

KALO:AI-Powered Precision in Nutrition Tracking

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Abstract—Kalo is an innovative system designed to enhance dietary management through precise calorie estimation. By analyzing food images using advanced machine learning and computer vision techniques, Kalo provides accurate calorie counts, empowering users to make informed decisions about their meals. This tool is particularly valuable for individuals managing obesity, chronic conditions like diabetes, or those following specialized dietary plans where accurate calorie tracking is crucial. It eliminates the need for manual calculations or reliance on food labels, simplifying the process and making dietary monitoring more accessible. Kalo operates on a mobile phone equipped with a camera, allowing users to capture images of their meals for analysis. Kalo utilizes a combination of deep learning models, image processing algorithms, and a robust food database to identify food items and estimate their nutritional values with high accuracy. The system is developed using React.js for the frontend, Node.js for the backend, and MongoDB for efficient data storage. Image recognition and calorie estimation are powered by TensorFlow and OpenCV, enabling precise analysis of food images. A cloud-based architecture ensures scalability, real-time updates, and seamless cross-device access. Kalo represents a significant advancement over existing technologies, providing superior accuracy and reliability. It benefits a wide array of users, including health-conscious individuals, fitness enthusiasts, and those on medically prescribed diets. With its dependable calorie estimations, Kalo helps users monitor their intake effectively, ensuring they stay on track with their nutritional goals. In addition to estimating calories and detecting allergens, Kalo includes comprehensive calorie tracking features (daily, weekly, and monthly), allowing users to monitor their dietary habits over time. The system also features an AI-driven chat assistant to address health concerns and provide personalized health recommendations and routine mapping. By promoting healthier eating habits and fostering a culture of informed dietary choices, Kalo bridges the gap between technology and personal health. This innovative solution advances the field of diet monitoring, addressing the challenges of accurate calorie tracking with convenience, reliability, and AI-powered insights.

—Keywords - calorie estimation, dietary management, food image analysis, AI, health technology, allergen detection, calorie tracking.

I. INTRODUCTION

The ability to accurately track calorie intake is crucial for managing various health conditions and achieving dietary goals. With the rise of obesity and related chronic diseases such as diabetes and heart disease, there is an increasing need for effective tools that can help individuals monitor their nutritional intake. Traditional methods of calorie tracking often involve manual calculations, reliance on food labels, and generic dietary guidelines, which can be time-consuming and prone to errors. Moreover, these methods may not account for variations in food preparation, portion sizes, or the nutritional content of homemade meals and restaurant dishes. To address these challenges, recent advancements in artificial intelligence (AI) and computer vision have led to the development of innovative systems that can analyze food images to estimate calorie content. These systems leverage deep learning algorithms, such as convolutional neural networks (CNNs), to recognize food items and estimate their nutritional values. However, existing systems often lack comprehensive features such as personalized health advice, allergen detection, and detailed calorie tracking over time. Kalo is an AI-powered calorie estimation and dietary management system designed to bridge these gaps. By combining advanced image recognition technology with AI-driven features, Kalo provides users with a convenient and reliable tool for monitoring their daily calorie intake. The system not only estimates calories from food images but also offers personalized health advice, detects potential allergens, and tracks calorie intake over daily, weekly, and monthly periods. This comprehensive approach empowers users to make informed dietary choices, enhancing their overall health and well-being. In this paper, we present the design and functionality of Kalo, highlighting its key features and how it differs from existing systems. We also discuss the benefits and applications of Kalo for various user groups, including health-conscious individuals, fitness enthusiasts, and those managing chronic health conditions.

II. LITERATURE SURVEY

Most current calorie tracking systems require users to manually input the foods they eat and their quantities. These systems rely heavily on nutritional databases or food labels. Some offer barcode scanning for packaged foods, making data entry slightly easier. Let us look at literature survey of similar systems. Calorie Estimation of Food and Beverages Using Deep Learning: Overview

This study introduces an image-based system designed to estimate the calorie content of food items. Users upload a food image, and the system calculates the estimated calories. It also provides weekly data on the user's calorie consumption and suggests calorie intake adjustments to prevent obesity-related diseases.

