IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 12, Issue 5, May 2025

DOI: 10.17148/IARJSET.2025.125356

"Food Recognition and Calorie Estimation"

Dr. Madhan Kumar G S[1], Mr. Charan S[2], Mr. Darshan N[3], Ms. Spoorthy R S[4], Ms. Sriya S[5]

Assistant Professor, Dept. of computer Science and Engineering, Maharaja Institute of Technology, Thandavapura[1]

Students, Dept. of computer Science and Engineering, Maharaja Institute of Technology Thandavapura[2-5]

Abstract: This project offers a new system for rapid and accurate food recognition and calorie estimation, increasingly important for personalized health and nutrition management. It utilizes a fine-tuned VGG16 deep learning model to classify images of common foods (like idly, dosa, rice) effectively. Following classification, the system retrieves calorie information from an Excel-based nutritional database, seamlessly linking image analysis with nutritional data. An intuitive Flask web application allows users to upload food images and instantly receive calorie estimations based on the identified food. This end-to-end system demonstrates the potential of combining deep learning with data-driven nutritional insights, enabling better dietary monitoring and smarter health applications.

I. INTRODUCTION

In response to the increasing emphasis on health and nutrition, diligently monitoring daily dietary intake has become crucial for fostering a balanced lifestyle. Nevertheless, the manual process of logging food consumption and its corresponding nutritional values can be both cumbersome and prone to inaccuracies. To overcome this hurdle, this initiative introduces an AI-driven Food Detection and Calorie Display system, designed to automate the identification of food and the estimation of its caloric content through the application of deep learning and a meticulously organized nutritional database.

The core of this system is a pre-existing VGG16 model, which has undergone specialized fine-tuning to accurately categorize frequently consumed food items, including but not limited to idly, dosa, and rice. Once a food item is classified, its type is cross-referenced with an Excel-formatted nutritional dataset to extract the relevant calorie information. This entire workflow is seamlessly integrated into a Flask web application, offering users the ability to upload images of their food and instantly receive both the food's classification and its associated calorie details.

The primary objective of this project is to streamline nutritional tracking and encourage healthier eating practices by offering a straightforward and automated method for estimating food calories. This application holds particular value for individuals who are health-conscious, nutritionists, and fitness enthusiasts seeking a prompt and dependable tool to evaluate their daily food intake.

II.PROBLEM STATEMENT AND OBJECTIVE

A.PROBLEAM STATEMENT

Amidst the demands of modern life, achieving a balanced diet is often complicated by insufficient understanding of food's nutritional value, rendering manual food logging and calorie estimation a cumbersome and inexact process. Current food tracking methods, dependent on manual data entry or static food databases, often lack the precision and user-friendliness needed for effective dietary management. The central problem is the automated identification of food items from visual input and the subsequent accurate determination of their caloric content without requiring user interaction. Traditional calorie estimation methods frequently fall short due to the inherent variability in food appearance, portion sizes, and presentation, the absence of automated processes necessitating manual input, and the complexities of integrating food recognition technologies with comprehensive nutritional databases for immediate and reliable calorie information. To address these challenges, this project introduces an innovative deep learning-based Food Detection and Calorie Display system. By employing a carefully fine-tuned VGG16 model, the system is designed to classify food images uploaded by users and subsequently map the identified food category to a pre-existing nutritional dataset containing detailed calorie information. This approach aims to significantly enhance the accuracy, efficiency, and overall usability of calorie tracking, thereby making dietary management more accessible and dependable for individuals striving for healthier eating habits.

B. OBJECTIVE

The primary objective of this project is to develop an automated system for the rapid and accurate identification

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of food items from digital images and the subsequent estimation of their caloric content. This will be achieved by leveraging deep learning techniques, specifically a fine-tuned convolutional neural network, to classify common food types. Following successful classification, the system aims to seamlessly retrieve the corresponding nutritional information, particularly calorie counts, from a structured digital database. The ultimate goal is to create a user-friendly application that allows individuals to effortlessly obtain calorie estimations of their meals by simply uploading food images, thereby simplifying dietary monitoring and promoting informed nutritional choices.

