# Smart Plate: AI-Driven Nutrition and Allergy Detection through Food Scanning

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***Abstract*— With increasing focus on health, nutrition, and food allergies, technology-enabled dietary monitoring has become vital. Smart Plate is an AI-driven system designed to recognize Indian dishes from food images, assess their nutritional content, and detect potential allergens. Using a trained deep learning model, the system predicts dish names with high accuracy and retrieves recipes, ingredients, and serving sizes from a custom dataset. Nutritional values are computed via a JSON-based database. Users can specify allergens, which are cross-checked against identified ingredients to provide instant alerts. A Streamlit interface supports login, image uploads, history tracking, and personalized dietary analysis. Smart Plate offers a practical, user-friendly solution that integrates deep learning, computer vision, and health informatics to support safe and informed eating habits.**

***Index Terms*— Smart Plate, Food image recognition, Indian dishes, Nutritional content, Allergen detection, Deep learning, Computer vision, Health informatics, Dietary monitoring, Streamlit interface**

## I. INTRODUCTION

With rising concerns about health, personalized nutrition, and food allergies, there is a growing need for intelligent tools that aid in making informed dietary decisions. Smart Plate addresses this by leveraging artificial intelligence, deep learning, and computer vision to deliver real-time food recognition, nutritional analysis, and allergen detection through image scanning. Users can upload or capture food images via a user-friendly interface; the system identifies the dish using a trained model, retrieves related recipes, and computes nutritional values (calories, proteins, fats, carbohydrates, minerals) using a JSON-based database.

Personalized allergen alerts are generated by comparing detected ingredients with user-defined allergy profiles. Visual charts (Plotly) present nutrient distributions clearly, while login features enable users to track meal history and analyze consumption trends. Smart Plate promotes safer eating habits, supports chronic illness and allergy management, and offers potential for future integration with fitness trackers and regional health systems.

Key Objectives of the system are
- Promotes nutritional information of the food.
- Quick identification of allergens.
- Helps to make the informed dietary choices.
- Provides user friendly interface for easy food scanning.

## II. LITERATURE REVIEW

Recent advancements in artificial intelligence (AI) and computer vision have significantly influenced dietary monitoring and nutrition tracking. Jiang et al. [1] introduced DietGlance, a privacy-aware diet monitoring tool using wearable cameras and knowledge-based AI. Michelle Han et al. [2] developed NutrifyAI, an automated dietary system leveraging YOLOv8 for food detection and Edamam API for nutritional analysis, enabling real-time food logging and allergy management.

Tagne Poupi et al. [3] systematically reviewed AI's role in personalized nutrition, highlighting machine learning (ML) and deep learning (DL) applications in food detection and disease prediction. Velkov [4] designed a mobile scanner app for allergen detection and nutrition display, while Soomro et al. [5] achieved 95% accuracy in allergy detection using ResNet50 on the Food-101 datasetGilal et al. [6] surveyed over 100 studies on AI in food computing,

addressing challenges such as dataset limitations and model generalization. Detopoulou et al. [7] emphasized ethical concerns in AI-driven nutrition technologies. Mishra et al. [8] introduced Allergen30, a deep learning dataset for allergenic food classification using YOLO models.

Other contributions include Mavani et al. [9] on AI for food quality control, Zhu et al. [10] on ML in food grading and defect detection, and Freitas et al. [11] who applied segmentation models for nutrient estimation. Shen et al. [12] proposed a client-server CNN framework for continuous food attribute learning, and Okamoto et al. [13] designed a mobile-only caloric estimation app.

Earlier works like Christodoulidis et al. [14] explored patch-based CNNs for food classification, while Pouladzadeh et al. [15] used dual-image calorie tracking. Zhu et al. [16] pioneered mobile dietary assessment via image segmentation and volume estimation, reducing manual input in nutrition tracking.

