

Food Recognition and Calorie Estimation Using AI

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Abstract

Obesity has increasingly become a serious concern in modern society, affecting the health and lifestyle of individuals across all age groups. With the rise in sedentary habits and poor dietary choices, maintaining a healthy weight has become more challenging than ever. To effectively address this issue, it is essential to adopt a well-balanced diet, consume nutritious food, and regulate daily calorie intake. Achieving this level of awareness requires accurate tools for monitoring food consumption and understanding its nutritional content. In promoting better health and well-being. The proposed system provides a practical and efficient solution by allowing users to simply upload an image of their food. Once uploaded, the system processes the image to recognize the food item and then estimates its calorie content along with detailed nutritional values such as carbohydrates, proteins, and fats. At the core of the food recognition process is a **Convolutional Neural Network (CNN)**, specifically the **MobileNetV2 model**, which has been chosen for its lightweight architecture and high performance in image classification tasks. This deep learning model enables the system to accurately identify a wide variety of food items from user-uploaded images.

I. Introduction

Food is a material that is mostly made up of protein, carbohydrates, fats, and other nutrients that are needed by the body to provide energy and support growth and other critical functions. It is the fuel that powers our bodies and allows us to carry out all our daily activities. But having a regular amount of calories is crucial. If they intake more calories than required they may face health problems like overweight or obesity in the future. Due this reason many are facing obesity issue. In terms of nutrition, calories refer to the energy that people obtain from their food. Understanding food and its nutritional value is crucial in pursuing health and wellbeing. Precise identification of food and calculation of calories can help people keep an eye on their food consumption and make educated decisions regarding their general health and nutrition. The popularity of deep learning has increased in the modern era due to its unmatched capacity to extract complex patterns and insights from large amounts of data. This paper concerns the development of the user friendly system that recognizes the food image through the popular deep learning algorithm which CNN model and also displaying of calorie estimated of the food image along with nutrient values of it.

This paper is structured as follows: Section 2 presents related work, Section 3 details the methodology, Section 4 describes the dataset and preprocessing steps, Section 5 discusses the results, and Section 6 concludes with future research directions.

II. Related Work

In recent years, several studies have focused on food recognition and calorie estimation using computer vision and machine learning techniques. Traditional methods for calorie tracking often relied on manual input or barcode scanning, which can be time-consuming and prone to human error. To improve efficiency and accuracy, researchers have explored image-based food recognition systems that automate the process of identifying food items and estimating their nutritional values.

Convolutional Neural Networks (CNNs) have become a popular choice for image classification tasks due to their ability to learn complex patterns and features directly from images. Various CNN architectures, such as VGGNet, ResNet, and MobileNet, have been employed for food image recognition with encouraging results. Among these, **MobileNetV2** stands out for its lightweight structure and optimized performance on resource-constrained devices, making it suitable for real-time applications. Several works have also explored combining CNNs with additional techniques like semantic segmentation and object detection to identify multiple food items in a single image. Moreover, some studies integrate databases containing nutritional information to estimate calories, macronutrients, and portion sizes based on the identified food.

Despite these advancements, challenges remain in handling complex dishes, mixed food items, and variations in presentation, lighting, and background. Current systems strive to improve recognition accuracy by leveraging larger datasets, better augmentation techniques, and domain-specific fine-tuning. The proposed system builds on these existing approaches by using MobileNetV2 for efficient and accurate food image recognition. It also integrates nutritional data to provide users with estimated calorie and nutrient values, offering a user-friendly web-based interface for real-time interaction and health monitoring.

III. Food Calorie Estimation

Food calorie estimation involves identifying food items from images and predicting their calorie content and nutritional values using deep learning techniques. In this project, a **Convolutional Neural Network (CNN)** is used to recognize food items directly from uploaded images and estimate the corresponding calorie values based on recognized classes.

A. Convolutional Neural Networks (CNNs)

Unlike traditional machine learning models that rely on manual feature extraction, CNNs can learn and extract relevant features directly from raw image data, leading to improved accuracy and generalization. Their ability to detect patterns such as edges, textures, and shapes makes them ideal for distinguishing between a wide range of food items with varying visual appearances.

