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An Integrated Artificial Intelligence Framework for Visual Food Understanding, Quality Safety Assessment, and Individualized Dietary Recommendation

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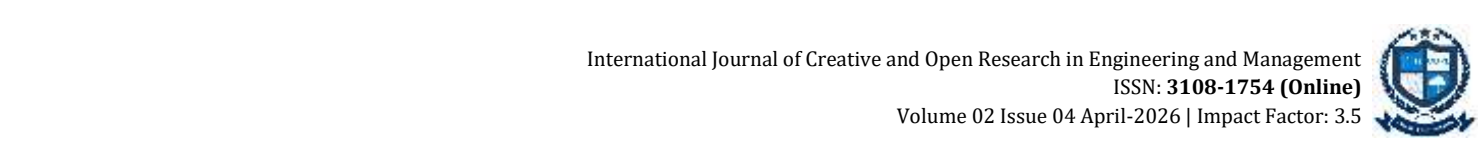
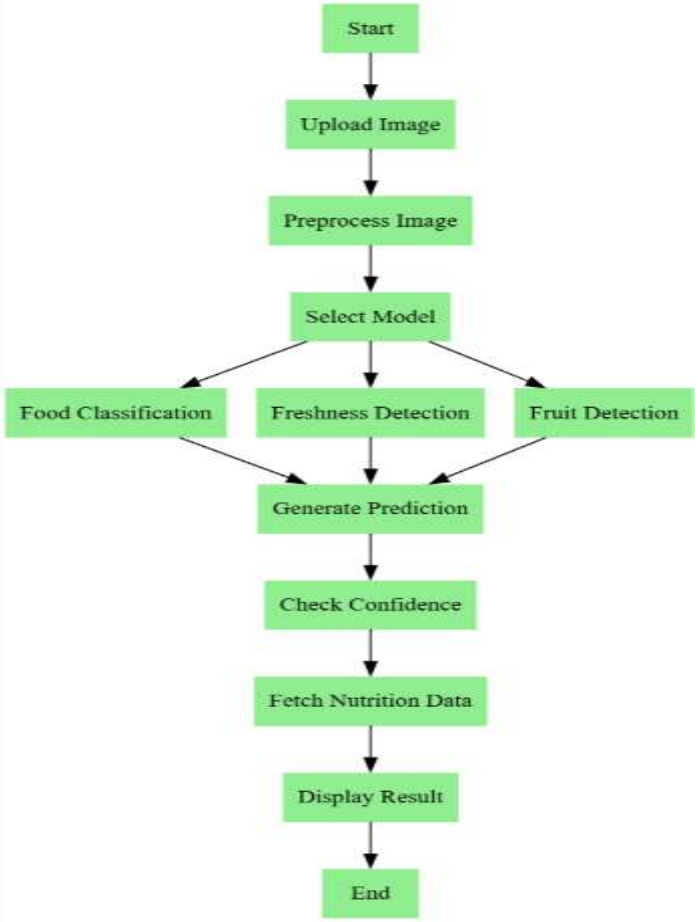
Abstract—

The rapid advancement of artificial intelligence has enabled the development of intelligent systems capable of analyzing food images and supporting informed dietary decisions. This study presents an integrated AI- based framework for visual food understanding, quality and safety assessment, and personalized nutrition recommendation. The primary objective is to address challenges in identifying food items, evaluating freshness, and providing accurate nutritional insights within a unified system. The proposed approach combines deep learning techniques, including convolutional neural networks for food classification and freshness detection, along with transformer-based models for recognizing fruits and vegetables. External nutrition data sources are integrated to retrieve detailed information such as calorie content and macronutrient composition. A web-based interface enables real-time interaction, allowing users to upload images and receive predictions. Experimental results demonstrate reliable performance with high prediction accuracy. The system contributes by offering a scalable solution for health monitoring, dietary planning, and food safety awareness.

Keywords— Artificial Intelligence; Food Classification; Freshness Detection; Deep Learning; Nutrition Analysis; Personalized Diet Recommendation



Proposed System:



I. INTRODUCTION

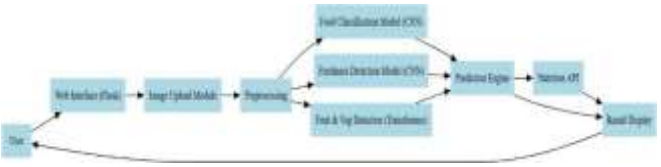
In recent years, increasing awareness of health and food safety has driven demand for intelligent dietary systems. Advances in artificial intelligence and computer vision enable automated food analysis with high accuracy [1]. Traditional food assessment methods rely on manual inspection, which is time-consuming and error-prone [2]. Existing solutions focus mainly on single tasks such as classification or calorie estimation, lacking integration. This research addresses this gap by proposing a unified system for food recognition, freshness detection, and nutrition recommendation. The objective is to develop a reliable and scalable solution for improving dietary awareness and food safety.

II. LITERATURE REVIEW

Deep learning techniques, particularly convolutional neural networks, have been widely used for food classification tasks due to their strong feature extraction capabilities [3]. Transfer learning using pre-trained models has improved accuracy and efficiency [4]. Several studies have explored food freshness detection using image processing techniques, analyzing color and texture features [5]. Transformer-based models have further enhanced image understanding by capturing global features [6]. Nutritional recommendation systems often rely on manual inputs, limiting their usability [7]. However, existing works lack an integrated approach combining all functionalities, highlighting the need for a unified framework.

III. METHODOLOGY

The proposed system consists of three main modules: food classification, freshness detection, and nutrition analysis. Convolutional neural networks are used to classify food items and detect freshness. A transformer-based model is used for fruit and vegetable recognition. The system integrates external APIs to fetch nutritional values such as calories, proteins, fats, and carbohydrates. A Flask-based web application is developed to provide a user-friendly interface. Users upload food images, which are processed and analyzed in real time. The system then displays classification results, freshness status, and nutritional details.



IV. RESULTS AND DISCUSSION

The system was evaluated using test datasets consisting of various food images. The food classification model achieved high accuracy in identifying different dishes. Freshness detection successfully distinguished between fresh and spoiled items under controlled conditions. The integration of multiple modules improved overall system performance. Compared to existing systems, the proposed framework provides a more comprehensive solution by combining multiple functionalities. The results demonstrate the effectiveness of the system in real-world applications

Sample Output (Text Representation)

Input: Image of Dosa Output:

- Food: Masala Dosa
- Freshness: Fresh
- Calories: 168 kcal
- Protein: 4.5g

Performance Analysis

Module	Performance
Food Classification	High accuracy for trained classes
Freshness Detection	Reliable for clear images
Fruit Detection	Good accuracy with pretrained model
Nutrition API	Real-time response

Comparison Between Existing and Proposed System

Feature	**Existing System**	**Proposed System**
Functionality	Single-task	Multi-functional
Food Classification	Available	Available
Freshness Detection	Not available	Available
Nutrition Analysis	Limited/manual	Automated via API
Real-Time Processing	Limited	Yes
User Interface	Basic/none	Web-based (Flask)
Accuracy	Moderate	High (DL-based)

V. CONCLUSION

This study presents an integrated AI-based system for food analysis, combining classification, freshness detection, and nutrition recommendation. The system improves dietary awareness and supports healthier lifestyle choices. Future work includes improving model accuracy with larger datasets and deploying the system on mobile platforms for wider accessibility

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