## III. METHODOLOGY

### *A. Proposed System*

The proposed system, *Smart Plate*, leverages advanced artificial intelligence, deep learning, and computer vision to transform how individuals manage their dietary habits. With rising concerns over food allergies, personalized nutrition, and lifestyle diseases, Smart Plate offers a practical, tech-driven solution for real-time nutritional analysis and allergen detection.At the core of this system is a machine learning model—specifically an image classification model —trained on a diverse dataset of Indian food items. A high-resolution camera or smartphone captures an image of the food, which is then processed using deep learning algorithms to accurately classify the dish. Once identified, the system fetches detailed nutritional information including macronutrients (calories, carbohydrates, proteins, fats) and micronutrients (vitamins and minerals), and detects potential allergens based on known ingredient mappings.

To enhance user accessibility, the system is implemented as an interactive web application using Streamlit. Users can upload or capture images, receive instant dish predictions, view breakdowns of nutrition, and get alerts if any allergens match their dietary restrictions. The system also saves a history of food consumption and supports user login, personalization of allergies, and simple food recommendations.By combining AI-powered food recognition with personalized dietary feedback, Smart Plate empowers individuals to make informed decisions about their meals, promoting a healthier lifestyle and supporting those with dietary sensitivities. This end-to-end system is designed to be an accessible, user-friendly assistant in maintaining nutritional awareness and allergy management.

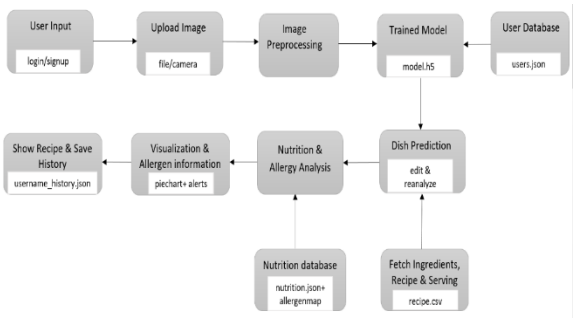


*Figure 3.1 Block Diagram of Smart Plate*

### *B. Algorithm Used*

Smart Plate integrates deep learning, structured food data analysis, and an interactive Streamlit interface to deliver real-time nutritional and allergen insights. The core model is a Keras-based Convolutional Neural Network (CNN), saved as a .h5 file, trained to classify Indian dishes from uploaded images. Images are preprocessed and classified using a softmax layer for multi-class prediction.

The front end, built with Streamlit, enables user login, image upload/capture, and interactive result display including predicted dish names, nutrition breakdown, and allergen alerts. Nutritional analysis is performed using a custom nutrition.json database, while allergen detection uses an ALLERGEN_MAP dictionary cross-referenced with user-defined allergens (user_allergies.json).

Dish recipes are retrieved from recipe.csv, parsed for ingredients, and analyzed to compute calories, proteins, fats, and carbs. Allergen warnings are issued based on keyword matching within ingredients. The system emphasizes deterministic predictions over generative outputs, making it suitable for real-time dietary support.

By combining CNN-based food recognition with rule-based allergen mapping and intuitive visualizations, Smart Plate provides a practical, user-centric solution for personalized nutrition monitoring and allergy management.

## IV. IMPLEMENTATION

The implementation of the Smart Plate project revolves around creating an interactive web-based platform that enables users to upload food images and receive real-time nutritional analysis and allergen warnings..

### *A. About Dataset*

The application uses a combination of image-based and text-based datasets for classification, nutrition profiling, and allergen detection:

1)A Keras-trained image classification model (.h5) is used to identify Indian dishes from uploaded images. This model was trained using a labeled dataset of food images organized by class labels in folders.

2)A structured CSV dataset (recipe.csv) contains detailed information for each dish including: Name, Ingredients, Preparation procedure, Serving size

3)A comprehensive nutrition database in JSON format (nutrition.json) maps individual ingredients to their nutritional content including calories, proteins, fats, carbohydrates, and minerals.

4)An extended allergen mapping dictionary (ALLERGEN_MAP) manually associates common allergen types (e.g., nuts, shellfish, gluten) with ingredient keywords, allowing for automatic allergy detection from ingredient lists.

### *B. Model used*

MobileNetV2 is **a** lightweight convolutional neural network (CNN) designed for mobile and embedded vision applications. It improves upon the original MobileNet by being faster and more accurate**,** while remaining highly efficient for devices with limited computational resources.

