Food Detection and Calorie Estimation using Deep Learning

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***Abstract*—Health is undeniably a vital component of human life, as it influences not only our physical well-being but also our mental and emotional states. However, achieving optimal health requires a comprehensive approach that involves various aspects such as regular exercise, a balanced diet, and adequate rest. Among these, maintaining a healthy diet is crucial, as it ensures that the body is receiving the necessary nutrients for proper functioning. In today's world, a healthy body depends on the number of calories that are consumed. Therefore, monitoring calorie intake is necessary to maintain good health. The suggested model uses a deep learning algorithm to offer a novel approach to calorie measurement. This calorie is measured from the different food images that have been trained to generate the model. For this, we trained CNN with characteristics extracted by Inception V3 to create a system that can recognize multiple foods. The input we provide to this model is an image taken of the food. The food calorie value is calculated from the proposed model with the help of food image detection. Additionally, we can know about the calorie level as we increase or decrease the amount of food we intake in grammes.**

Keywords—Deep Learning, CNN, ResNet, Food Classification, Food Detection, Pattern Recognition, TensorFlow

I. INTRODUCTION

Eating a well-balanced diet is crucial for maintaining optimal health and wellness. Nowadays, as a result of the development of technologies, individuals are more conscious of the food they consume to satisfy their hunger. This occurs as a result of obesity being a widespread issue in recent years. The youth, including children, are more likely than ever to consume fast food and other junk foods, which increases their risk of developing a variety of chronic diseases like heart blockage, stroke, diabetes, liver issues, kidney damage, etc. Food journaling has grown in popularity as a way to assist people keep track of how many calories, they should take at any one time in order to avoid these kinds of issues. So, the idea of food recognition, calorie estimate and digital journaling using cellphones or cameras is born. However, there is a great deal of doubt because there are several varieties of various food imagery from various cuisines all over the world. Researchers have been working on this problem for years, and they have given us many different kinds of hypotheses. In this paper, a model for detecting food from a given image using a Convolutional Neural Network (CNN) is developed. To start, we created a dataset of 20 food categories for classifying various foods. After that, we used ResNet152V2 to extract features from the photos and CNN to train the model. The model was then installed on a website that would display the outcome. When an image is provided as input, the system estimates what meal it is and displays the number of calories. The outcome is evaluated in the homepage. The method for detecting food are Food Recognition, Image Preprocessing and Train-Test Split.

II. LITERATURE REVIEW

The contributions that are made in this field are getting more advanced day by day. Some of the information we obtained and discussed are given below:

1. Ayon et.al [1] proposed a system for food detection and calorie estimation based on a Convolutional Neural Network (CNN). The system uses a CNN-based food detection model to detect the presence of food in an input image, and then uses a separate CNN-based calorie estimation model to estimate the number of calories in the food item. The system was trained and evaluated on a dataset of food images with ground truth calorie information, achieving high accuracy in both food detection and calorie estimation. The authors note that their system has potential applications in the areas of health and nutrition, such as dietary monitoring and meal planning. The success of this method was confirmed to yield a rate of approximately 89.48% accuracy.

2. Kasyap et.al [2] proposed a similar system for food calorie estimation based on a CNN. The system takes an input image of food and uses a CNN to predict the number of calories in the food item. The authors trained and evaluated their model on a dataset of food images with ground truth calorie information, achieving promising results with an average error rate of 14.8%. The system has potential applications in areas such as healthcare, nutrition and fitness. This method's success was verified to produce an accuracy rate of about 97%.

3. Zhang et.al [3] proposed a system for food calorie estimation based on various machine learning models. The authors compared the performance of four different machine learning models (linear regression, k-nearest neighbours, support vector regression, and random forest) on a dataset of food images with ground truth calorie information. The results showed that random forest achieved the best performance, with an average error rate of 21.9%. The system has potential applications in areas such as healthcare, nutrition and fitness.

4. Deshmukh et.al [4] proposed a system for estimating the calorie count of food using a mobile phone camera and machine learning algorithms. The system uses image processing techniques to identify food items in an image and then uses a trained machine learning model to estimate their

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calorie content. The authors conducted experiments to evaluate the system's accuracy and found that it had an average error rate of 4.27% for 50 different food items. The paper suggests that Caloriemeter has the potential to be a useful tool for individuals and healthcare professionals looking to track their calorie intake. However, the authors note that the system's accuracy could be improved with more extensive training data and further development of algorithm.

