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KASABA BAWADA, KOLHAPUR

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence & Machine Learning)

Synopsis

on

"Automated food recognition for personalized calorie tracking"

Presented by

Sr.No.	Student Name	Roll No.
1	Shantanu Chougule	71
2	Abhijeet Jainapure	67
3	Swapnil Alange	60
4	Aditya Patil	56
5	Gourav Kumbhar	52

B.Tech Sem - VII

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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2024-2025 Sem-VII

A Project - III
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1. Introduction

Food recognition systems have a significance beyond personal health benefits; it is a way of utilizing technology to address public health challenges. It is no secret that obesity and diabetes are among the most common diet-related illnesses today. Hence, there is an urgent need for tools which can enable individuals to make healthier food choices on their own. Food recognition systems provide real-time calorie input feedback thus users are able to take control over their diets in an intuitive manner and backed with scientific facts. This will ensure that dietary management becomes available to many especially now when lifestyle diseases are rising day by day.

More so, these systems' amalgamation with mobile phones enhances their usability. With smartphones being everywhere around the world, anybody can get access to food recognition applications at any moment regardless of where they are or how busy they might be leading hectic lives filled with lots of activities including work. This kind of convenience appeals more to younger generation since they are familiar with using digital gadgets in managing their health. On top of that as these systems develop over time it would be possible for them accommodate different dietary needs such as ones having specific nutrient requirements and allergies towards certain types of foods.

One of the most promising aspects of food recognition systems is their potential for continuous improvement through machine learning. As more users interact with these systems, the data collected can be used to refine the algorithms, leading to even more accurate food identification and calorie estimation. This iterative process ensures that the system remains up-to-date with new food items and changing dietary trends, making it a dynamic tool that adapts to the evolving needs of its users. Furthermore, the integration of advanced technologies such as augmented reality (AR) and artificial intelligence (AI) could open new possibilities, such as providing users with visual portion size estimates or suggesting healthier alternatives in real-time.

The impact of such innovations is not limited to individual users. On a larger scale, data gathered from these systems can provide valuable insights into population-wide eating habits, informing public health policies and initiatives. For instance, aggregated data could help identify regions with high consumption of unhealthy foods, enabling targeted interventions to promote healthier eating habits. This intersection of personal health tracking and public health research highlights the far-reaching implications of food recognition systems in shaping a healthier society.

Apart from their contribution to health, food recognition systems are also able to ensure environmental sustainability. With these systems tracking food consumption patterns, users can be more aware of their portions and habits hence reducing food wastages. Moreover, they make people become aware of the environmental impacts of different foods thus directing them to more sustainable decisions concerning diet. As the worries regarding climate change and depletion of resources increase, the role that technology plays in promoting both health and ecological accountability assumes greater significance.

At the end of it all therefore, food recognition systems converge technology with health and sustainability providing a holistic solution to some of world's most pressing issues. In other words they enable achieving individual control over one's own health with an emphasis on larger public health goals as well as enhancing environmental conservation by making calorie counting and dietary management more accessible. The evolution of these systems will undoubtedly highlight how we would approach food and nutrition in the coming years while they remain pivotal in future health technology.

Beyond the immediate benefits of food detection and calorie estimation, food recognition systems also play a pivotal role in promoting long-term healthy eating habits. By consistently tracking dietary intake, these systems can identify patterns in a user's food choices, such as a tendency towards high-calorie or less nutritious foods. This information is invaluable for individuals aiming to prevent diet-related conditions like obesity, diabetes, and cardiovascular diseases. The system acts as a proactive tool, empowering users to make informed dietary decisions and avoid potential health risks.

Inspired by these benefits, our project aims to develop a comprehensive food recognition system that not only detects food items from images but also provides accurate calorie values associated with them. The system is trained on a diverse dataset of food items, utilizing the combined power of CNNs for feature extraction and SVMs for classification. By categorizing food items into groups such as burgers and pizzas, our system offers a robust solution for individuals looking to monitor their diet while promoting overall health.

In conclusion, the creation of a food recognition system for personalized calorie tracking represents a significant advancement in dietary management technology. These systems democratize the process of food intake monitoring by integrating cutting-edge image recognition techniques with user-friendly platforms. As society continues to prioritize health and well-being, innovations like these will become increasingly essential in helping individuals achieve their dietary goals and maintain a healthier lifestyle.

