IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Automated Food Recognition And Personalized Health Recommendation System

AI Based System To Promote Healthy Lifestyle.

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Abstract: The Automated Food Recognition and Personalized Health Recommendation System combines AI-driven food recognition and nutritional analysis to provide users with tailored health recommendations. By leveraging Google Gemini API and user input, the system accurately recognizes food items, calculates calorie intake, and offers personalized diet and fitness suggestions. The project addresses the challenges of managing dietary habits and fitness by integrating advanced image recognition, user-specific data, and calorie estimation in a user-friendly application. This innovative approach contributes to health management, helping individuals maintain a balanced lifestyle.

Keywords: Food Recognition, Calorie Estimation, Personalized Health Recommendations, AI in Nutrition, Diet Management, Fitness Insights.

Introduction

The Automated Food Recognition and Personalized Health Recommendation System integrates advanced artificial intelligence (AI) technologies to address the challenges of dietary management and fitness. With the increasing prevalence of lifestyle-related health issues, such as obesity and cardiovascular diseases, there is a pressing need for tools that can simplify nutrition tracking and provide personalized guidance.

This project aims to fill that gap by offering a comprehensive solution that combines image recognition, calorie estimation, and tailored health recommendations, leveraging the Google Gemini API. The system allows users to upload images of their meals, which are processed to recognize food items and estimate their nutritional value. It also provides an option for users to input ingredients and measurements, enhancing the accuracy of calorie calculations. By incorporating user-specific data such as age, gender, weight, height, and activity levels, the system generates tailored diet plans, fitness recommendations, and health metrics such as Body Mass Index (BMI) and Body Fat Percentage (BFP). This personalized approach ensures that users receive actionable insights aligned with their unique health goals.

Unlike traditional methods of dietary assessment, which can be time-consuming and error-prone, this system automates the process using cutting-edge AI technologies. The integration of Google Gemini API ensures robust food recognition and calorie analysis, while the user-friendly interface, developed using Stream lit, enhances accessibility. Additionally, the system generates downloadable PDF reports, enabling users to track their progress and share insights with healthcare professionals.

The scope of this project extends beyond individual use cases, with potential applications in healthcare, fitness centers, and dietary consulting. It promotes healthier eating habits, supports fitness routines, and encourages proactive health management. By simplifying complex dietary and fitness decisions, this system empowers individuals to take control of their well-being. In conclusion, this project represents a significant step forward in leveraging AI for health management.

Its seamless integration of food recognition and personalized health insights demonstrates the potential of AI to transform how individuals approach nutrition and fitness. As health consciousness continues to rise, this system serves as a timely and practical solution, aligning with the growing demand for innovative and accessible health tools.

I. Literature Review

1. Food Detection and Calorie Estimation using Deep Learning: Allaboina Deepika , Goriparthi Sowmya, Nemali Susmitha, G. Sravan Kumar

Precise measurement of food and energy intake is crucial in the fight against obesity and diet related illnesses. This article proposes a calorie measurement technique using a deep learning algorithm, specifically a convolutional neural network (CNN), to automate calorie estimation from food images.

By classifying food images using CNNs, the system aims to offer a practical, intelligent solution for tracking daily caloric consumption, aiding both patients and medical professionals.

2. FoodieCal: A Convolutional Neural Network Based Food Detection and Calorie Estimation System: Shahriar Ahmed Ayon; Chowdhury Zerif Mashrafi; Abir Bin Yousuf

Recent studies highlight the importance of a healthy diet for overall well-being, leading to increased interest in tracking daily calorie intake. This paper presents a neural network-based model that predicts food items from images and estimates their caloric content. Using a dataset of 23,000 images across 23 food categories, the model, trained with CNNs using Inception V3, achieved 89.48% accuracy.)

