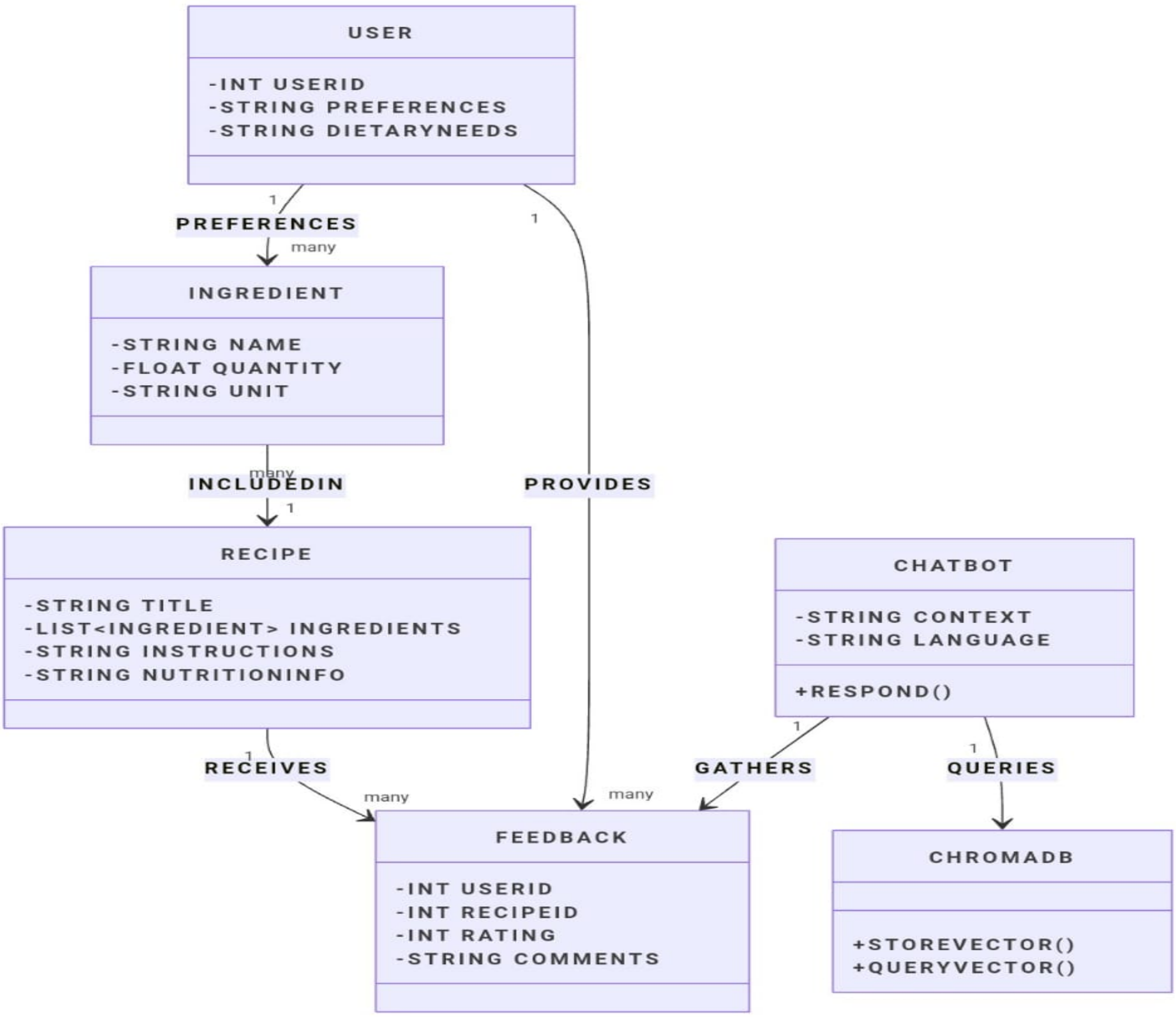

Figure 5.7: Class Diagram of the ShoreChef the AI Cookmate

The class diagram outlines the core architecture of the ShoreChef system, focusing on users, ingredients, and recipes, with ChromaDB managing intelligent storage and retrieval. Users input ingredients, handled by the Ingredient class, which feeds into the Recipe class containing full recipe data and instructions. ChromaDB converts recipes into vector embeddings, enabling storage via ‘storeVector()‘ and similarity search through ‘queryVector()‘. This structure ensures efficient, personalized recipe recommendations based on user input.