2. 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; Fahad Hossain.

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 around 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 Techniques:

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. Various machine learning methods, including Deep Neural Networks, were used for calorie estimation, with the Deep Neural Network providing the most accurate results and lowest error rate. The system aims to assist users in better managing their nutrition and weight.

3. Problem Statement

The growing prevalence of obesity and diet-related health issues, such as hypertension, diabetes, and cardiovascular diseases, underscores the urgent need for tools that help individuals monitor and manage their dietary intake. Traditional methods of calorie tracking are often cumbersome and prone to inaccuracies, making it difficult for people to consistently adhere to healthy eating habits. This project aims to address this challenge by developing a food recognition system that uses deep learning techniques to automatically identify food items from images and estimate their caloric content. By leveraging a simple frontend and a highly accurate machine learning model, the system will provide users with personalized dietary recommendations based on their individual characteristics such as gender, height, weight, and age. The goal is to create a user-friendly and scalable solution that empowers individuals to take control of their health by easily tracking their daily calorie intake.

4. Objectives

The following are the objectives of automated food recognition for personalized calorie tracking:

1. **Food Recognition:** To Develop a food recognition system using deep learning techniques to classify food items from images.
2. **User-Friendly Interface Implementation:** To Implement a user-friendly interface for seamless interaction.
3. **Personalized Calorie Calculation:** To Calculate personalized daily calorie recommendations based on user details such as gender, height, weight, and age.
4. **High Classification Accuracy**: To Achieve high accuracy in food classification, targeting around 95% accuracy.
5. **Real-Time Calorie Estimation**: To Enable users to upload images and receive real-time calorie estimates.
6. **Support for Gallery Inputs**: To Ensure the system supports gallery inputs for image uploads.
7. **User Engagement Enhancement:** To Enhance user engagement by offering intuitive and interactive features for diet tracking.

5. Methodology

The proposed food recognition system for personalized calorie tracking employs a systematic approach involving several key steps, as outlined in the flowchart provided.

Fig 5.1 Methodology

1. **Data Collection and Preparation**

- Data Collection: Gather a comprehensive dataset of food images across various categories. This dataset should be diverse, including different angles, lighting conditions, and portion sizes to ensure robustness in the recognition model.
- Data Annotation: Label the collected images with the appropriate food categories and corresponding calorie information. Use bounding boxes to annotate different food items within the same image.
- Data Augmentation: Apply data augmentation techniques such as rotation, scaling, and flipping to increase the diversity of the training set, improving the model's ability to generalize.

2. **Food Image Segmentation**

- Image Preprocessing: Convert images to a consistent format and size suitable for processing by the segmentation model. Normalize pixel values and apply filters to enhance important features.
- Segmentation Model Development: Develop a segmentation model to identify and isolate food items within an image. Utilize convolutional neural networks (CNNs) for this task, employing a model architecture like U-Net for precise segmentation.
- Training and Validation: Train the segmentation model on the annotated dataset, using a portion of the data for validation to ensure that the model does not overfit and generalizes well to new images.

3. **Food Portion Recognition**

- Portion Size Estimation: Implement algorithms to estimate the portion size of each segmented food item. This can involve calculating the area of the food item in the image and correlating it with real-world portion sizes using reference objects within the image.

- Calibration with Real-World Data: Use a calibration dataset with known portion sizes to refine the estimation algorithms, ensuring that they provide accurate measurements across different food types.

4. Food Image Classification

- Model Training: Train a deep learning model, such as a CNN, to classify segmented food items into predefined categories. Use the annotated dataset to teach the model to distinguish between similar-looking food items.
- Accuracy Optimization: Fine-tune the model parameters to achieve a classification accuracy of around 95%. Techniques like transfer learning with a pre-trained model (e.g., Inception V3) can be used to enhance performance.

5. Calorie and Nutrition Estimation

- Calorie Calculation Algorithms: Develop algorithms to estimate the calorie content of the identified food items based on their portion sizes and classification. The algorithms will use a database of calorie information for different food types.
- Nutritional Information Integration: Integrate additional nutritional information, such as macronutrient content (proteins, fats, carbohydrates), to provide users with a comprehensive overview of their food intake.