3. Food image recognition and calorie prediction using deep learning approach: Gayatri B. Ardad, Dipak B. Gunjal, Ajay S. Sonawane, Aparna Bagde

With rising health concerns related to obesity and overeating, people are increasingly cautious about their diets to prevent diseases like hypertension, diabetes, and heart issues. To help monitor calorie intake, this report proposes a deep learning-based food recognition system that analyzes images to predict calorie content. The system classifies food items, detects surface area, and calculates calories using deep learning algorithms, helping users track their daily intake and distinguish between healthy and unhealthy foods.

4. Food Item Recognition with Calorie Estimation: Kumari Tanya

This report proposes a food recognition system that helps users monitor their daily calorie intake. The application has a user-friendly HTML frontend with JavaScript, asking for user details like gender, height, weight, and age to calculate personalized calorie recommendations. Users upload food images, which are processed by a model trained on 101 food classes with a round 95% accuracy. The system then classifies the food item and helps track calorie consumption.

5. Image-based Food Recognition and Calorie Estimation using Machine Learning: Rattikorn Sombutkaew; Orachat Chitsobhuk

A wide range of health-related innovations aims to help individuals monitor their exercise and dietary habits, promoting better health and disease prevention. This paper proposes a calorie estimation system on an Android app, where food calories are estimated using images captured by a mobile camera and segmented with a fine-tuned Mask R-CNN. The system aims to assist users in better managing their nutrition and weight.

6. NutrifyAI: An AI-Powered System for Real-Time Food Detection, Nutritional Analysis, and Personalized Meal Recommendations: Michelle Han, Junyao Chen, Zhengyuan Zhou

With diet and nutrition apps reaching 1.4 billion users in 2022 [1], it's not surprised that popular health apps, MyFitnessPal, Noom, and Calorie Counter, are surging in popularity. However, one major setback [2] of nearly all nutrition applications is that users must enter food data manually, which is time-consuming and tedious.

7. A Food Recommender System Considering Nutritional Information and User Preferences: Raciel Yera Toledo; Ahmad A. Alzahrani; Luis Martínez

The World Health Organization identifies the overall increasing of noncommunicable diseases as a major issue, such as premature heart diseases, diabetes, and cancer. Unhealthy diets have been identified as the important causing factor of such diseases.

In this context, personalized nutrition emerges as a new research field for providing tailored food intake advices to individuals according to their physical, physiological data, and further personal information.

8. Health-Aware Food Recommendation Based on Knowledge Graph and Multi-Task Learning : Yi Chen 1,Yandi Guo , Qiuxu Fan

Current food recommender systems tend to prioritize either the user's dietary preferences or the healthiness of the food, without considering the importance of personalized health requirements. To address this issue, we propose a novel approach to healthy food recommendations that takes into account the user's personalized health requirements, in addition to their dietary preferences.

II. OBJECTIVE AND SCOPE OF PROJECT

3.1 Objective of Project

- **Food Recognition:** To classify food items from images using deep learning techniques.
- **User-Friendly Interface:** To implement a seamless and interactive user interface.
- **Personalized Calorie Calculation:** To calculate daily calorie recommendations based on user details.
- **High Classification Accuracy:** To achieve approximately 95% accuracy in food classification.
- **Real-Time Calorie Estimation:** To provide real-time calorie estimates for uploaded images.
- **Support for Gallery Inputs:** To enable image uploads directly from the gallery.
- **User Engagement Enhancement:** To boost user engagement through interactive diet-tracking features.

3.2 Scope

The project aims to simplify dietary and fitness management by integrating AI-powered food recognition, calorie estimation, and personalized health recommendations. It allows users to upload food images, receive detailed nutritional analysis, and obtain tailored diet and workout plans. The system supports real-time processing, user-friendly interaction, and report generation for tracking progress, with applications in healthcare, fitness centers, and personal health management.

