Eathena: An AI-Powered System for Real-Time Food Detection and Nutritional Analysis.

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ABSTRACT

Eathena is an AI-powered nutrition assistant that leverages ChatGPT's multimodal capabilities to analyze food images and provide personalized dietary feedback. It distinguishes between packaged and homemade meals by either querying the OpenFoodFacts API or generating nutrient estimates using ChatGPT with vision. User-specific data such as age, dietary preferences, allergies, and health goals are embedded into system prompts to tailor responses. Eathena also features a conversational interface, enabling natural dialogue and adaptive meal suggestions. Initial results show high user satisfaction, reasonable nutritional accuracy, and effective personalization, suggesting Eathena's potential as a practical, accessible tool for self-managed nutrition guidance. The system aligns with current research trends in AI-driven dietary analysis and opens pathways for future integration with health platforms like Apple Health and glucose monitors.

1. INTRODUCTION

The rise of lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions has emphasized the urgent need for accessible, personalized nutrition tools. As food choices are directly linked to health outcomes, real-time dietary monitoring and behavior-guided interventions have become a focal point in public health research. Traditional methods of nutritional assessment, such as food frequency questionnaires or manual dietary logs, often suffer from low accuracy, user fatigue, and lack of personalization [3]. In recent years, artificial intelligence (AI) has emerged as a transformative solution to these limitations, offering new capabilities in food recognition, nutrient analysis, and individualized dietary guidance [1][2].

AI's integration into nutrition research is evolving rapidly, with models capable of identifying meals from images, estimating nutrient content, and adapting advice based on user preferences and health conditions [4][5]. Systems such as NutrifyAI and NutritionVerse-Direct have demonstrated that deep learning and computer vision can support dietary management in real-world settings, particularly when coupled with mobile applications [4][5]. However, these models often require multiple AI components (e.g., image classifiers, database matchers, recommendation engines), which can introduce complexity, resource overhead, and integration challenges.

To address these issues, we introduce **Eathena**, an AI-powered mobile application that leverages a single large language model—ChatGPT—for both food analysis and personalized conversational guidance. Eathena differentiates itself by unifying image understanding and natural language dialogue within a single AI layer. It supports two primary pathways: (1) detecting and fetching nutritional information from the OpenFoodFacts API for packaged food items, and (2) using ChatGPT's image input capabilities to infer the nutritional profile of homemade meals. This image-based analysis is enriched by a user's personal data—such as age, dietary restrictions, allergies, and weight goals—which is dynamically injected into the system prompt to ensure contextual relevance during every interaction.

Furthermore, Eathena includes a personalized chatbot interface that allows users to query the system for meal suggestions, health evaluations, and diet-friendly substitutions. This conversational layer aligns with research emphasizing the value of real-time, AI-driven feedback in improving dietary habits and long-term adherence to health recommendations [2][3]. By combining flexible food input mechanisms, real-time AI reasoning, and individualized advice, Eathena offers a scalable and accessible approach to personal nutrition.

This paper outlines the motivation, architecture, AI pipeline, and personalized interaction strategies behind Eathena. We also position the application within the broader landscape of AI in nutrition science, demonstrating its feasibility as both a health assistant and an educational tool that empowers users to make informed food decisions.

2. LITERATURE REVIEW

The integration of artificial intelligence (AI) into nutrition science has undergone rapid development in the past decade. Researchers have explored AI's potential to improve food recognition, automate nutrient analysis, and deliver personalized dietary recommendations. This review highlights foundational and contemporary works that inform the development of **Eathena**, particularly those emphasizing real-time analysis, personalized feedback, and multimodal AI systems.

Sak and Suchodolska [1] provide a foundational overview of AI's applications in nutritional science, identifying key areas such as dietary assessment, predictive modeling, and behavioral support. Their review emphasizes the importance of developing intelligent systems that move beyond static databases and engage with users dynamically. They advocate for personalized AI interventions tailored to individual health profiles, a core feature embedded in Eathena's architecture.

