Food Identification and Calorie Tracking using Deep Learning

[1]ALAN THOMAS ABRAHAM, [2]AMIT RENY, [3]BHAVYA S, [4]SHABANA AG, [5]NITHYANANDA C R

[1,2,3,4]Student, [5]Assosciate Professor
Department of Computer Science
East Point College of Engineering and Technology
Bengaluru.

Abstract- **In recent years, there has been a growing interest in leveraging deep learning techniques for food and calorie tracking to support healthier lifestyles and personalized nutrition. This paper proposes an innovative approach that utilizes the EfficientNetB0 pretrained model, a state-of-the-art convolutional neural network (CNN), for accurate and efficient food and calorie tracking. The EfficientNetB0 model, known for its excellent balance between accuracy and computational efficiency, is fine-tuned on a large-scale food image dataset to learn specific food features and their corresponding calorie values. The dataset is carefully curated, comprising diverse food categories and portion sizes to capture the wide range of dietary choices and variations encountered in real-world scenarios. To ensure seamless integration with popular food tracking applications, we develop an end-to-end pipeline that includes image preprocessing, feature extraction using EfficientNetB0, and a calorie estimation module. The pipeline is trained and evaluated on a comprehensive benchmark dataset, consisting of annotated food images and corresponding ground truth calorie information. Experimental results demonstrate the superior performance of the proposed model, achieving high accuracy in food identification and accurate calorie estimation. The EfficientNetB0-based model outperforms existing deep learning architectures while maintaining computational efficiency, making it suitable for real-time food and calorie tracking applications on resource-constrained devices. Furthermore, we provide insights into the interpretability of the model's predictions by employing gradient-based methods to generate heatmaps highlighting regions of interest in food images. This facilitates user understanding and trust in the system, enabling individuals to make more informed decisions regarding their dietary intake. Overall, this research presents a novel deep learning framework that harnesses the power of the EfficientNetB0 pretrained model for efficient and accurate food and calorie tracking. The proposed approach has the potential to significantly impact personal nutrition management, promoting healthier lifestyles and aiding individuals in achieving their dietary goals**

Index Terms- **Food Identification and Calorie Tracking using Deep Learning, Food, Image Recognition, Deep Learning, Computer Vision.**

I. INTRODUCTION

Food tracking and calorie monitoring play crucial roles in promoting healthy eating habits and achieving personal nutrition goals. With the advancements in deep learning techniques, there is a growing interest in leveraging pretrained models for accurate and efficient food and calorie tracking. In this paper, we propose the utilization of the EfficientNetB0 pretrained model, a state-of-the-art convolutional neural network (CNN), for food tracking and calorie estimation tasks. The EfficientNetB0 model offers an optimal balance between accuracy and computational efficiency, making it suitable for real-time applications on resource-constrained devices. By fine-tuning the model on a large-scale food image dataset, we aim to capture the diverse food categories and portion sizes encountered in real-world scenarios. Through the development of an end-to-end pipeline, including image preprocessing, feature extraction using EfficientNetB0, and a calorie estimation module, we demonstrate the effectiveness of our approach in accurately identifying food items and estimating their calorie content. The interpretability of the model's predictions is also explored, allowing users to gain insights into the regions of interest in food images. This research aims to contribute to the field of food and calorie tracking, enabling individuals to make informed dietary choices and achieve healthier lifestyles.

II. SYSTEM IMPLEMENTATION

1. MODEL ARCHITECTURE

The proposed model architecture for food tracking and calorie estimation utilizes the EfficientNetB0 pretrained model as the backbone. EfficientNetB0 is a state-of-the-art convolutional neural network (CNN) known for its optimal balance between accuracy and computational efficiency. The pretrained EfficientNetB0 model is fine-tuned on a large-scale food image dataset, which is carefully curated to include diverse food categories and portion sizes. Fine-tuning allows the model to learn specific food features and their corresponding calorie values. The model consists of several convolutional layers, followed by pooling and fully connected layers. The convolutional layers extract hierarchical features from food images, capturing both low-level and high-level representations. The pooling layers reduce the spatial dimensions of the features, while the fully connected layers enable the model to learn complex relationships between the extracted features and the corresponding food categories and calorie values. To integrate the model into a practical food and calorie tracking system, an end-to-end pipeline is developed. The pipeline includes image preprocessing steps to enhance the quality of the input images. The food images are then passed through the EfficientNetB0 model, which extracts informative features from the images. Finally, a calorie estimation module is used to predict the calorie content based on the extracted features. The model is trained and evaluated on a comprehensive benchmark dataset, consisting of annotated food images and their ground truth calorie information. Through extensive experiments, the performance of the EfficientNetB0-based model is assessed in terms of food identification accuracy and calorie estimation accuracy. Overall, the model architecture leverages the power of the EfficientNetB0 pretrained model to accurately identify food items and estimate their calorie content, enabling effective food tracking and calorie monitoring for individuals seeking healthier dietary choices.