Key Methodologies: Image Recognition: A Convolutional Neural Network (CNN) is used to identify food items from images. The CNN architecture extracts features and classifies the images. Segmentation: Image processing techniques like canny edge detection, watershed segmentation, morphological operators, and Otsu's approach are employed to segment the food item in the image. A thumb is used for calibration to estimate the food item's true size and volume accurately. Feature Extraction: Features such as size, color (HSV histogram), texture (Gabor filters), and shape (moments) are extracted to create a feature vector. Classification: A Support Vector Machine model is trained using the feature vector to categorize the food products. Calorie Calculation: The system estimates calorie content based on the identified food and its estimated volume. Deep Learning Approach: The system uses deep learning, specifically convolutional neural networks, to overcome the challenges of food and drink image recognition. Deep learning models automatically recognize relevant features, reducing the need for manual feature definition. Dataset: The system was trained and tested using a dataset of food images with 20 classes and 500 images in each class, achieving an accuracy of 78.7 percentage during testing and 93.29 percentage during training. Additionally, the Fruits 360 collection was used, with 90483 photos of 131 fruits and vegetables. 15 different kinds of produce were selected and scaled to 224*224. Proposed System Improvements: The proposed system identifies food using size, shape, color and texture. It categorizes images using pre-processing and neural network training. Expected Benefits: The system aims to help users and healthcare professionals rapidly assess dietary practices and food choices related to health.[7] A Study of Calorie Estimation in Pictures of Food .This study presents an efficient approach for real-time calorie estimation and food recognition using deep learning techniques. The project is implemented using Python, owing to its strong ecosystem of libraries for machine learning and deep learning. While the specific framework isn't mentioned explicitly, it is evident that libraries like TensorFlow or Keras were used, as the architecture (MobileNet) is commonly implemented in them. MobileNet is used for its efficiency and lightweight nature. It utilizes depthwise separable convolutions to reduce computational

complexity, making it suitable for deployment on mobile and embedded devices. Transfer learning is employed by fine-tuning the MobileNet model, pre-trained likely on ImageNet, using the Food-101 dataset. The system is trained and validated on the Food-101 dataset, which contains 101 categories of food images. A web-based interface is developed (specific framework like Flask/Django is not specified) to allow users to upload food images and receive calorie estimates in real-time. While the hardware specifics are not elaborated in the paper, the choice of tools and architectures suggest the following: The use of MobileNet indicates deployment on smartphones and tablets. The model's lightweight nature ensures smooth performance on devices with limited processing power and memory. MobileNet's optimization also enables potential deployment on embedded systems such as IoT health monitoring devices. The web framework possibly runs on a cloud server handling the model inference and providing the web interface services. Methodology Overview Images from the Food-101 dataset are resized, normalized, and augmented (via techniques like flipping, rotation) to improve model robustness. The pre-trained MobileNet model is fine-tuned on the specific dataset to adapt it to food image classification. Users upload food images, which are processed by the model to recognize the food type and map it to its calorie value based on predefined data. Key Features of the Project Lightweight and Mobile-Friendly: Achieved via MobileNet, ensuring real-time inference on mobile hardware. User-Friendly Web Interface: Simplified usage for non-technical users. Focus on Health Impact: Helps users monitor calorie intake, especially targeting obesity management. Project Limitations Dataset Limitation: The system uses the Food-101 dataset, which, while comprehensive, may not include all food types, particularly regional or home-cooked variations. Generalization to unseen or mixed dishes may be poor. Portion Size Estimation: The model lacks the ability to assess actual portion size. Calorie estimation is based solely on the food type, assuming a standard serving size. No Ingredient-Level Breakdown: Complex dishes with multiple ingredients are classified as single categories without detailed nutritional analysis per ingredient. No Integration with Personalized Health Data: The system does not factor in user-specific health metrics like BMI, dietary goals, allergies, or medical conditions, leading to generic outputs. Real-Time Processing Bottlenecks: Though MobileNet is optimized, reliance on a web server introduces potential latency, especially under heavy usage or poor internet conditions. Visual Similarity Challenges: Foods that look similar but have different ingredients/calorie contents might be misclassified due to reliance on image recognition alone.[8]

III. PROPOSED SYSTEM

Kalo is an AI-powered calorie estimation and dietary management system designed to address the limitations of existing calorie tracking systems. By leveraging advanced image recognition technology and deep learning algorithms, Kalo provides users with a comprehensive tool for monitoring their daily calorie intake and achieving their dietary goals.