III.SYSTEM DESIGN

The system's functionality is logically divided into a two-stage process: a rigorous training phase and an efficient prediction phase. The training phase commences with essential preprocessing of labeled food images, ensuring data consistency and quality. Subsequently, data augmentation techniques are applied to artificially expand the training dataset and introduce variability, thereby improving the resilience and generalizability of the deep learning model. The core of this phase involves the fine-tuning of a pre-trained VGG16 convolutional neural network. This transfer learning approach leverages the rich feature representations learned by VGG16 on a massive image dataset, adapting them specifically for accurate classification of diverse food items.

The prediction phase initiates when a user uploads an image of a meal or food item. This uploaded image is then processed by the previously trained and fine-tuned VGG16 model, which performs real-time classification to identify the food present. Once the food item is recognized, the system queries a linked nutritional database, retrieving the associated calorie information corresponding to the classified food type. Finally, this retrieved calorie data is presented to the user through the intuitive Flask web interface. The system's architecture is deliberately designed with modularity in mind, allowing for independent updates and expansions of its components, such as the deep learning model or the nutritional database. Furthermore, the Flask framework ensures seamless and responsive real-time interaction, providing users with immediate feedback on their uploaded images, including both the food classification and its estimated calorie content. This end-to-end design prioritizes accuracy, efficiency, and a positive user experience for dietary monitoring.

IV METHODOLOGY

T This project presents an automated deep learning system for recognizing food in images and estimating its caloric value. A curated dataset of frequently consumed foods, such as idly, dosa, and rice, was assembled and meticulously labeled with both their food category and corresponding calorie data. To enhance the model's robustness and ability to generalize, image augmentation and essential preprocessing steps were applied to the dataset. At the core of the system is a VGG16-based convolutional neural network, which serves to extract relevant visual features from the input images and subsequently classify the identified food item. The predicted food category is then utilized to query a linked nutritional database, enabling the retrieval of its associated calorie information. A user-friendly web application, built using the Flask framework, provides an intuitive interface where users can upload images of their meals and instantly receive both the identified food type and its estimated calorie count. The system's operational process, encompassing image analysis, food classification, calorie data retrieval, and presentation, can be precisely described through algorithms and effectively visualized using flowcharts.

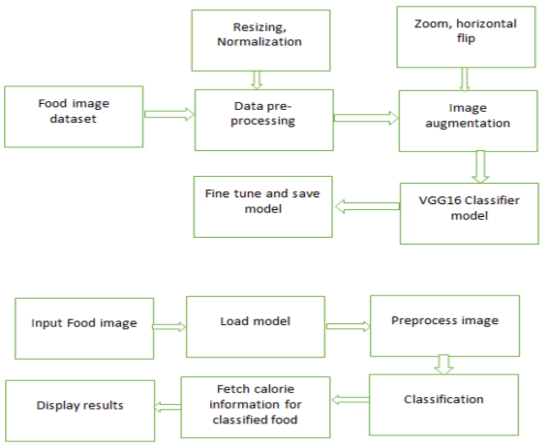

Fig: - Flow Chart.

Step 1: User uploads a food image through the web application.
Step 2: The uploaded image is received by the Image Input module.

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Step 3: The image undergoes cleaning and formatting in the Preprocessing Module.
Step 4: The preprocessed image is then fed into the trained food classification model.
Step 5: The model identifies the food type present in the image.
Step 6: The identified food type is used to retrieve calorie information from the Nutritional Data module, and the results are prepared for display.
Step 7: The identified food type and its estimated calorie content are displayed to the user.

V. IMPLEMENTATION

The implementation of this food recognition and calorie estimation system involved the integration of data preprocessing, model training, and deployment into a cohesive pipeline. Python served as the primary programming language, leveraging libraries such as PyTorch for constructing and training the deep learning model, OpenCV and PIL for image manipulation, and NumPy and Pandas for data management. The core of the model is based on the VGG16 architecture, adapted with a classification output head tailored for food category prediction. This design enables efficient feature reuse from the shared feature extractor. A consolidated training script was developed to calculate and propagate the loss, ensuring synchronized learning for the food classification task.