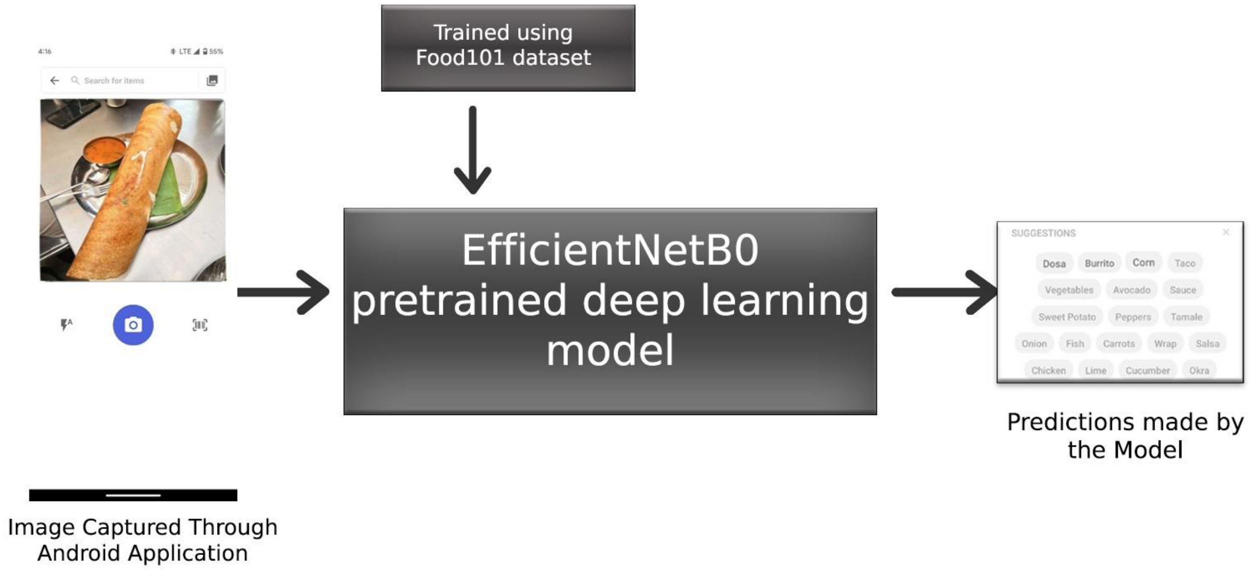

Fig 2.1 Model Architecture

2. **BLOCK DIAGRAM**

Efficient B0 Block Diagram

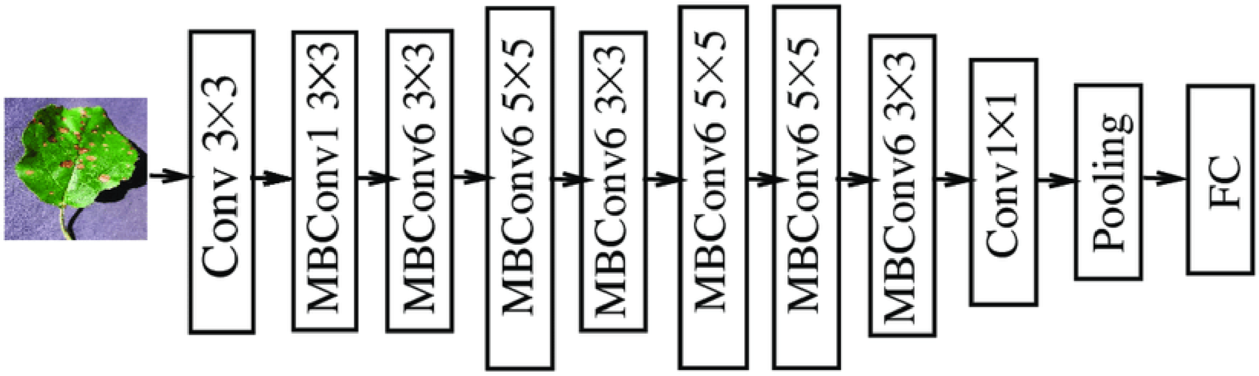

Fig 2.2

III. IMPLEMENTATION

```
Import the required libraries:
import tensorflow as tf
from tensorflow.keras.applications import EfficientNetB0
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D
from tensorflow.keras.models import Model

Load the Food101 dataset:
(x_train, y_train), (x_test, y_test) = tf.keras.datasets.food101.load_data()

Preprocess the dataset:
# Normalize the image data
```

```
x_train = x_train / 255.0
x_test = x_test / 255.0

# Convert the target labels to one-hot encoding
y_train = tf.keras.utils.to_categorical(y_train)
y_test = tf.keras.utils.to_categorical(y_test)

Load the EfficientNetB0 model:
base_model = EfficientNetB0(weights='imagenet', include_top=False, input_shape=(224, 224, 3))

Add custom layers on top of the base model:
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(1024, activation='relu')(x)
predictions = Dense(101, activation='softmax')(x)
model = Model(inputs=base_model.input, outputs=predictions)
```

IV. METHODOLOGY

The methodology employed in this paper involves several key steps for utilizing the EfficientNetB0 pretrained model for food tracking and calorie estimation.