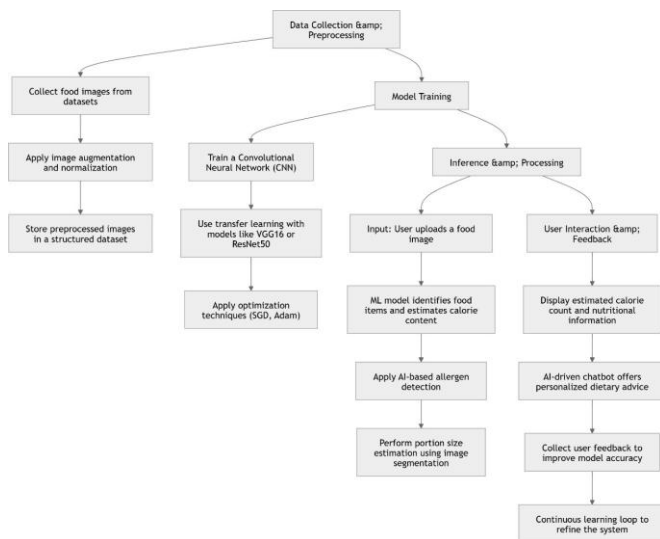


Fig. 1. Workflow of Kalo's Calorie Estimation and Allergen Detection System

Image Analysis : Kalo's image analysis component is built on a robust Convolutional Neural Network (CNN) architecture, leveraging the advancements in deep learning for visual object recognition. This system is designed to analyze food images uploaded by users, accurately identifying the food items and estimating their calorie content.

1) Convolutional Neural Network (CNN) Architecture:
Layers: The CNN model includes multiple convolutional layers for feature extraction, pooling layers for downsampling, and fully connected layers for classification. This architecture is effective for recognizing patterns in images and has been widely used in food image classification tasks.
Training Dataset: The model is trained on a large dataset of food images, such as the Food-101 dataset, which contains over 100,000 images across 101 categories. This extensive training dataset helps improve the model's accuracy in recognizing diverse food types.

2) Image Preprocessing:
Resizing and Normalization: Images are resized to a consistent size and normalized to ensure uniformity across the dataset, enhancing the model's ability to focus on relevant features rather than size or color variations.
Data Augmentation: Techniques such as rotation, flipping, and color jittering are applied to artificially increase the size of the training dataset, improving the model's robustness to different lighting conditions and orientations

3) Model Training:
Transfer Learning: To leverage pre-trained models like VGG16 or ResNet50, which have already learned general features from large datasets like ImageNet, Kalo uses transfer learning. This approach significantly reduces training time and improves accuracy by fine-tuning the pre-trained layers on the food image dataset.
Optimization Techniques: The model is optimized using stochastic gradient descent (SGD) with momentum or Adam optimizer, along with techniques like dropout and batch normalization to prevent overfitting

4) Food Recognition and Calorie Estimation:
Recognition Accuracy: The trained CNN model achieves high accuracy in recognizing food items, which is crucial for accurate calorie estimation. Studies have shown that CNNs can achieve top-1 accuracy of up to 77.4 percentage.
Calorie Estimation: Once a food item is recognized, Kalo estimates its calorie content based on a comprehensive nutritional database. This database is updated regularly to ensure accuracy and relevance.
Calorie Estimation : Kalo's calorie estimation feature plays a vital role in helping users manage their diet. By combining cutting-edge image recognition with machine learning algorithms, it transforms a simple food photo into an accurate calorie count. Here's how the process works in a user-friendly and efficient way:

5) Food Identification: Image Analysis: When a user uploads a food image, Kalo's Convolutional Neural Network (CNN) analyzes it to identify the food items. Kalo picks up on visual cues like color, texture, and shape to distinguish between different foods—even in complex dishes.
Database Matching: Once the food is identified, Kalo cross-references it with a rich nutritional database to retrieve the calorie and nutrient information.

6) Portion Size Estimation: Image Processing Techniques: Estimating how much food is on the plate is just as important as identifying what's there. Kalo uses methods like edge detection and image segmentation, along with calibration techniques (e.g., recognizing common objects like a thumb for scale) to gauge portion sizes.
Volume Calculation: With the portion size estimated, Kalo calculates the volume of the food and converts it into mass using standard density tables. This step ensures the calorie count is based on realistic serving sizes.

7) Calorie Calculation: Nutritional Data Retrieval: Using the mass of each food item, Kalo pulls detailed nutritional information from its database, including calorie content.
Total Calorie Estimation: It then sums up the calories for all identified items to give users an accurate total for their meal.

