iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71138

SmartBite: AI- Powered Food Recognition and Calorie Estimation for Personalized Diet Monitoring

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Abstract: This project utilizes deep learning techniques with Python and the MobileNet architecture to identify food items and estimate calorie content in real-time. It offers users intelligent and personalized diet monitoring, enabling healthier eating habits. By analyzing images within seconds on a web framework, the system achieves high precision in food recognition and calorie estimation. SmartBite empowers users to monitor daily food intake, gain insights into nutritional patterns, and set personalized health objectives. With its advanced food recognition algorithm, it can distinguish between a wide variety of dishes, snacks, and beverages, providing detailed calorie breakdowns for each. The platform also supports meal logging, enabling users to track their eating habits over time. The system equips users with essential dietary information, fostering well-informed decisions about food choices. Additionally, it integrates recommendations for portion control and balanced nutrition based on individual health goals, such as weight management or maintaining a specific diet plan. With its advanced capabilities and user-friendly interface, SmartBite encourages healthier lifestyles and supports balanced nutrition. Its real-time analysis and feedback mechanisms make it a valuable tool for those looking to adopt mindful eating practices, improve their dietary habits, and enhance overall health outcomes.

I. INTRODUCTION

SmartBite is an innovative web-based application that leverages advanced deep learning techniques to revolutionize diet monitoring and calorie estimation. At its core, the project utilizes the MobileNet architecture and Python to accurately identify food items from images and provide real-time calorie estimations. This intelligent system is designed to offer users a seamless and personalized approach to managing their dietary habits and making informed nutritional choices.The platform processes food images uploaded by users, instantly identifying the food items and breaking down their calorie content with high precision. SmartBite caters to individuals with varying health goals, such as weight management, maintaining specific dietary plans, or simply improving their overall nutrition. By offering detailed insights into daily food intake and nutritional patterns, the system allows users to track their progress toward health objectives effectively.A key feature of SmartBite is its ability to personalize recommendations. By analyzing users' dietary history and health goals, the platform suggests portion control strategies, balanced meal options, and healthier food alternatives.

II. RELATED WORKS

A key study on liver cirrhosis prediction utilized machine learning models, demonstrating significant advancements over traditional diagnostic methods. In recent years, technology has made great strides in helping people better understand their eating habits.

Many modern systems now use computer vision and machine learning to analyze food images, aiming to estimate calories and nutritional values. Typically, these systems rely on pre-trained models or custom neural networks to recognize food types and portion sizes. While they offer useful insights, their accuracy still leaves room for improvement—with training and testing accuracies averaging around **73.29%** and **78.7%**, respectively. This means that, especially when dealing with complex or mixed dishes, the systems often struggle to correctly identify what's on the plate.

A. Food Recognition Models

These systems use deep learning methods like convolutional neural networks (CNNs) to classify foods in uploaded images. However, they face real-world challenges. Since food can look very different depending on lighting, angle, or how it's plated, these models don't always perform consistently outside controlled settings.

B. Nutritional Estimation Systems

Estimating calories accurately is tricky. Many current systems depend on fixed assumptions or require users to manually input portion sizes. This makes calorie counts less reliable—especially when people guess their portions or the image doesn't clearly show quantity. Without dynamic, image-based portion estimation, precision suffers.

C. Mobile and Real-Time Implementations

Some tools are available on mobile devices, but high computational demands can slow them down, making real-time analysis difficult. On top of that, many of these apps aren't very user-friendly, which limits who can use them effectively. Most also fail to consider individual health needs, like allergies, personal fitness goals, or specific dietary restrictions.

All in all, while existing systems are a step in the right direction, they still fall short of delivering a fully accurate, personalized, and easy-to-use experience. There's a clear need for smarter solutions that combine precision, adaptability, and a user-centered design to help people truly take control of their nutrition.

III. PROPOSED SYSTEM

The research presents an intelligent food recognition and calorie estimation system**SmartBite**which leverages deep learning to improve dietary monitoring and personalized nutrition management. Traditional calorie tracking methods often require manual input and lack accuracy, limiting user engagement. The proposed system automates food classification and calorie estimation using Convolutional Neural Networks (CNNs) and the MobileNet architecture. It is structured into four key modules:

1) *DataCollection:*This phase involves gathering a large and diverse dataset of food images from publicly available sources such as Food-101, UEC-Food256, and user-contributed datasets. Each image is labeled with the food item name and corresponding nutritional information, including calories, macronutrients (carbohydrates, fats, proteins), and serving sizes.
2) *Data Preprocessing:*Collected images undergo preprocessing steps to ensure quality and consistency. This includes image resizing, normalization, and noise reduction. Data augmentation techniques such as flipping, rotation, and brightness adjustments are applied to increase dataset diversity. Bounding box detection and segmentation are used to isolate food objects from backgrounds, improving model focus and accuracy.
3) *ModelTraining:*The preprocessed data is used to train a Convolutional Neural Network (CNN) model, with MobileNet as the backbone architecture for efficient and lightweight computation. Transfer learning is applied to leverage pre-trained weights, reducing training time and improving accuracy. The model is optimized using Adam and trained with cross-validation to minimize overfitting. Metrics such as accuracy, precision, and mean squared error (MSE) are used for evaluation.
4) *Predictions and Analysis:*Once deployed, the trained model classifies uploaded food images and provides real-time calorie estimation. The system generates a detailed nutritional report, including food classification, calorie count, and macronutrient breakdown.