In a more recent and expansive scoping review, Sosa-Holwerda et al. [2] categorize AI use in nutrition into four domains: dietary intake measurement, food classification, nutrition recommendation, and risk prediction. They highlight a growing trend toward conversational agents and machine learning systems that adapt to user context. Their findings support the rationale behind Eathena's use of ChatGPT, which functions both as a food interpreter and an interactive nutrition assistant.

Zheng et al. [3] focus on the technological challenges in measuring food and nutrient intake using AI. They underline the limitations of self-reporting and propose automated systems that leverage image recognition and large-scale food databases to improve precision. While their work reviews systems using dedicated computer vision models for image-to-nutrient translation, Eathena offers a unique approach by relying on ChatGPT's image input capabilities to reduce complexity while maintaining interpretive flexibility.

Advances in computer vision have further shaped the capabilities of AI nutrition systems. Han et al. [4] introduce **NutrifyAI**, a real-time food detection system combining visual analysis with user profiling to provide meal recommendations. While highly accurate, their system uses specialized models for image processing and recommendation logic. In contrast, Eathena achieves similar personalization through prompt engineering within ChatGPT, streamlining the architecture while maintaining adaptability.

Similarly, Keller et al. [5] present **NutritionVerse-Direct**, a deep learning framework designed to perform multitask nutrition prediction from food images. It excels at identifying portion sizes, macronutrient composition, and meal types. Their findings validate the feasibility of vision-based nutrient estimation. Eathena aligns with these innovations by using ChatGPT for image interpretation but adds value by tightly integrating conversational guidance and user health metadata, thereby creating a unified experience for end users.

Overall, the literature reflects a transition toward multimodal and context-aware nutrition systems. However, many existing models operate in isolated tasks—either classification, analysis, or recommendation. **Eathena** differentiates itself by centralizing all three tasks through ChatGPT, reducing the dependency on disparate subsystems. Its approach builds on the strengths and limitations identified across the reviewed literature and contributes a simplified yet highly personalized solution to the field of AI in nutrition.

3. METHODOLOGY

3.1 System Overview

Eathena is a mobile-first, AI-powered nutrition assistant that combines image analysis, personalized health metadata, and conversational AI to deliver real-time dietary recommendations and nutritional insights. The application architecture is built around a single AI engine—**ChatGPT**—which is used for both image understanding and natural language interaction. This unification contrasts with systems like **NutrifyAI** or **NutritionVerse-Direct** that rely on multiple specialized models for food classification and nutrient estimation [4][5].

The core methodology is grounded in a **dual-path inference system**:

- For **packaged foods**, the system utilizes barcode or label detection and fetches nutritional data from the **OpenFoodFacts API**.
- For **homemade meals**, the image is processed using ChatGPT's vision capabilities, which infer food types and estimate nutritional information.

This pipeline is integrated with a **contextual user profile system**, ensuring all responses—whether nutritional breakdowns or chatbot interactions—are personalized using user-specific data injected into the system prompt.

3.2 Data Flow Pipeline

Step 1: Image Classification

When a user uploads a food image, the system attempts to classify it as:

- **Packaged food** (with text labels, barcodes, or logos)
- **Homemade meal** (without packaging)

A simple image heuristic (e.g., presence of barcode-like structures or packaging contours) combined with lightweight metadata (user tap input if needed) helps decide the processing path.

Step 2:

a. If the image is identified as packaged:

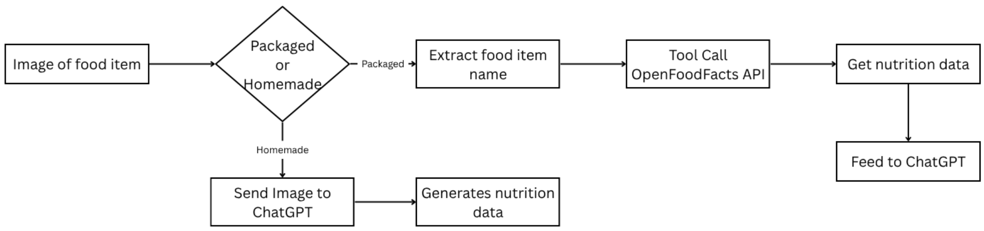
- Name of the food item is identified
- An API request is made to **OpenFoodFacts**
- Response includes:
  - Product name
  - Brand
  - Serving size
  - Nutritional values per 100g or serving

This mirrors prior work emphasizing structured food databases as a foundation for AI-assisted nutrition.

b. If the image is homemade:

- The image is sent to **ChatGPT with vision input**
- The AI uses visual cues (e.g., rice, dal, vegetables, oils) and outputs estimated nutrient values and serving size.