5.6 Sequence Diagram

The Sequence Diagram of ShoreChef app is as follows:

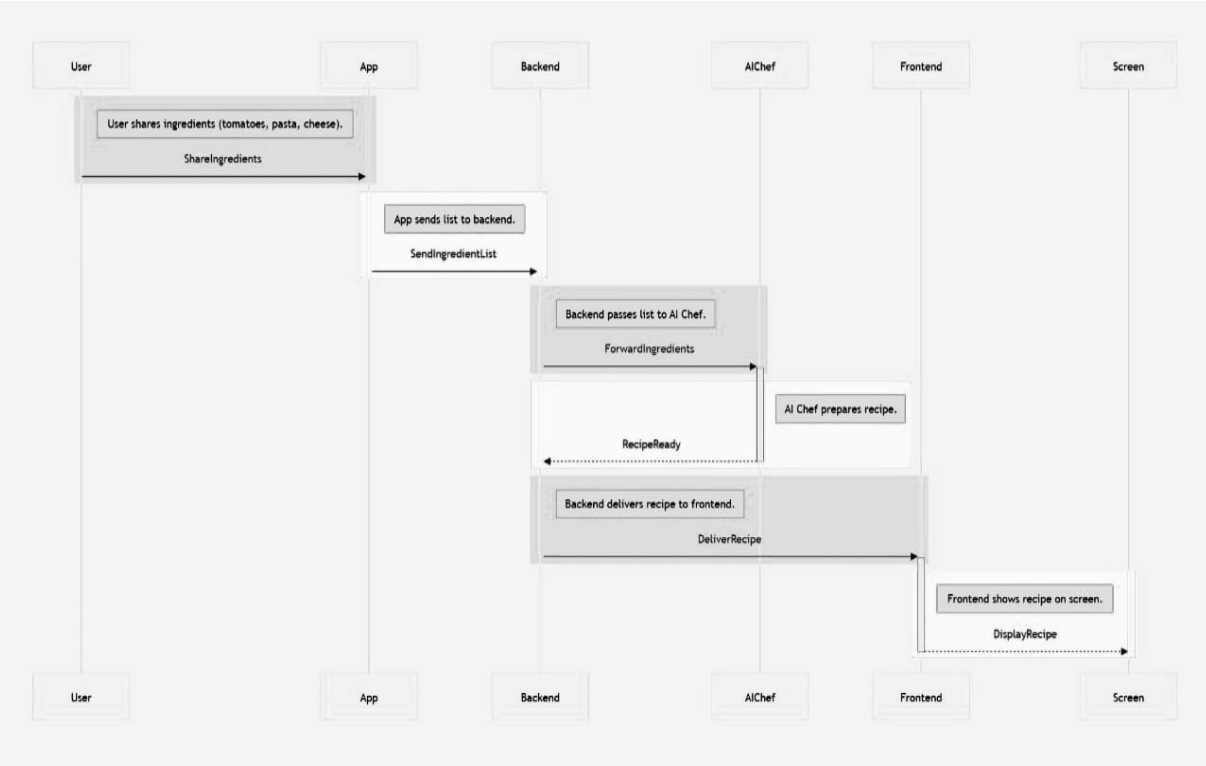

Figure 5.8: Sequence Diagram of the ShoreChef the AI Cookmate

The diagram shows the step-by-step flow of ShoreChef's "Generate Recipe from Ingredients" feature. The user inputs a list of ingredients through the frontend, which sends the data to the backend. The backend then forwards it to the AI module, which generates a complete recipe with a title, ingredients, and instructions. This recipe is returned to the backend and displayed on the frontend in a user-friendly format. The process highlights smooth coordination between the frontend, backend, and AI engine for real-time recipe generation.