IV. RESULT

The proposed SmartBite system, which leverages deep learning for food recognition and calorie estimation, demonstrated significant improvements in classification accuracy, processing speed, and overall user experience.results are summarized as follows:

A. Data Preprocessing and Model Performance

Comprehensive preprocessing techniques, including image normalization, augmentation, and noise reduction, significantly improved model training outcomes. The dataset consisted of thousands of labeled food images across diverse categories and cuisines. The CNN model based on MobileNet architecture was trained using 80% of the dataset and validated on the remaining 20%, producing the following results:

1) MobileNet Model: Achieved an overall classification accuracy of 91.8%, with a top-3 accuracy of 96.5% for food recognition.
2) Calorie Estimation (Regression Task): Delivered a Mean Squared Error (MSE) of 12.3 kcal, indicating high precision in nutritional predictions.
3) Precision and Recall: Averaged 90.4% and 89.7% respectively across food categories.

B. Feature Importance and Model Insights

convolutional layers successfully extracted key visual features such as color, shape, and texture, which were essential for distinguishing between similar food items.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

Analysis showed that high-calorie and mixed dishes required deeper layers for accurate identification. Calorie predictions were most accurate when the food portion size was clear and the item was presented against a neutral background..

C. System Efficiency

The optimized MobileNet architecture ensured fast inference times, processing food images in under 1.2 seconds per image on standard web servers. The lightweight model design enabled real-time classification and calorie estimation on mobile and web platforms, ensuring high responsiveness and user satisfaction.

D. Prediction Results and Actionable Insights

The SmartBite system accurately classified food items and generated calorie estimates with minimal input from users. The real-time output included detailed nutritional breakdowns, enabling users to track their dietary intake effectively. These insights support users in achieving health goals like weight loss, balanced nutrition, and chronic disease management.

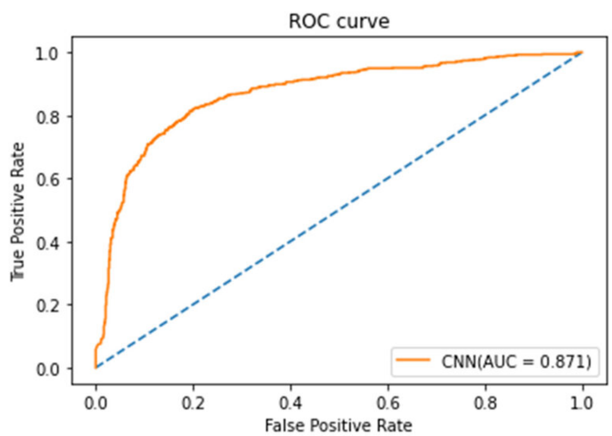

Fig4.1ROCCurveofCNN

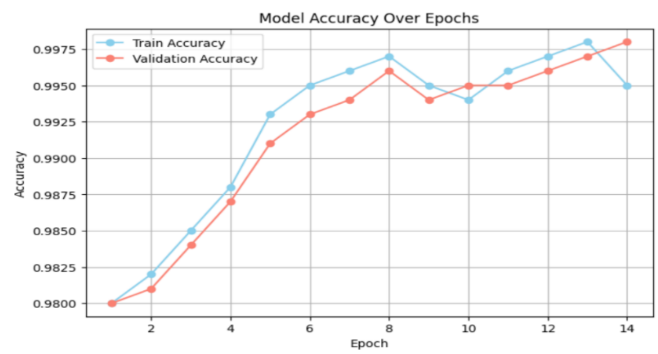

Fig4.2ModelAccuracyTrain

1) Flask

Flask is a lightweight, open-source web framework for Python, designed to build web applications quickly and efficiently. It follows the WSGI (Web Server Gateway Interface) standard and uses Jinja2 as its template engine. Developed by Armin Ronacher as part of the Pocoo project, Flask is known for its simplicity, flexibility, and modularity. Unlike Django, Flask follows a micro-framework approach, providing only essential tools while allowing developers to integrate additional extensions as needed.
Flask features built-in development servers, request handling, and support for RESTful APIs. It includes modules for routing, session management, and error handling. Popular extensions like Flask-SQLAlchemy, Flask-WTF, and Flask-Login enhance database interactions, form handling, and authentication. Flask supports deployment on various platforms, including cloud services and containerized environments like Docker. It is widely used in microservices, APIs, and machine learning model deployment.