III. SYSTEM ARCHITECTURE

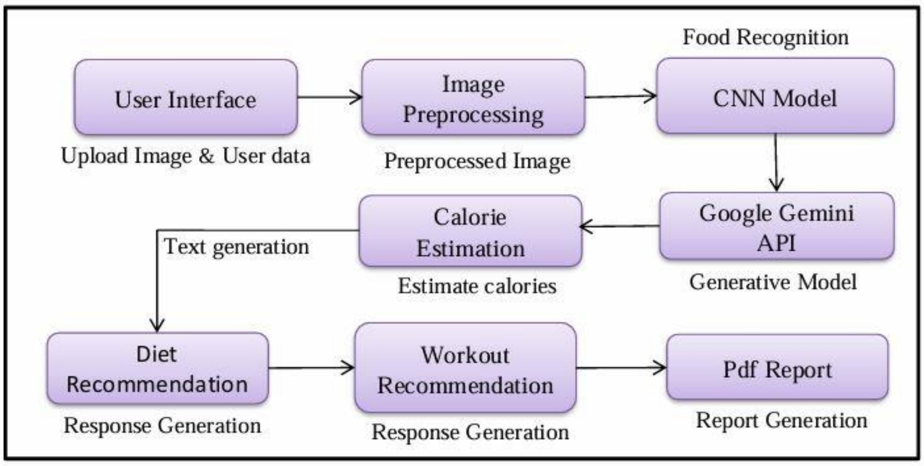

Fig.1: System Architecture

The architecture diagram illustrates a system for food recognition, calorie estimation, and personalized recommendations. Here's a concise explanation:

1. **User Interface:** Users upload food images and provide data.

2. **Image Preprocessing:** Uploaded images are prepared for analysis

3. **CNN Model:** A Convolutional Neural Network (CNN) identifies the food in the image.

4. **Calorie Estimation:** Using food recognition results, system estimates calorie content, potentially using Google Gemini API for generative tasks.

5. **Recommendations:**
   - **Diet Recommendation:** Suggestions for a diet plan are generated based on the calorie estimate and user data.
   - **Workout Recommendation:** Exercises tailored to the user's needs are proposed.

6. **PDF Report Generation**: A comprehensive report with all recommendations is created and shared with the user. This system integrates image processing, AI-based recognition, and user-centric recommendation to provide personalized health guidance.

IV. METHODOLOGY

5.1. Data Collection and Preparation

- Food Image Dataset: A diverse dataset of food images is collected from various online sources to train the food recognition model. The images are categorized by food types such as fruits, vegetables, and other common items.
- User Data Collection: The application collects user input such as age, weight, height, gender, medical conditions, and activity levels. Additionally, users can input ingredients and their measurements for more accurate calorie estimation.

5.2. Food Recognition Using Google Gemini API

- Image Preprocessing: Users upload images of food items. These images are processed and sent to the Google Gemini API for recognition.
- API Integration: The Google Gemini API is used to recognize and classify the food items from the uploaded image. The recognized items are further analysed for their nutritional value (calories, protein, carbs, etc.).

5.3. Personalized Health Recommendation System

- User Profile: Based on the user inputs (age, weight, activity level, etc.), the application creates a personalized health profile.
- Calorie Estimation: The ingredients entered by the user are analyzed by the Gemini API, helping provide accurate calorie counts and detailed nutrition information.
- Diet and Workout Recommendations: Based on the recognized food and user profile, personalized diet (meal suggestions, food to take or avoid) and workout plans (exercises, duration) are generated.
- Body Mass Index (BMI) and Body Fat Percentage (BFP): The system calculates the user's BMI and BFP based on their physical data to give more accurate recommendations

5.4. Report Generation and Output

- PDF Report Generation: Once the recommendations are generated, the system produces a downloadable PDF report summarizing the user's health insights, including food recognition results, nutrition analysis, and personalized recommendations.
- User Interface: The app provides an easy-to-use interface with a file uploader for images, input fields for personal data, and buttons for submitting requests for food recognition and recommendations.

5.5. System Integration

- Frontend (Streamlit): The Streamlit framework is used for building the frontend, where users interact with the system. It allows for real-time image uploads, data input, and display of results.
- Backend (Google Gemini and TensorFlow): The backend integrates Google Gemini API for food recognition and personalized recommendations. TensorFlow was initially used for CNN-based food recognition, but this has been replaced by Gemini for food recognition.