Following the training and validation of the VGG16 model, it was saved and deployed within a Flask-based web interface for real-time interaction. This interface allows users to upload food images, which are then processed on the server side to generate predictions. The application is designed to be intuitive and user-friendly, requiring no specialized technical knowledge, thus making it accessible to a broad range of users interested in dietary monitoring. Furthermore, utility scripts were developed for tasks such as image preprocessing, visualizing training progress, and evaluating the model's performance on unseen data. The modular design of the system facilitates easy updates and the addition of new features without necessitating a complete overhaul of the codebase.

VI. SYSTEM REQUIREMENTS

Installation of the seed germination forecasting system needs to have a configuration to facilitate deep learning model building, training, and deployment. At least a system with an Intel i5 processor, 8 GB of RAM, and 10 GB disk space available will suffice to operate the application and make inferences. But for efficient training of the model, particularly when dealing with big data or in multi-task learning, a system with an Intel i7 or AMD Ryzen 7 processor, 16 GB RAM, and an NVIDIA GPU with CUDA support (like GTX 1660 or RTX 2060) is preferred. Solid-state storage is also recommended to enhance data loading and training speeds.

On the software front, the system is developed based on Python (version 3.8 or later) and is dependent on a number of important libraries like PyTorch for deep learning, torchvision for image data handling, and Streamlit for constructing the web-based UI. Other dependencies are NumPy, Pandas, OpenCV, Pillow for image handling, scikit-learn for ancillary machine learning functions, and Matplotlib for training visualization. The software can operate on significant operating systems, such as Windows, Linux (Ubuntu 20.04+), and macOS. Access to the user interface requires a contemporary web browser, with the system being easily accessible across platforms with little configuration.

VII. CONCLUSION

In this project, a deep learning-based food detection and calorie estimation system has been developed using the VGG16 model. The system is designed to help users monitor their dietary intake by identifying food items from images and retrieving corresponding calorie information stored in an external dataset. By leveraging the power of convolutional neural networks (CNNs), the model achieves high accuracy in food classification, enabling reliable calorie estimation for common food items such as idly, dosa, and rice.

The integration of this model into a Flask-based web application ensures a user-friendly interface, allowing users to upload food images and receive instant classification results along with calorie details. This system has significant potential for promoting health-conscious eating habits, aiding individuals in maintaining balanced diets, and assisting those managing health conditions such as obesity and diabetes. While the current model performs well in recognizing common food items, future enhancements could include expanding the dataset to cover a broader range of foods, improving classification accuracy through advanced deep learning architectures, and incorporating portion size estimation for more precise calorie calculation. Additionally, integrating real-time food detection using mobile applications can further enhance the system's usability and accessibility.

VIII. FUTURE ENHANCEMENTS

Future enhancements for this project aim to expand its capabilities and user value in several key areas. One crucial direction involves broadening the range of recognizable food items by incorporating more diverse datasets and

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potentially exploring more advanced deep learning architectures capable of finer-grained food classification, including variations in preparation methods and specific ingredients within composite dishes. To improve accuracy in calorie estimation, future work will focus on integrating techniques for portion size estimation from images, moving beyond reliance solely on the identified food type.

Furthermore, the system could be enhanced by incorporating user personalization features, such as the ability to track dietary history, set nutritional goals, and receive personalized dietary recommendations based on their preferences and health requirements. Integration with other health and fitness tracking platforms could provide a more holistic view of the user's well-being.

From a user interface perspective, future improvements could include a more interactive and visually appealing design, potentially incorporating augmented reality features for real-time food analysis. Additionally, exploring deployment on mobile platforms would significantly increase accessibility and convenience for users.

Finally, the underlying nutritional database could be expanded and enriched with more detailed nutritional information beyond just calories, such as macronutrient and micronutrient content. Incorporating functionalities for handling regional and cultural food variations would also enhance the system's global applicability.

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