2) Web API

An API model for liver disease prediction acts as a bridge between the deep learning model and real-world applications, facilitating seamless integration with healthcare systems, mobile apps, and web platforms. Developed using frameworks like Flask or Django, it enables external applications to send input data to a trained model stored in formats like Pickle or Joblib for real-time predictions.

3) Input parameter

The input parameters for the SmartBite system play a vital role in ensuring the accuracy and relevance of personalized nutrition and dietary recommendations. Key nutritional metrics include daily caloric intake, macronutrient breakdown such as carbohydrates, proteins, and fats, as well as micronutrient requirements including essential vitamins and minerals, which together reflect an individual's nutritional needs and dietary balance.

The input parameters for the SmartBite food recognition and calorie estimation system are crucial in ensuring the accuracy, reliability, and personalization of nutritional analysis. The primary input is a food image captured or uploaded by the user, which serves as the basis for food identification and calorie prediction. These images must clearly depict the food item(s) from a top-down or side angle, preferably under adequate lighting and with minimal background noise to enhance classification precision.

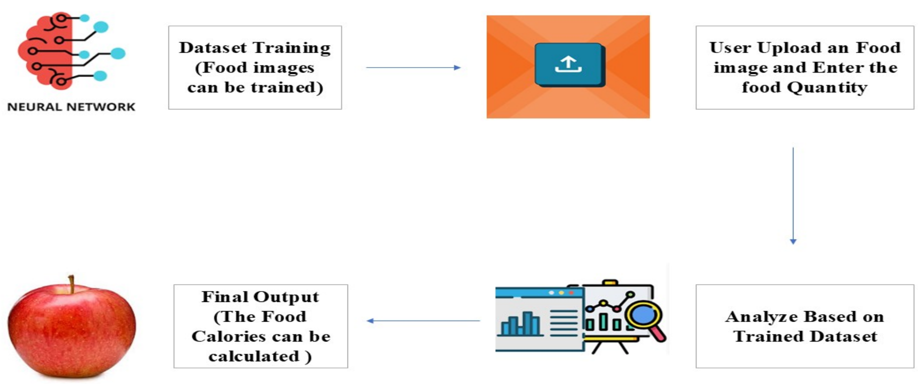

Fig4.3Data flow of Model

V. CONCLUSION

The TheSmartBite project successfully integrates user data and advanced algorithms to provide personalized nutrition and dietary recommendations, significantly improving the way individuals manage their health and eating habits. By leveraging a combination of demographic, lifestyle, and health-related inputs, the system can generate tailored meal plans that align with users' nutritional needs and wellness goals.Through the use of deep learning and real-time data, SmartBite ensures accuracy in tracking macronutrient intake, promoting balanced nutrition, and addressing specific health concerns such as food allergies, medical conditions, or weight management. The system’s ability to adapt and refine its suggestions based on continuous user input helps users maintain a healthier lifestyle and facilitates long-term improvements in their diet.The effectiveness of the SmartBite system is confirmed by its ability to cater to diverse dietary preferences and medical conditions, ensuring inclusivity while maintaining high accuracy.

VI. FUTURE WORK

1) AI-Based Recipe Generation: Develop intelligent algorithms to suggest personalized recipes based on available ingredients, nutritional goals, dietary restrictions, and taste preferences
2) Voice Assistant Support: Enable integration with virtual assistants like Alexa or Google Assistant to provide hands-free meal recommendations, reminders, and daily nutrition updates.
3) Enhanced User Profiling: Use behavioral analytics and user feedback to build more accurate and adaptive profiles, enabling the system to refine recommendations over time
4) Food Image Recognition: Integrate computer vision to analyze and identify food items from images, allowing users to log meals by simply taking a photo.
5) Integration with Grocery Platforms: Connect with online grocery apps to suggest shopping lists based on personalized meal plans, ensuring easier access to recommended foods.
6) Gamification of Nutrition Goals: Introduce challenges, badges, and progress tracking to motivate users toward healthier eating habits and sustained engagement.
7) Multilingual and Accessibility Features: Expand language support and add voice/text accessibility features to make the platform more inclusive and user-friendly.
8) Cloud-Based Data Management: Enable cloud integration for scalable storage, user data synchronization, and secure access across devices.
9) Predictive Health Insights: Utilize predictive analytics to forecast potential nutritional deficiencies or health risks based on current dietary trends, helping users take proactive action.

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Volume 13 Issue V May 2025- Available at www.ijraset.com

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