6. User Interface and Experience

- Interface Design: Design a user-friendly interface that allows users to easily upload images, view results, and navigate through the system. The interface should be intuitive, with clear instructions and feedback mechanisms.
- Real-Time Processing: Ensure the system processes images in real-time, providing instant feedback on calorie and nutritional content. Optimize the backend to handle multiple user requests efficiently.

7. Testing and Validation

- System Testing: Conduct extensive testing to validate the accuracy of food recognition, portion estimation, and calorie calculation. Use a diverse set of test images to evaluate the system's performance across different scenarios.
- User Testing: Perform user acceptance testing (UAT) with a group of potential users to gather feedback on the system's usability and accuracy. Make necessary adjustments based on the feedback.

8. **Deployment and Scalability**

- System Deployment: Deploy the system on a scalable platform that can handle varying loads, such as AWS or Google Cloud. Ensure that the system is secure and can protect user data.
- Scalability Planning: Design the system architecture to support future scalability, allowing for the addition of new features, more food categories, or increased user traffic without degrading performance.

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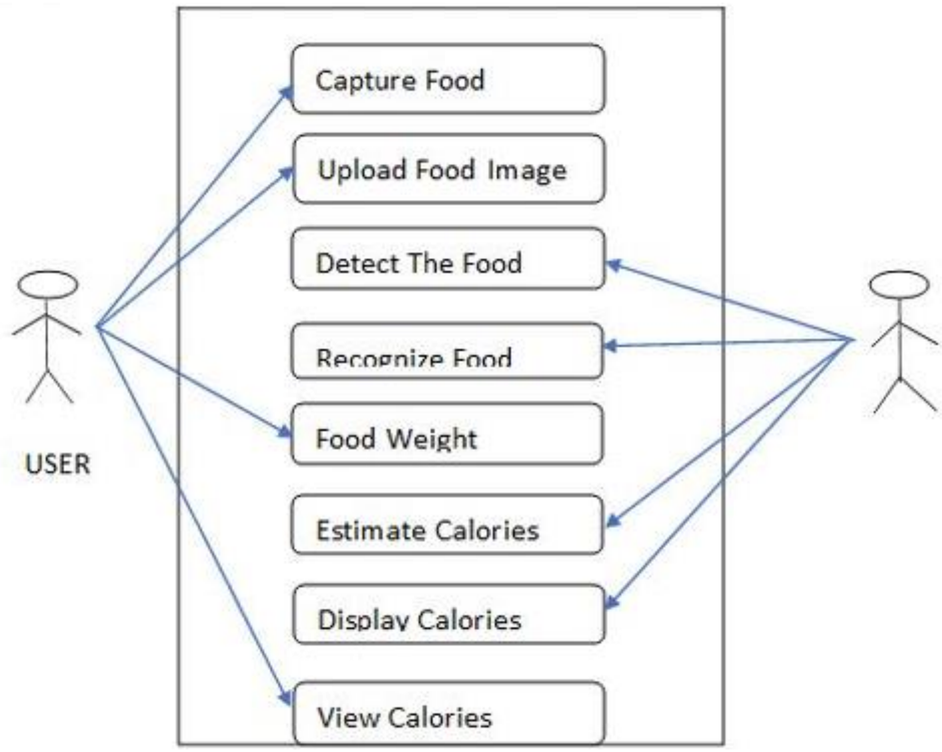


Fig 5.2 Use Case diagram

The use case diagram provides a clear visual representation of the interaction between the user and the food recognition system, outlining the system's core functionalities. It starts with the user capturing or uploading a food image, which is then processed by the system to detect and recognize the food items present. The system calculates the food's weight, estimates the associated calories, and displays this nutritional information back to the user. Each step in the diagram is connected, showing how the system processes the user's input through multiple stages to deliver accurate calorie tracking.