8) Accuracy Enhancement: Training Dataset: To ensure reliability, Kalo's model is trained on a diverse set of food images, ensuring it can recognize everything from simple snacks to elaborate meals.
Continuous Learning: Kalo improves over time by learning from user feedback and updating its database, enhancing both recognition accuracy and calorie estimates.
Allergen Detection : Kalo's allergen detection feature is designed with user safety at its core, helping individuals identify potential allergens in their meals. By harnessing the power of AI, this feature enables users with dietary restrictions to make safer, more informed food choices.

9) Ingredient Analysis: AI-Powered Algorithms: Kalo uses advanced AI algorithms to examine the molecular structure of ingredients, pinpointing potential allergenic proteins and compounds. This cutting-edge approach mirrors methods used in the food industry to predict allergen risks by analyzing ingredient properties and how they're processed.
Comprehensive Allergen Database: To back its detection system, Kalo relies on an extensive, regularly updated database of common allergens—including dairy, wheat, eggs, fish, tree nuts, shellfish,

soy, and peanuts—ensuring its information is accurate and up-to-date with the latest research and regulations.

10) *Real-Time Allergen Identification: Image Recognition:* With a quick photo upload, users can have their meals analyzed. Kalo's machine learning models, trained on vast datasets of food images, identify not only the foods but also their potential ingredients. *Instant Alerts:* If any allergens are detected, Kalo promptly notifies users, empowering them to make safer dietary choices before they take a bite.

11) *Integration with Calorie Estimation: A Holistic Approach:* Kalo seamlessly combines allergen detection with calorie estimation, offering a complete dietary management solution. This integration means users can simultaneously monitor their calorie intake and watch out for potential allergens—no need to juggle multiple apps.

12) *User Input and Customization: Personalized Alerts:* Kalo allows users to input their specific allergens, enabling personalized notifications tailored to their needs. For those with severe allergies, this feature provides peace of mind and helps prevent accidental exposures. *Calorie Tracking :* Kalo's calorie tracking feature is designed to give users an easy-to-understand overview of their eating habits. Whether you're aiming to lose weight, maintain a healthy lifestyle, or manage conditions like diabetes, this tool has you covered.

13) *Daily Calorie Tracking: Meal Logging:* Users can track their meals in ways that suit them best—snap a picture of your food, type it in manually, or quickly scan a barcode for packaged items. This flexibility makes daily tracking less of a chore and more of a helpful routine. *Real-Time Feedback:* As you log meals, Kalo provides immediate feedback on your calorie intake. This guidance helps you stay on target with your daily goals, whether you're working toward weight loss or maintaining a balanced diet.

14) *Weekly Calorie Tracking: Summary Reports:* At the end of each week, Kalo compiles your data into an easy-to-read report, showing total calories consumed, daily averages, and a breakdown of macronutrients (carbs, proteins, fats). Spotting patterns and making adjustments becomes straightforward. *Goal Adjustment:* Based on these insights, you can tweak your goals to better align with your lifestyle and progress—keeping motivation high and setbacks minimal.

15) *Monthly Calorie Tracking: Long-Term Insights:* Kalo doesn't just focus on the short term. Monthly summaries provide a bigger-picture view of your eating habits, helping you identify trends like seasonal cravings or changes in portion sizes over time. *Progress Visualization:* Interactive charts and graphs make it easy to see how far you've come, adding an extra layer of motivation and clarity to your journey.

16) *Personalized Recommendations: AI-Driven Insights:* Using the data you've tracked, Kalo's smart algorithms suggest ways to improve—offering tips for better meal planning, portion control, and nutrient balance tailored to your goals. *Continuous Learning:* The more you use Kalo, the better it gets. It learns from your feedback and evolves its recommendations to stay relevant to your needs. *AI-Driven Chat Feature :* Kalo's AI-driven chat feature is designed to be more than just

a virtual assistant—it's like having a personal health coach in your pocket. By combining advanced natural language processing (NLP) with machine learning, this feature provides personalized guidance, answers health-related questions, and helps users stay on track with their dietary goals in an intuitive, conversational way.