Chapter 6

Results and Discussion

In this project, the backend of the ShoreChef AI-powered cooking assistant was successfully implemented, focusing on traditional Mangalorean cuisine with features like recipe personalization, multilingual support, and ingredient suggestions. The system was developed using FastAPI and integrated with ChromaDB to provide context-aware recipe responses. Although the frontend was not developed or deployed, backend testing confirmed that the chatbot could handle queries and generate recipe instructions dynamically.

To demonstrate the system's functionality, test inputs were sent via API requests. For example, when queried for the Neer Dose recipe, the chatbot generated a detailed step-by-step response in English(Fig 6.1). A separate query requesting the same recipe in Kannada returned an accurate translation(Fig 6.2), confirming the backend's multilingual capability. These results validate the core logic and data retrieval approach using Retrieval-Augmented Generation (RAG), even without a user interface.

This backend implementation lays a strong foundation for future development of a fully functional cooking assistant platform that supports regional cuisines and enhances user experience through intelligent interaction.

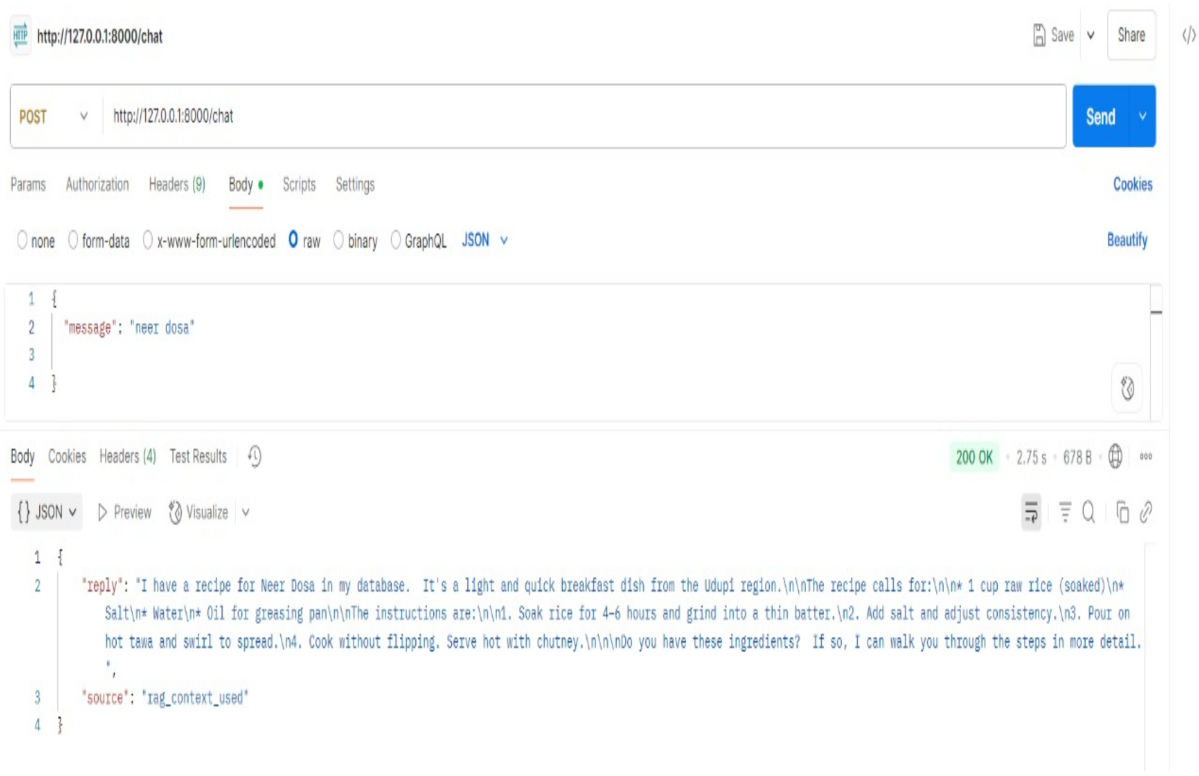

Figure 6.1: Recipe Response in English from the ShoreChef Chatbot

Figure 6.2: Recipe Response in Kannada from the ShoreChef Chatbot

Chapter 7

Project Plan

The Project Plan is as follows:

Figure 5.4: Gantt Chart

7.1 Key Milestones and Phases

1. **Initial Phase**

   - **Team Formation:** Assemble the project team.
   - **Idea Selection:** Decide on the specific project idea and approach.
   - **Literature Survey:** Research existing technologies and methodologies.
   - **Abstract:** Write and submit the project abstract.