III. PROPOSED METHOD

A. *Dataset Collection*

We used over 70 photos from 20 distinct food classes to create the dataset for multiple food detection. Before training our system, we verified that the correct photos were present in each of the food groups. In our dataset, the Training Dataset and the Validation Dataset underwent in-depth analysis. Our dataset's 20 food classes are as follows:

- Biriyani, Dosa, Idly, Butternaan and Chaat
- Chappati, Upma, Dhokla and Halwa
- Gulab Jamun, Kathi Roll, Meduvadai, Noodles and Tandoori Chicken
- Paniyaram, Poori, Samosa, Vada Pav and Ven Pongal, Besebelebath

B. *Dataset Sample*

We used a total of 20 different food categories for our datasets and each cuisine class had 70 photos. It is a bit challenging to present a high-quality sample from the database. However, the dataset included most of the food consumed by the people.

C. *Data Preprocessing*

We had to perform the following actions for the dataset we used to recognize several things from an image: importing certain necessary libraries, initializing directories, and resizing the images before extracting features. To begin the data preprocessing, we imported the os, tensorflow, numpy as np, glob, matplotlib.pyplot as plt, etc. libraries. Once more, following the import of these libraries, we initialized the dataset directory so that the model could access the photos, begin resizing them, and then begin extracting features. We uploaded our entire dataset to Google Drive, where it was organized in a folder called Dataset. There were two folders in that folder with the names Train and Test. Finally, we changed the dimensions of our photos to Image height=224, Image width=224, and Number of Classes=20. We proceeded to extract features using our model after resizing the images.

D. *Convolutional Neural Network*

The Convolutional Neural Network or CNN primarily employs a pooling technique to decrease the processing time or energy needed to process the data by decreasing the dimension [5]. Additionally, CNN employs a multi-layer system, with the first layer's output serving as an input for the second layer, the second layer's output serving as an input for the third layer, and so on. CNN flattens the image into column vectors after preparing it for multilayer perceptron. These flattened images are fed into a neural network, and we then utilize backtracking and back propagation to analyze and discover mistakes. This procedure is repeated during training iteratively. The weight is adjusted in the inner layer or hidden layer after the mistake has been calculated in order to reduce the error. Up until the algorithm generates the desired output, this procedure is repeated through back propagation.

E. *Feature Extraction Technique*

The first introduction of ResNet appeared in a study written by He et al. [6]. The ResNet idea was developed to train and test hundreds of convolutional layers with high performance. In essence, the skip connection determines which layers reduce accuracy and skips those in training. Instead of allowing the network to learn underlying mapping, the authors [6] have enabled the network to learn residual mapping. The remaining blocks are made up of layers. ResNet-50, for instance, comprises 50 layers of residual blocks. The authors have designated the underlying mapping as H(x) in the suggested residual network model and allowed the residual network fit mapping, which results in H(x):=f(x)-x. The original mapping is finally transformed into H(x). The residual function in this case is designated as F(x). According to the authors [6], optimizing the residual mapping F(x) is simpler to complete than optimizing underlying mapping H(x).

IV. BUILD THE MODEL

The primary phase in food calorie detection is model construction. The algorithms are used by the user when developing the model. The actions required are:

A. *Import the necessary libraries*

```
import os
from pathlib import Path
from glob import glob
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, classification_report
import tensorflow as tf
import warnings
warnings.filterwarnings('ignore')
```

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B. *Create data generators for train, validation and test datasets*

```
train_datagen = tf.keras.preprocessing.image.ImageDataGenerator(
    rescale = 1./255,
    zoom_range = 0.2,
    height_shift_range = 0.2,
    width_shift_range = 0.2,
    horizontal_flip = True,
    validation_split = 0.2
)
test_datagen = tf.keras.preprocessing.image.ImageDataGenerator(rescale = 1./255)
val_generator = train_datagen.flow_from_dataframe(
    dataframe = train_df,
    x_col = "FilePath",
    y_col = "Labels",
    target_size = (img_rows, img_cols),
    batch_size = batch_size,
    subset = "validation",
    shuffle = False,
    class_mode = "categorical"
)
test_generator = test_datagen.flow_from_dataframe(
    dataframe = test_df,
    x_col = "FilePath",
    y_col = "Labels",
    target_size = (img_rows, img_cols),
    batch_size = batch_size,
    shuffle = False,
    class_mode = "categorical"
)
```