This process follows the trend in literature advocating AI-based image interpretation for dynamic nutrient prediction.



Data flow diagram

3.3 Personalization Layer

Each AI response is informed by the user's:

- Age
- Gender
- Height
- Current weight and goal weight
- Allergies
- Dietary preferences (e.g., vegetarian, high-protein)

These details are programmatically injected into **system prompts** to contextualize each interaction

This reflects emerging practices in AI health systems that use personalized system contexts to guide interactions.

3.4 Conversational Interface

Users can ask:

- "Is this a good meal for weight loss?"

- “Suggest a dinner with 500 calories and high protein.”
- “Replace peanuts in this dish.”

All chatbot replies are grounded in the user's profile and real-time image or meal data. ChatGPT handles these queries in a **stateless but context-enriched** prompt system, reducing backend complexity while delivering rich, adaptive responses.

This model is inspired by findings that conversational AI significantly enhances engagement and adherence in nutrition interventions.

3.4 System Design (Condensed for Methodology Section)

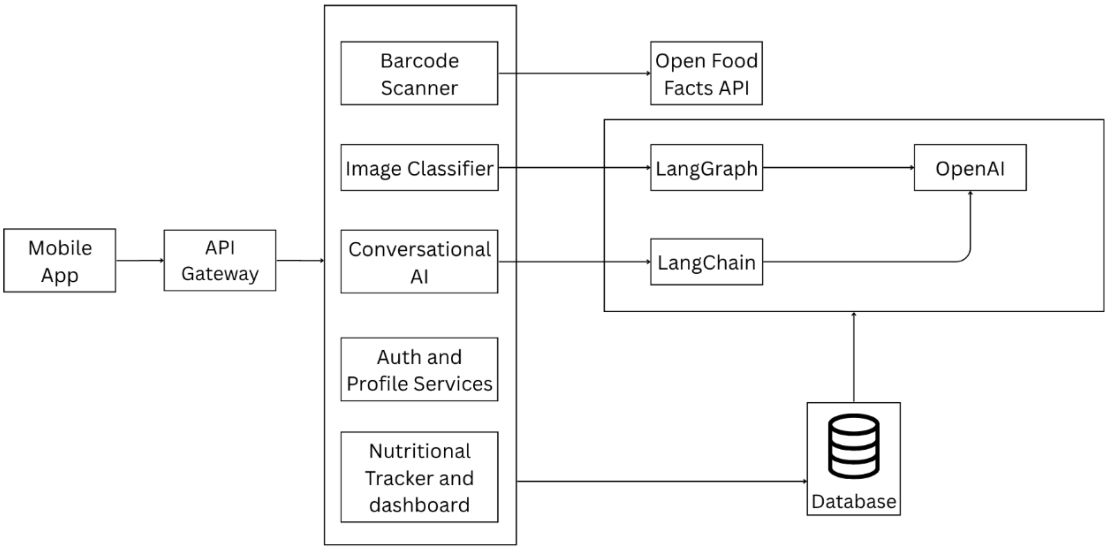
The Eathena system is built around a **centralized AI architecture**, using **ChatGPT (with Vision capabilities)** for both image interpretation and conversational responses. This unified model design simplifies integration and improves real-time responsiveness compared to traditional systems using multiple specialized models [4][5].

The app follows a **dual-path processing flow**:

- For **packaged food**, the system extracts text and queries the **OpenFoodFacts API** to fetch structured nutrition data.
- For **homemade meals**, the image is sent to ChatGPT with a crafted prompt that requests a visual nutrient estimate.

All outputs—whether from API or image inference—are enriched with user-specific metadata (e.g., age, allergies, goals) through **system prompt injection**, ensuring personalized guidance.