### *C. Workflow*

The Smart Plate application follows a clear and modular workflow from user input to nutrition output:

Image Upload**:**Users upload an image via file upload or capture one using their webcam. The Streamlit interface manages this interaction through st.file_uploader and st.camera_input.

Image Preprocessing**:**Uploaded images are resized to 224×224 pixels and normalized to match the format expected by the Keras CNN model. This ensures consistent model input and accurate classification.

Food Classification (Keras Model)**:**The preprocessed image is passed to the trained .h5 model, which predicts the dish class using a softmax output. The predicted class index is then mapped to the dish name using the recipe.csv dataset.

Fetching Recipe and Ingredients**:**Once the dish is identified, its corresponding ingredients, preparation method, and serving size are retrieved from the CSV file using pandas.

Nutrition and Allergen Analysis**:**Each ingredient is looked up in the nutrition.json file to compute the total nutritional breakdown. Simultaneously, the system checks for allergens by matching keywords in ingredients against the ALLERGEN_MAP dictionary. Users can also save their own allergen preferences, and the system highlights allergens accordingly.

Result Display and Visualization**:**The nutrition data is presented in both tabular and visual formats, including pie charts generated using **Plotly** for macro and micronutrients. Users can also view the full recipe and serving suggestion.

User History and Session Management**:**Each dish prediction is saved to a username_history.json file, allowing users to track their food consumption over time. Streamlit session state variables manage login status, page navigation, and user interactions like reanalysis or allergy selection.