17) *Health Concerns and Queries: Personalized Conversations:* Users can ask the chat feature questions about their diet, health concerns, or specific conditions. Whether you're curious about the best foods for energy, wondering how to manage a dietary restriction, or looking for advice on portion control, Kalo is ready to help. *Tailored Responses:* The AI doesn't just provide generic advice—it takes into account the user's dietary history, health goals, and preferences to deliver recommendations that truly resonate with each individual.

18) *Personalized Health Checkup and Routine Mapping: Customized Plans:* Planning for better health just got easier. Kalo's chat helps users create personalized checkup schedules and daily routines tailored to their unique lifestyle and objectives. *Helpful Reminders:* Forgetting a workout or skipping a meal plan isn't an issue anymore. Users receive timely reminders and motivational notifications, ensuring they stay consistent with their health routines.

19) *Nutritional Coaching: Dietary Guidance:* Kalo's chat provides practical advice that users can easily apply to their everyday lives, considering their nutritional needs and preferences. *Personalized Recipes:* The chat can suggest recipes that align with users' dietary restrictions and goals, making healthy eating both exciting and accessible.

20) *Seamless Integration with Other Features: Holistic Support:* Kalo's chat isn't an isolated tool ,it works hand-in-hand with the app's calorie tracking and allergen detection features. Users can get real-time updates on their calorie intake, track potential allergens, and receive comprehensive dietary advice all in one place. *Continuous Improvement:* The more users interact with Kalo, the smarter it becomes. By learning from user feedback and conversations, the system refines its responses, ensuring more accurate and relevant guidance over time. *Personalization :* Kalo's personalization feature ensures every user enjoys a dietary management experience tailored to their unique needs: *User Profiling:* Kalo gathers data on user habits, preferences, goals, and demographics to create individualized profiles, similar to how platforms like MyFitnessPal offer tailored advice. *Targeted Recommendations:* Using AI, Kalo provides dynamic diet tips, meal plans, and recipe suggestions that adapt as users' habits and preferences change. *Customizable Dashboards:* Users can select which metrics matter most to them—whether it's calorie intake, nutrient breakdowns, or progress toward goals—making their dashboard a personalized hub for health tracking. *Interactive Daily Blogs:* To keep users informed and motivated, Kalo offers daily blogs on nutrition, wellness tips, and the latest health trends directly within the app. These articles are designed to be practical, easy to understand, and immediately applicable.

User Interface : Kalo's user interface is designed to provide a seamless and intuitive experience for users, focusing on

simplicity, consistency, and feedback. The UI is crafted to ensure that users can easily navigate the app, access its features, and manage their dietary habits effectively.

1. **Simplicity and Consistency: Clean Design:** The interface features a clean and modern design, ensuring that users can quickly find what they need without clutter. This approach aligns with principles that emphasize simplicity and ease of use. **Consistent Elements:** Consistent design elements, such as colors, fonts, and button styles, are used throughout the app to create a cohesive user experience.

2. **Intuitive Navigation: Clear Hierarchy:** The app's layout is organized with a clear hierarchy, guiding users through its features and ensuring that key functions are easily accessible. This is achieved by using proper alignment, color, and typography to draw attention to important elements. **Responsive Design:** Kalo's UI is responsive, adapting seamlessly to different devices and screen sizes, ensuring a consistent experience across platforms.

3. **Feedback and Interactivity: Real-Time Feedback:** Users receive real-time feedback on their interactions, such as when uploading food images or tracking their calorie intake. This feedback helps users understand the system's responses and stay informed about their progress. **Interactive Elements:** Interactive elements like buttons and forms are designed to be intuitive and responsive, making it easy for users to perform tasks without confusion.

4. **Accessibility and Onboarding: Accessible Design:** The UI is designed with accessibility in mind, ensuring that it is usable by people with disabilities. This includes features like clear text labels, high contrast options, and easy navigation. **Straightforward Onboarding:** The onboarding process is straightforward, introducing users to the app's core features and functionality in a clear and concise manner. This helps users quickly understand how to use the app effectively.

5. **Daily Blogs Integration: In-App Content:** Kalo integrates daily blogs directly into the dashboard, providing users with valuable insights and advice on nutrition and health. This content is presented in an engaging and easy-to-read format, enhancing the overall user experience.