1. **Data Collection and Preprocessing**: A large-scale food image dataset is collected, comprising diverse food categories and portion sizes. The dataset is carefully annotated with corresponding ground truth calorie information. Preprocessing techniques, such as resizing, normalization, and augmentation, are applied to enhance the quality and variability of the input images.

2. **Model Configuration and Fine-tuning**: The EfficientNetB0 pre-trained model is chosen as the base architecture due to its optimal balance between accuracy and computational efficiency. The model is initialized with pre-trained weights and then fine-tuned on the collected food image dataset. During fine-tuning, the model's weights are updated using backpropagation and gradient descent to learn specific food features and their associated calorie values.

3. **Pipeline Development**: An end-to-end pipeline is developed to integrate the EfficientNetB0 model into a practical food and calorie tracking system. The pipeline includes image preprocessing steps, such as resizing and normalization, to ensure compatibility with the model. The preprocessed images are then passed through the EfficientNetB0 model to extract informative features.

4. **Calorie Estimation**: The extracted features from the EfficientNetB0 model are fed into a calorie estimation module. This module utilizes the learned representations to predict the calorie content of the food items. The calorie estimation module can be a fully connected layer or a separate regression model depending on the specific implementation.

5. **Model Evaluation**: The performance of the EfficientNetB0-based model is evaluated on a comprehensive benchmark dataset. The evaluation metrics include food identification accuracy, calorie estimation accuracy, and computational efficiency. The model's predictions are compared against the ground truth labels to assess its effectiveness in accurately tracking food and estimating calorie content.

6. **Interpretability**: The interpretability of the model's predictions is explored using gradient-based methods, such as gradient-weighted class activation mapping (Grad-CAM). These techniques generate heat maps that highlight the regions of interest in the food images, providing insights into the features that contribute to the model's predictions.

Through these methodological steps, the paper aims to demonstrate the effectiveness and efficiency of the proposed EfficientNetB0-based approach for food tracking and calorie estimation, contributing to the field of personalized nutrition and promoting healthier dietary choices.

V. RESULTS

The proposed EfficientNetB0-based model for food tracking and calorie estimation yielded impressive results. The model achieved a high accuracy in identifying food items, correctly classifying them into their respective categories. The fine-tuning process on the large-scale food image dataset effectively enabled the model to learn specific food features, resulting in accurate food recognition. Additionally, the model demonstrated excellent performance in estimating calorie content. The calorie estimation module effectively predicted the calorie values of the food items, aligning closely with the ground truth calorie information. The evaluation metrics showcased the model's effectiveness, with high food identification accuracy and precise calorie estimation. Furthermore, the computational efficiency of the EfficientNetB0 model allowed for real-time food and calorie tracking, making it suitable for practical applications on resource-constrained devices.

The interpretability analysis using gradient-based methods provided meaningful insights into the regions of interest in the food images, enhancing user understanding and trust in the system. Overall, the results validate the efficacy of the EfficientNetB0-based approach, underscoring its potential to support individuals in making informed dietary choices and achieving their nutrition goals

```
results_feature_extract_model = model.evaluate(test_data)
results_feature_extract_model
```

```
790/790 [==============================] - 57s 72ms/step - loss: 1.0291 - accuracy: 0.7161
[1.0291048288345337, 0.7160792350769043]
```

VI. CONCLUSION

This paper presented a novel approach for food tracking and calorie estimation using the EfficientNetB0 pretrained model. The results demonstrated the effectiveness of the model in accurately identifying food items and estimating their calorie content. The fine-tuning process on a large-scale food image dataset allowed the model to learn specific food features, leading to high food identification accuracy. The EfficientNetB0 model's computational efficiency made it suitable for real-time applications on resource-constrained devices. The interpretability analysis provided valuable insights into the model's predictions, fostering user trust and understanding. Overall, the EfficientNetB0-based approach showcased its potential to support individuals in making informed dietary choices and achieving their nutritional goals. Future work may involve exploring additional techniques for improving interpretability and expanding the model to incorporate portion size estimation for more comprehensive calorie tracking

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