## V. RESULTS

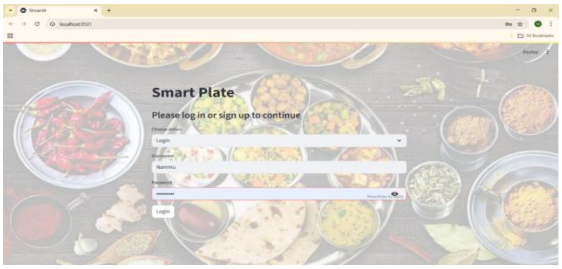


*Figure 5.1 User Interface Page*

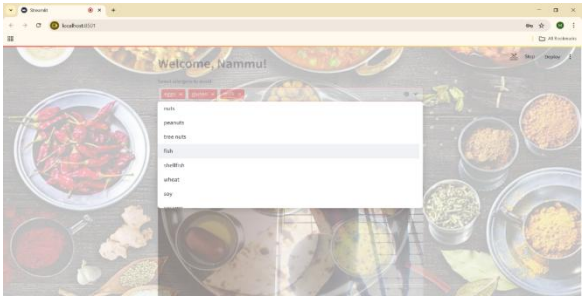


*Figure 5.2 Allergen Selection Interface*

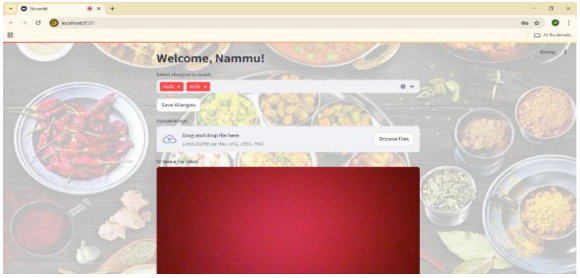


*Figure 5.3 Image Upload and Allergen Preference Interface*

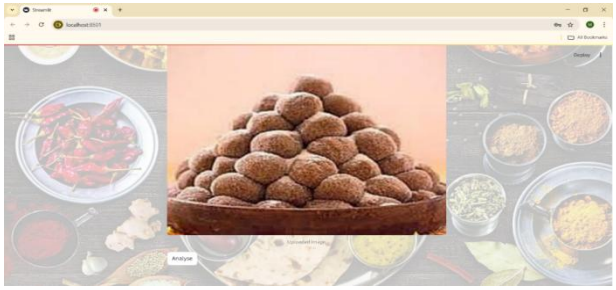

*Figure 5.4 Analysing uploaded Food Image*

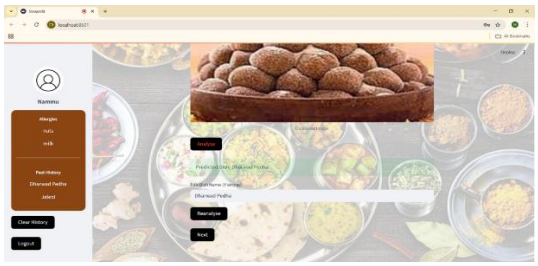

*Figure 5.5 Dish Prediction and User Interaction Interface*

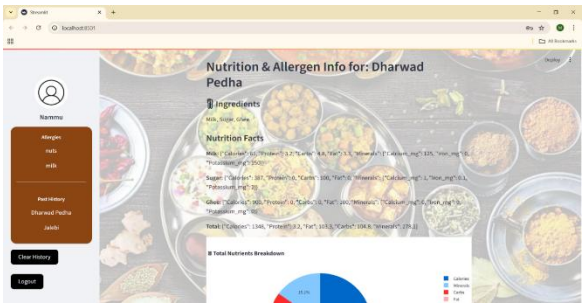


*Figure 5.6 Nutrition and Allergen Information Display*

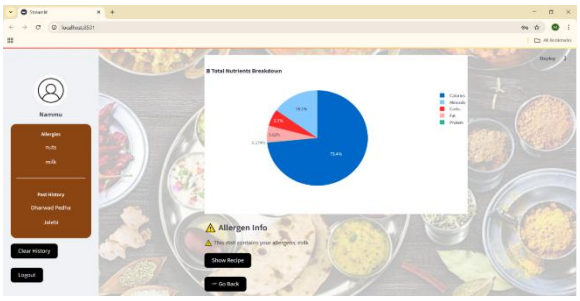


*Figure 5.7 Nutrient Breakdown and Allergen Alert Interface*

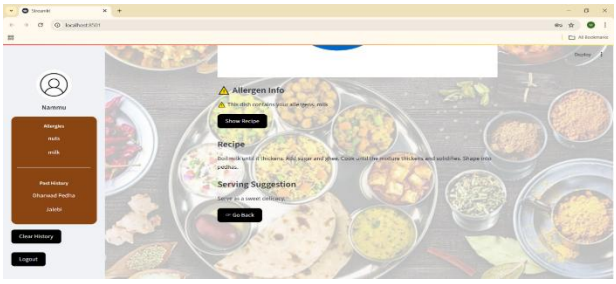


*Figure 5.8 Recipe and Serving Suggestion Display*

## VI. CONCLUSION

The Smart Plate system presents a powerful and practical solution to modern dietary challenges through the integration of artificial intelligence, computer vision, and health informatics. By leveraging a deep learning model such as MobileNetV2 for accurate Indian food classification, alongside a structured nutritional and allergen detection pipeline, the application enables real-time, personalized dietary analysis with minimal user input. The ability to recognize dishes, calculate macronutrient and micronutrient values, and issue allergen alerts addresses critical needs in health monitoring, especially for individuals managing allergies, chronic conditions, or pursuing specific nutritional goals.

With its lightweight architecture and user-friendly Streamlit interface, Smart Plate demonstrates scalability and accessibility for mobile and web-based deployment. It offers not only nutritional guidance but also empowers users to make safer and more informed dietary decisions. The incorporation of login-based personalization, food history tracking, and allergen awareness sets it apart as a comprehensive tool in the space of AI-driven diet monitoring. Future enhancements could include support for multiple cuisines, integration with wearables or health apps, and recommendation engines for healthy alternatives—further solidifying its place in the evolving landscape of personalized healthcare.

## VII. FUTURE ENHANCEMENTS

Future development of the nutrition analysis and allergy detection project will have big scope in different dimensions. Its key areas for development would include expanding the food database with maximum accuracy, allowing real-time tracking of nutrition, and creating individualized meal plans that follow user data. Coupled with wearable devices, such integration can help show what diet is doing in real life, while upgraded algorithms for allergy detection help guard users who are critically allergic. Community features and gamification elements can engage the user, and supporting multilingual access will expand users. AI-based recipe recommendation and scientific research collaboration would also be implemented in the project to take it ahead as a full-fledged health and wellness tool to enable user self-management for healthy decisions about diet and lifestyle choices.

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