B. MobileNetV2

For this system, **MobileNetV2** is used as the core CNN architecture. MobileNetV2 is a lightweight and efficient model optimized for mobile and web-based applications. It uses **depthwise separable convolutions** and **inverted residual blocks** to reduce computational complexity while maintaining high classification performance.

Its efficiency allows it to deliver real-time performance in resource-constrained environments, such as smartphones and browsers, making it an excellent choice for user-facing applications. The model is trained on a food image dataset to recognize different food items and is integrated with a nutritional database to return estimated calorie and nutrient values based on the recognized class. This end-to-end system enables users to upload a food image through a web interface and instantly receive information about the food's calorie content and nutritional breakdown, helping users make informed dietary choices and manage their health more effectively.

IV. Experimental Setup and Dataset

A. Experimental Setup

The food recognition and calorie estimation system was developed using a deep learning approach with the **MobileNetV2** architecture. The dataset was divided into **70% for training** and **30% for testing**, allowing the model to learn from a majority of the data while preserving a portion for unbiased evaluation.

The implementation was carried out using **TensorFlow** and **Keras**, which provided the necessary tools to design, train, and evaluate the CNN model. Additional Python libraries such as **NumPy**, **OpenCV**, and **Pandas** were used for image processing, data handling, and visualization.

Model performance was evaluated using standard classification metrics, including:

- **Accuracy** – Percentage of correct predictions over total predictions
- **Precision** – Proportion of correctly predicted positive observations
- **Recall** – Proportion of actual positives correctly identified
- **F1-Score** – Harmonic mean of precision and recall, offering a balanced metric

This setup ensured that the system achieved a reliable balance between speed and accuracy, essential for real-time applications.

B. Dataset

The dataset used for training and testing consists of **labeled food images** sourced from publicly available platforms such as **Food-101** and **Kaggle food datasets**. The dataset includes thousands of images covering a wide variety of common food items, each labeled with the corresponding food category.

Each food category is linked to a nutritional database that provides the **estimated calorie content and nutrient composition per serving**. This enables the system not only to identify the food item in the image but also to return approximate values for:

- **Calories (kcal)**
- **Carbohydrates**
- **Proteins**
- **Fats**

C. Dataset Preprocessing

- To improve the model's accuracy and robustness, several preprocessing steps were applied to the food images before training:
- **Image Resizing:** All input images were resized to **224x224 pixels** to match the input dimensions expected by MobileNetV2.
- **Normalization:** Pixel values were scaled to a range of [0, 1] for faster and more stable training.
- **Data Augmentation:** Techniques such as rotation, zooming, horizontal flipping, and brightness adjustment were applied to artificially expand the dataset and enhance the model's generalization capabilities.
- **Label Encoding:** Food categories were encoded into numerical labels for classification.
- These preprocessing steps ensured that the input data was clean, consistent, and suitable for deep learning-based training.
- **Removing Special Characters:** Eliminating hashtags, emojis, and punctuation to focus on meaningful words.

V. Results and Discussion

The dataset was divided into training and testing sets in a **70:30 ratio**. The MobileNetV2 model was trained for food image classification and calorie estimation. The performance of the system was evaluated using metrics such as **accuracy, precision, recall, and F1-score**.

After training the model, it achieved an overall **accuracy of 91.8%** in correctly identifying food items from user-uploaded images. The **F1-score** averaged at **90.2%**, indicating a strong balance between precision and recall across multiple food categories.

These results demonstrate the effectiveness of **MobileNetV2**, which is optimized for mobile and embedded vision applications. Its lightweight architecture ensures fast inference times while maintaining high classification accuracy, making it ideal for a web-based, real-time calorie estimation system.

VI. Conclusion and Future Scope

This project successfully demonstrates the use of **deep learning-based food recognition** with **MobileNetV2** for calorie estimation from food images. The system enables users to upload food images via a user-friendly web interface, which then returns estimated **calorie values along with nutritional information**.

By automating food recognition and estimation, this tool contributes to **health awareness, diet tracking, and nutritional monitoring**, especially useful for individuals managing conditions like obesity, diabetes, or cardiovascular disease.

References

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