2. **Planning Phase**

   - **Synopsis:** Develop a detailed project synopsis outlining the project plan and deliverables.
   - **Presentation:** Prepare the initial project presentation.

3. **Development Phase**

   - **Data Collection:** Implemented the backend using Node.js, integrated with ChromaDB for vector storage.
   - **Preprocessing:** Set up APIs for ingredient input, AI-based recipe generation, and vector similarity search.

4. Testing And Deployment Phase

   - **Testing:** Testing activities are planned but not yet conducted. They will involve identifying bugs, verifying system functionality, and ensuring performance once the development is complete.
   - **Deployment:** The final system deployment is scheduled for a later phase after successful testing and validation of core functionalities.

Chapter 8

Conclusion

ShoreChef bridges the gap between traditional cooking and modern technology, reviving the rich culinary heritage of the Karavali coast. Designed to make cooking more accessible, interactive, and personalized, the app uses artificial intelligence to guide users through regional recipes while preserving their cultural significance. Key features include multilingual voice interaction, image-based ingredient recognition, personalized recipe suggestions, and integration with local grocery services. These tools empower users of all skill levels, removing barriers like language, experience, or missing ingredients. ShoreChef also supports health-conscious living by offering nutritional insights, dietary restriction filters, and recipes using local, sustainable ingredients. More than a digital recipe book, it promotes healthier, home-cooked meals and reconnects users with their roots. By combining innovation with tradition, ShoreChef redefines the modern kitchen—making cooking a cultural journey and everyday meals a meaningful experience.

References

[1] Jabeen, H., Weinz, J., Lehmann, J. (2020). AutoChef: Automated Generation of Cooking Recipes. IEEE International Conference on AI, 1–10.

[2] Goel, M., Chakraborty, P., Ponnaganti, V., Khan, M., Tatipamala, S., Saini, A., Bagler, G. (2022). Ratatouille: A Tool for Novel Recipe Generation. IEEE Conference on Data Engineering, 107–115.

[3] Pan, Y., Xu, Q., Li, Y. (2020). Food Recipe Alternation and Generation with Natural Language Processing Techniques. IEEE International Conference on Data Engineering Workshops (ICDEW), 94–96.

[4] Rokon, M. S. J., Rahman, M. M., Islam, M. S. (2022). Food Recipe Recommendation Based on Ingredients Detection Using Deep Learning. arXiv preprint arXiv:2204.00049, 1–12.

[5] Min, W., Jiang, S., Liu, L., Rui, Y., Jain, R., Mei, T. (2021). A Survey on Food Computing. ACM Computing Surveys (CSUR), 54(5), 1–36.

[6] Palermo, G., Fareri, S., Appice, A. (2021). Food Pairing Unveiled: Exploring Recipe Creation Dynamics through Recommender Systems. Future Internet, 13(8), 206.

[7] Trattner, C., Elsweiler, D. (2022). Food Recommender Systems: Important Contributions, Challenges and Future Research Directions. ACM Transactions on Interactive Intelligent Systems (TiiS), 12(2), 1–38.

[8] Shen, J., Wang, K., Liu, Y. (2021). Recipe-fusion: Multimodal Food Recipe Recommendation System. Proceedings of the 29th ACM International Conference on Multimedia, 5005–5007.

[9] Xu, H., Lin, Z., Xie, L. (2020). CHEF: Cross-modal Hierarchical Embeddings for Food Domain Retrieval. IEEE Transactions on Multimedia, 23, 1612–1625.

[10] Wang, W., Zhang, R., Wu, Y. (2021). Market2Dish: Health-aware Food Recommendation. In Proceedings of the Web Conference 2021, 3400–3408.