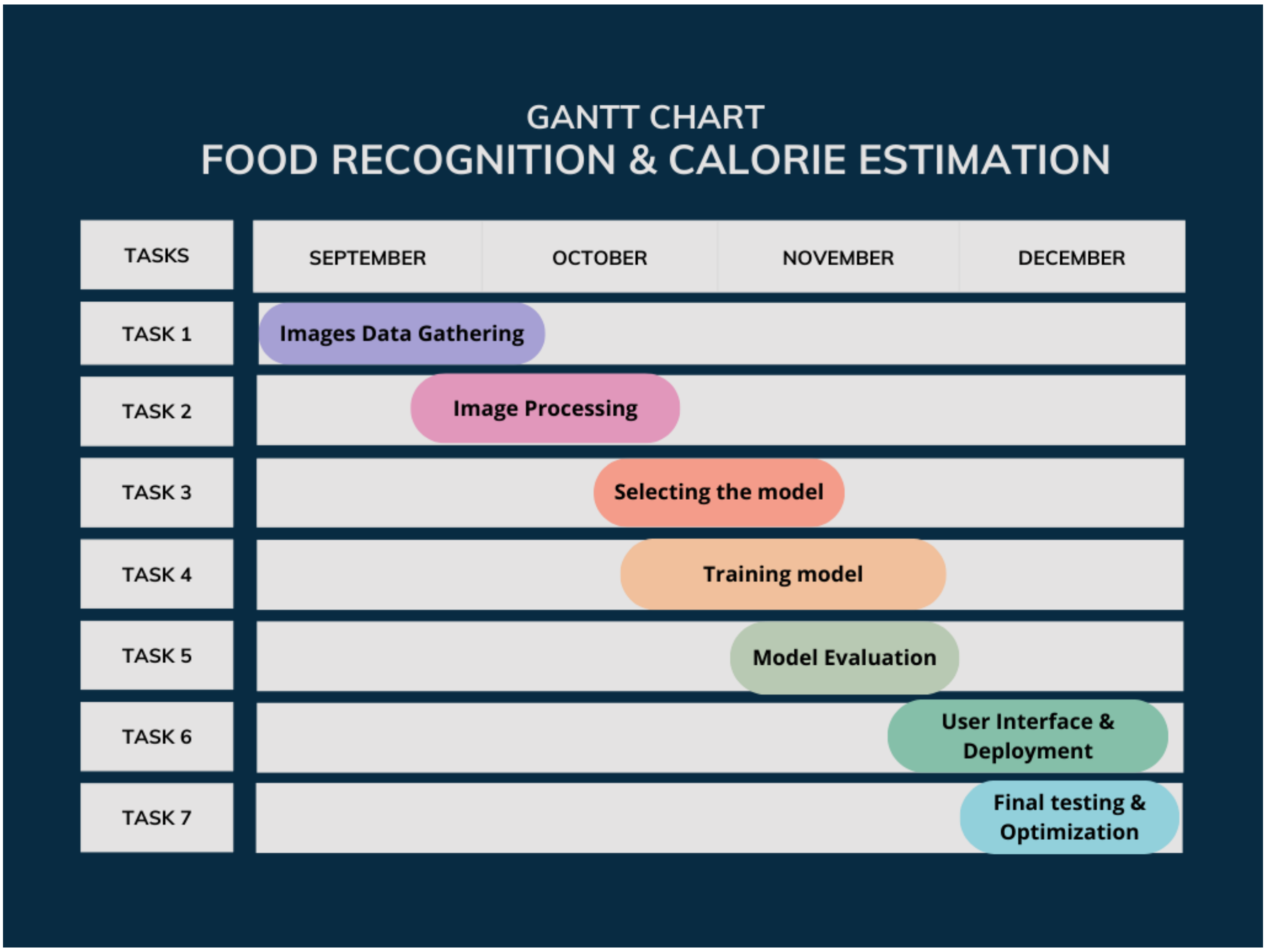
The user is at the centre of the process, highlighting the system's user-centric design. Additionally, the diagram reflects the system's ability to handle various tasks in a sequential and integrated manner, ensuring that the user experience is smooth and intuitive. The use case diagram also suggests the potential for future scalability, where new features or enhancements can be incorporated without disrupting the existing workflow. This structure ensures that the system remains adaptable and capable of meeting evolving user needs.

6. System Requirements

1. **Hardware requirements:**
   - 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).

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

7. Project Schedule (Timeline)



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Date:

Place: Kolhapur

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Remarks by Project Guide :(Accepted/Rejected/Suggested for Corrections)

Remarks by Project Panel: (Accepted/Rejected/Suggested for Corrections)

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