APPLICATIONS

Kalo brings a host of benefits and practical applications for people from all walks of life. Whether you're aiming to manage your weight, maintain overall health, or reach specific fitness goals, Kalo is designed to make the journey smoother and more personalized. **Obesity Management** **Accurate Calorie Tracking:** Keeping track of calories can be challenging, but Kalo simplifies the process. By providing accurate calorie counts, it empowers users to make mindful dietary choices and stay on course with their weight loss journey. **Personalized Advice:** Everyone's health journey is unique. That's why Kalo offers tailored diet tips and suggestions that cater to individual needs, keeping users motivated and aligned with their goals.

Diabetes Management : Precise Calorie Estimation: For individuals managing diabetes, consistency is key. Kalo ensures users can track their calorie intake with precision, helping

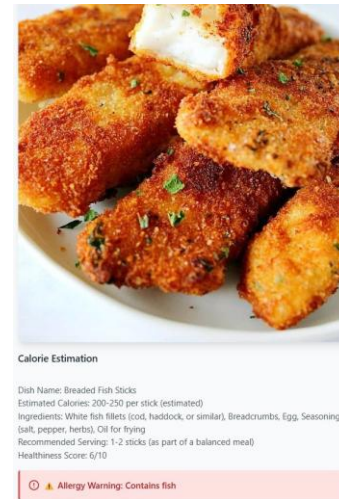


Fig. 2. Sample Calorie Estimation from Kalo

to maintain stable blood sugar levels. **Nutritional Insights:** With detailed insights into nutritional content, Kalo helps users better manage their carbohydrate intake and maintain a balanced diet for long-term well-being.

Specialized Dietary Plans : Customized Support: Whether you're following a gluten-free, vegan, or keto diet, Kalo provides accurate calorie estimates and identifies potential allergens, ensuring your dietary plan stays on track. **Adaptive Recommendations:** As your preferences and goals evolve, Kalo evolves with you, offering dynamic suggestions tailored to your current needs.

Health-Conscious Individuals : Nutritional Awareness: Making healthier choices starts with understanding what's on your plate. Kalo makes it easier to monitor calorie intake and make informed decisions for a healthier lifestyle. **Educational Content:** With daily blogs and articles on nutrition and wellness, Kalo provides valuable information to support users in making lasting, healthy habits.

Fitness Enthusiasts : Optimized Nutrition: Fueling your body properly is essential for peak performance. Kalo helps you track calories and optimize your nutrition to power through workouts and recover efficiently. **Personalized Meal Planning:** With recommendations tailored to specific fitness goals, users can plan meals that complement their training regimens and enhance performance.

Community and Support: Shared Knowledge: Health journeys are better when shared. Kalo fosters a supportive community where users can exchange experiences, tips, and encouragement. **Expert Guidance:** Kalo's AI-driven chat feature provides reliable, personalized health guidance whenever you need it, offering peace of mind along the way.

IV. CONCLUSION

Kalo marks a transformative step forward in dietary management, providing users with a comprehensive, user-friendly tool to monitor their calorie intake and support their overall

health. By harnessing cutting-edge image recognition technology, intelligent AI features, and personalized health insights, Kalo empowers individuals to take charge of their nutrition and make informed choices with confidence.

One of Kalo's standout strengths lies in its ability to accurately estimate calories from food images—a feature that simplifies meal logging without the need for manual input. Its built-in allergen detection ensures that users with dietary restrictions can eat safely, while tailored dietary recommendations provide guidance that aligns with each individual's unique health goals. Whether managing obesity, diabetes, or simply striving for healthier habits, Kalo offers practical support and real-time insights.

Beyond tracking calories, Kalo enriches the user experience with educational content and daily blogs, helping users deepen their understanding of nutrition and make lasting lifestyle changes. Its comprehensive tracking capabilities—spanning daily, weekly, and monthly monitoring—enable users to observe patterns in their eating habits, while the integrated AI-driven chat feature delivers expert advice at their fingertips.

Ultimately, Kalo bridges the gap between technology and personal well-being. It provides a convenient, reliable, and personalized dietary solution, tackling common challenges such as accurate calorie counting, allergen awareness, and tailored health guidance. By making healthy eating more accessible and less overwhelming, Kalo encourages users to build sustainable habits that promote long-term wellness.

Looking ahead, future enhancements could include expanding the food database to represent an even wider range of cuisines, refining AI algorithms for greater accuracy, and integrating seamlessly with wearable devices to provide a holistic health monitoring experience. With continuous innovation, Kalo has the potential to reshape how individuals approach dietary management and make meaningful contributions to better health outcomes for all.

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