5.6. Testing and Validation

- Model Validation: The system is tested for various food types and ingredient combinations to ensure accuracy in recognition and calorie estimation.
- User Testing: The application is tested with real users to gather feedback and ensure that the recommendations are relevant and helpful.

5.7. Deployment

- Cloud Deployment: Once the application is fully tested, it is deployed on a cloud platform (e.g., Streamlit Sharing, AWS) for easy access by users worldwide.

V. System Requirements

6.1.Hardware Requirement

- CPU: Intel i5/Ryzen 5 or better recommended).
- GPU: NVIDIA MX 250 or better
- RAM: At least 8 GB
- Storage: SSD with sufficient space for datasets and model files (at least 50 GB free space).

6.2.Software requirements

- Dataset: Food Images Kaggle dataset
- Operating System: Windows 10
- Programming Languages: Python, HTML, CSS
- Libraries and Frameworks: NumPy, Pandas, Streamlit
- Development Environment: Visual Studio

VI. Results and Discussions

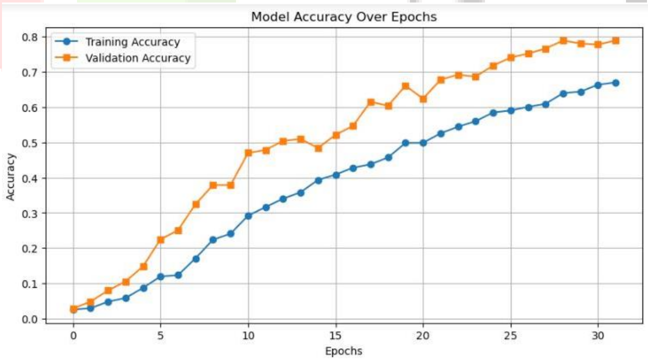

Fig.2: Model accuracy over epochs

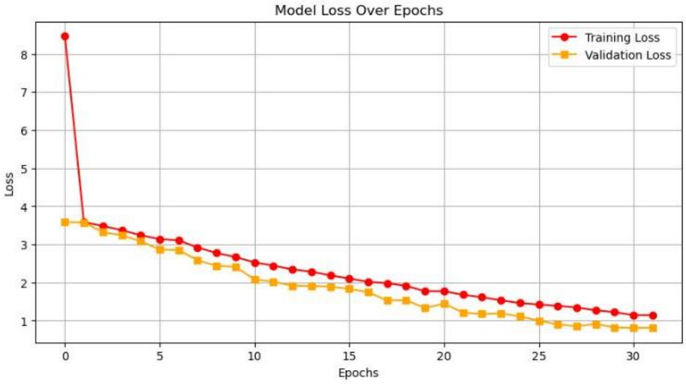

Fig.3: Model loss over epochs

7.1. Accuracy Trends

The training and validation accuracy curves (Figure 1) indicate a steady improvement over the 30 epochs. Validation accuracy surpasses training accuracy, peaking at around 80%, suggesting the model generalizes well but might also be slightly overfitting due to the gap between the two accuracies.

7.2. Loss Trends

The training and validation loss curves (Figure 2) show a sharp decline in the initial epochs, stabilizing around epoch 25. The validation loss consistently remains below training loss, implying effective learning and good generalization performance. However, the difference may suggest some regularization could improve the results further.

7.3. Observations

The model's ability to reduce validation loss and increase accuracy indicates the selected deep learning architecture and hyperparameters are largely appropriate. Fine-tuning the learning rate or adding dropout layers may help narrow the gap between validation and training accuracy.

7.4. Overall Evaluation

The performance curves demonstrate that the model successfully learned the key features of the dataset, enabling it to make accurate predictions while avoiding significant overfitting. The results are promising for real-world deployment with further refinements.