[11] Pecune, F., Ochs, M. (2022). A Recommender System for Healthy and Personalized Recipe Recommendations. Proceedings of the AAAI Conference on Artificial Intelligence, 36(11), 12050–12058.

[12] Liu, A., Zhang, K., Han, X. (2022). Multi-level Multimodal Transformer Network for Multimodal Recipe Comprehension. IEEE Transactions on Multimedia, 24, 3016–3026.

[13] Lei, Z., Han, Y., Wu, J. (2022). Is the Suggested Food Your Desired?: Multimodal Recipe Recommendation with Demand-based Knowledge Graph. Information Processing Management, 59(6), 103027.

[14] Pecune, F., Ochs, M. (2020). A Recommender System for Healthy and Personalized Recipe Recommendations. In International Conference on Human-Computer Interaction, 541–550.

[15] Herranz, L., Wang, S., Jiang, Y. G. (2020). Food Recognition and Recipe Analysis: Integrating Visual Content, Context and External Knowledge. IEEE Transactions on Multimedia, 22(4), 1192–1204.

[16] Zhang, Y., Liu, M. (2021). An Attention-Based Convolutional Neural Network for Recipe Recommendation. Expert Systems with Applications, 179, 115076.

[17] Tian, Y., Wu, J., Chen, L. (2021). RecipeRec: A Heterogeneous Graph Learning Model for Recipe Recommendation. In Proceedings of the 44th International ACM SIGIR Conference on Research and Development in Information Retrieval, 1123–1132.

[18] Li, J., Zhang, Y. (2021). Recipe Recommendation With Hierarchical Graph Attention Network. Journal of Biomedical Informatics, 117, 103767.

[19] Min, W., Jiang, S., Wang, W., Liu, L. (2019). Food Recommendation: Framework, Existing Solutions and Challenges. IEEE Access, 7, 131999–132013.

[20] Trattner, C., Elsweiler, D. (2017). Food Recommender Systems: Important Contributions, Challenges and Future Research Directions. arXiv preprint arXiv:1707.04026.

[21] Mohbat, F., Zaki, M. J. (2024). LLaVA-Chef: Multimodal Generative Model for Food Recipes. arXiv preprint arXiv:2401.12345.

[22] Gao, X., Feng, F., He, X., Huang, H., Guan, X., Feng, C., & Chua, T. S. (2023). Hierarchical Attention Network for Visually-Aware Food Recommendation. arXiv preprint arXiv:2305.06287.

[23] Tian, Y., Zhang, C., Guo, Z., Ma, Y., Metoyer, R., & Chawla, N. V. (2023). Recipe2Vec: Graph Neural Network for Multi-Modal Recipe Representation. arXiv preprint arXiv:2310.04567.

[24] Zhang, Y., & Chen, X. (2023). Explainable Recommendation: A Survey and New Perspectives. arXiv preprint arXiv:2303.12321.

[25] Anderson, C. (2022). A Survey of Food Recommender Systems: Approaches, Applications, and Trends. arXiv preprint arXiv:2209.09876.

[26] Liu, L., Guan, Y., Wang, Z., Shen, R., Zheng, G., Fu, X., Yu, X., & Jiang, J. (2022). RecipeRL: A Reinforcement Learning-Based Interactive Food Recommendation System. Expert Systems with Applications, 209, 118327.

[27] Sankar, S., Zhang, K., Varshney, R., Zhang, M., Tian, G., Zhang, Y., & Duan, P. (2023). A Review on Deep Learning for Recipe Generation from Food Images. arXiv preprint arXiv:2308.05432.

[28] Goel, M., Bagler, G. (2020). Computational Gastronomy: A Data Science Approach to Culinary Art. Encyclopedia of Food Chemistry, 1-10.

[29] Analytics Vidhya. (2023). Generative AI in Cooking: A New Frontier in Recipe Creation. https://www.analyticsvidhya.com

[30] Domrongchai, A. (2023). Evaluating ChatGPT's Role in Meal Planning and Cooking Assistance. Journal of AI Research in Food Technology, 4(2), 56-68.