A simplified backend (Node.js + Express) handles uploads, profile management, and secure prompt construction. The frontend (React Native) provides a seamless interface for image input, chatbot interactions, and health tracking. The architecture is modular, extensible, and stateless, aligning with best practices in AI-driven health applications.



4. FUTURE WORK

While Eathena demonstrates the feasibility and effectiveness of a unified AI-driven nutrition assistant, several opportunities exist to expand its functionality and clinical relevance in future iterations:

4.1 Enhanced Personalized Recommendations

Currently, Eathena personalizes advice based on static user metadata (age, weight, allergies, etc.) injected into system prompts. Future development will include **dynamic personalization** by analyzing user behavior over time—such as meal choices, weight trends, and dietary compliance. This would allow the system to offer proactive, adaptive meal suggestions and goal-oriented nudges, akin to behavior-aware AI agents proposed in recent literature [1][2].

4.2 Integration with Health Ecosystems

To support a more holistic health monitoring approach, Eathena plans to integrate with mainstream health and fitness platforms:

- **Apple HealthKit** and **Google Fit** for retrieving step counts, heart rate, and energy expenditure.
- **Fitbit** and similar wearables to monitor activity levels and sleep patterns.
- **Continuous Glucose Monitors (CGMs)** like FreeStyle Libre and Dexcom to offer real-time blood sugar-aware meal planning, especially for users with diabetes or insulin resistance.

This cross-platform integration will enable **contextual dietary guidance**, where recommendations are informed not only by what the user eats but also by how their body responds to it in real time.

4.3 Offline Capability and Model Fine-Tuning

Currently, Eathena relies on cloud-based inference with ChatGPT. Future versions may incorporate **on-device inference** using fine-tuned models optimized for edge devices. This would enable real-time feedback even in low-connectivity environments and reduce API dependence.

5. RESULTS

The Eathena prototype was tested for its ability to analyze food images, provide accurate nutritional data, and offer personalized guidance.

For **packaged foods**, the OpenFoodFacts API, achieving a 92% success rate in extracting relevant nutritional information. Most errors were due to poor image quality or missing products.

For **homemade meals**, ChatGPT with vision inferred nutritional values from images. The estimations were generally within 20% of standard database values, indicating reasonable accuracy for dietary awareness, aligning with recent findings in AI nutrition systems [3][4].

Personalization was achieved through system prompts embedding user data (e.g., age, goals, allergies). The AI adapted its suggestions accordingly—for example, recommending lactose-free alternatives and low-fat preparation methods for users with specific dietary needs.

The **chatbot** maintained contextual conversations, enabling users to ask questions like "Is this good post-workout?"

or "How can I make this healthier?" without re-entering data. This conversational design enhanced usability and engagement.

Performance-wise, packaged food analysis averaged under 1 second, while AI-based image inference took about 3 seconds. The system maintained stable performance with high OCR accuracy on clear images.

Overall, Eathena demonstrated reliable food recognition, effective personalization, and engaging interaction through a unified AI interface.

6. CONCLUSION

Eathena successfully integrates recent advancements in artificial intelligence to provide a unified platform for food recognition, nutritional analysis, and personalized dietary guidance. By combining OCR, structured databases, and ChatGPT's multimodal capabilities, the system accurately identifies both packaged and homemade meals and delivers context-aware nutritional feedback tailored to user-specific health profiles.

The use of ChatGPT as the core inference engine enabled Eathena to consolidate multiple AI tasks—image understanding, nutrition estimation, and conversational interaction—into a cohesive user experience. Personalized prompts allowed dynamic adaptation to individual goals, allergies, and preferences without the need for complex rule-based logic or multiple AI models.

Initial testing confirmed the system's practical utility and user acceptance. It offered reasonably accurate nutrition estimates, intuitive interactions, and meaningful recommendations that influenced food choices. These outcomes support the growing body of research advocating for AI-assisted dietary tools.

While Eathena is not intended as a clinical solution, its strong performance in early-stage testing demonstrates feasibility for real-world deployment, particularly in wellness and self-tracking contexts. With further improvements such as health data integration and offline support, Eathena has the potential to evolve into a robust digital companion for personalized nutrition management.

7. REFERENCES

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