7.5. Discussion

The system bridges the gap between manual calorie tracking and automated health insights, providing a unique solution for dietary and fitness management. While the dependency on an external API (Google Gemini) limits offline functionality, the trade-off is offset by its robust performance in food recognition and recommendation generation. Future improvements could include offline capabilities using pre-trained local models or expanding the scope to support multilingual interfaces for broader accessibility. The results validate the system's capability to assist users in maintaining a balanced lifestyle, making it a valuable tool for personal health management and potential applications in healthcare and fitness industries.

VII. USER INTERFACE

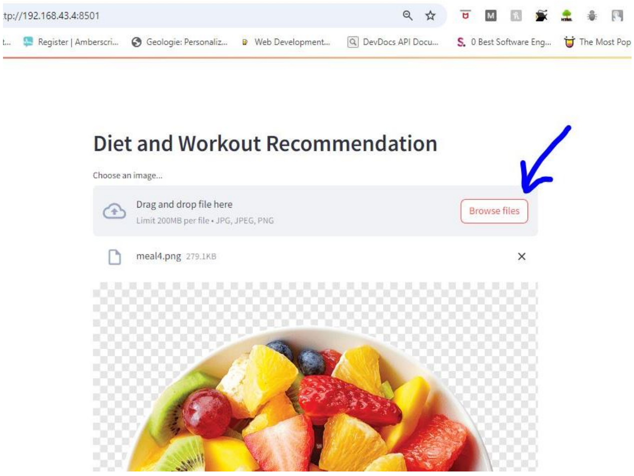

Fig.4: Upload Image

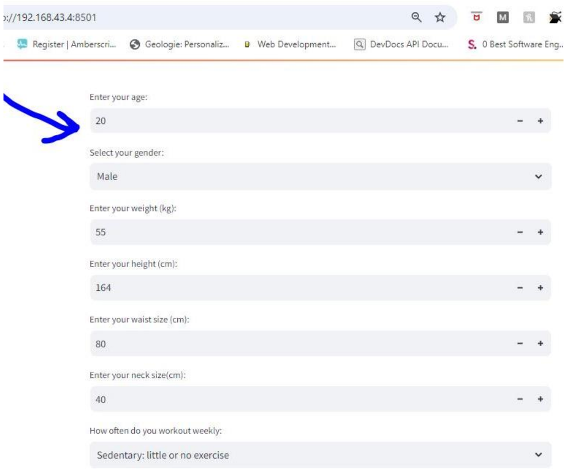

Fig.5: Upload User Data

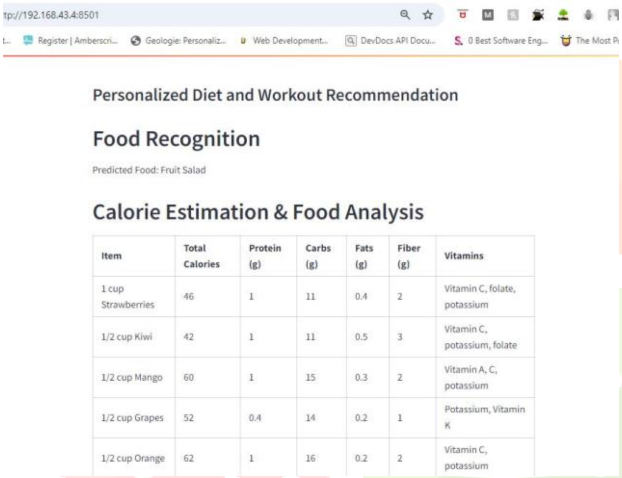

Fig.6: Food Recognition

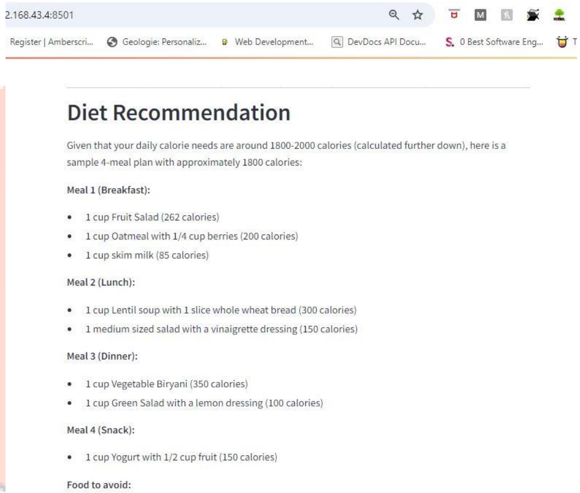

Fig.7: Diet Recommendation

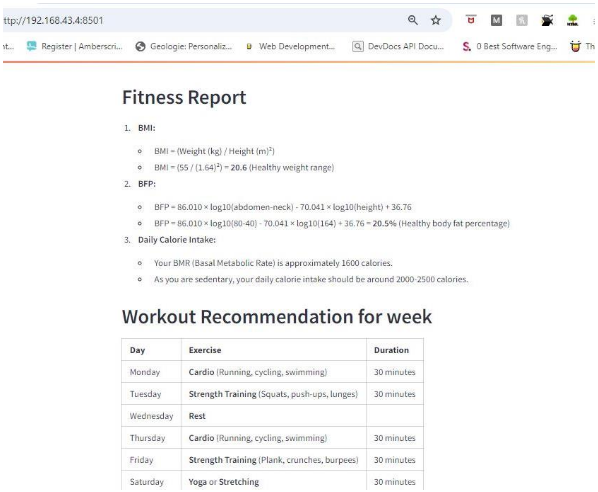

Fig.8: Workout Recommendation

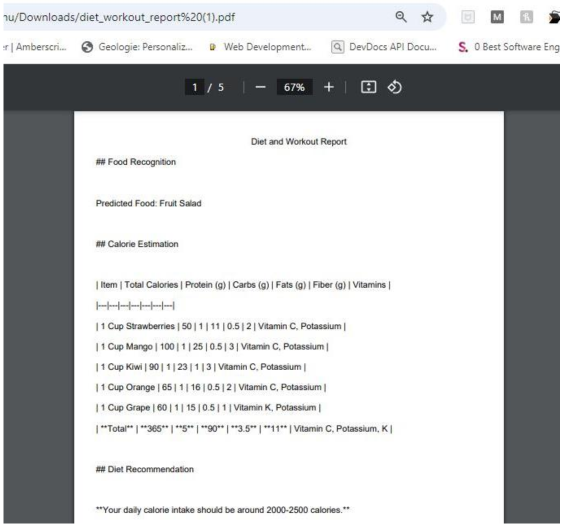

Fig.9: Report Generation

VIII. Advantages and Disadvantages

9.1. Advantages

- Provides accurate food recognition and calorie estimation.
- Offers personalized diet and fitness recommendations.
- Enhances user experience with a downloadable health report.

9.2. Disadvantages

- Dependence on the Gemini API limits offline functionality.
- Accuracy is reliant on the quality of uploaded images.
- System requires internet connectivity for API-based operations.

IX. Conclusion

This project successfully developed an automated food recognition system with personalized calorie tracking using deep learning. The system utilized a convolutional neural network (CNN) for food image classification and achieved notable results in training and validation accuracy, peaking at 80%. The validation loss consistently remained lower than the training loss, demonstrating effective learning and generalization .A user-friendly interface was implemented to ensure seamless interaction, allowing users to upload images for real-time calorie estimation. The model also incorporated features like personalized calorie recommendations based on user inputs such as gender, weight, height, and age. By supporting gallery inputs and providing intuitive diet tracking functionalities, the system enhanced user engagement. The project outcomes indicate that the proposed solution is effective in identifying food items and estimating their caloric content. It holds significant potential for aiding individuals in maintaining a healthy diet and preventing lifestyle-related health issues.

Future work could focus on expanding the food dataset, improving classification accuracy, and incorporating more advanced features such as dietary recommendations or multi-food item recognition. Overall, the project successfully achieves its objectives and sets a foundation for scalable and impactful health-tech applications.

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