C. *Train the model*

```
history = model.fit(
    train_generator,
    epochs = 100,
    validation_data = val_generator
)
```

D. *Creating and Assigning a list of classes to the variable classes*

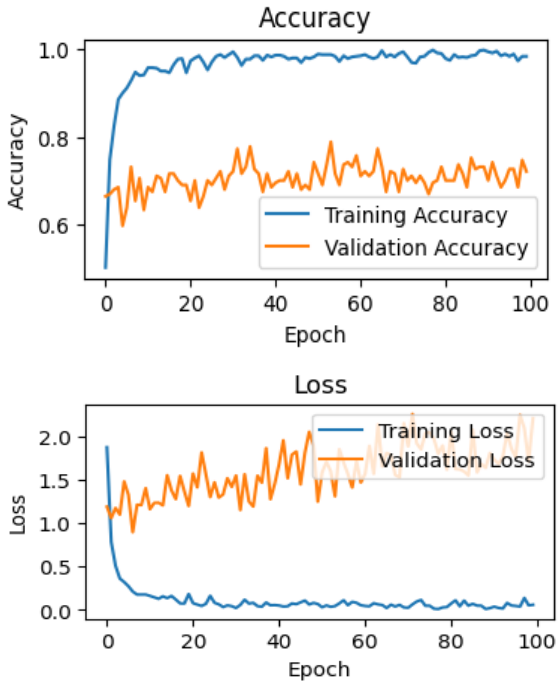
```
class_labels = test_generator.class_indices
class_labels = {v:k for k,v in class_labels.items()}
classes = list(class_labels.values())
classes
```

```
['biriyani',
 'bisibelebath',
 'butternaan',
 'chaat',
 'chappati',
 'dhokla',
 'dosa',
 'gulab jamun',
 'halwa',
 'idly',
 'kathi roll',
 'meduvadai',
 'noodles',
 'paniyaram',
 'poori',
 'samosa',
 'tandoori chicken',
 'upma',
 'vada pav',
 'ven pongal']
```

E. *Evaluating the Accuracy*

```
scores = model.evaluate(val_generator, verbose = 1)
print("Loss: {:.3f}".format(scores[0]))
print("Accuracy: {:.3f}".format(scores[1]))
```

```
7/7 [==============================] - 6s 776ms/step - loss: 2.0308 - accuracy: 0.7216
Loss: 2.031
Accuracy: 0.722
```



F. *Classification Report*

TABLE I.

Food item	Classification Report			
	precision	***recall***	***F1-score***	***support***
Biriyani	1.00	0.70	0.82	23
dosa	0.36	0.84	0.50	19
idly	0.84	0.64	0.73	25
poori	0.96	0.86	0.91	28
samosa	0.82	1.00	0.90	18
upma	0.52	0.58	0.55	26
Accuracy			0.73	417
Macro Avg	0.77	0.74	0.73	417
Weighted Avg	0.78	0.73	0.73	417

V. RESULT AND CONCLUSION

The image detection and calorie estimation system is a reliable and effective way to track the nutritional intake of individuals, which can be particularly helpful for those trying to maintain a healthy diet or manage their weight. The system is able to accurately identify and estimate the calorie content of various food items. The dataset is utilized to provide the images that are displayed. The user provides the appropriate input to get the image detected and estimating the calorie associated with the food item in the detected image.

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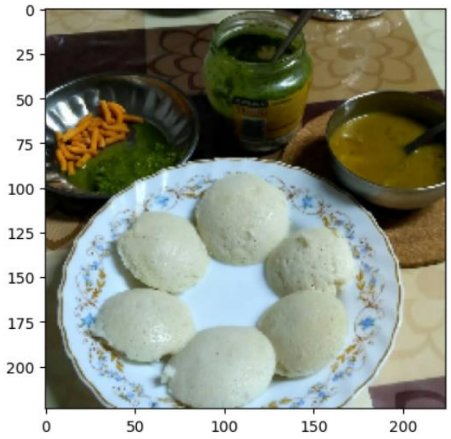
```
img_path = '/content/drive/MyDrive/Dataset/test_set/idly/idlytest (5).jpg'
img = tf.keras.preprocessing.image.load_img(img_path, target_size=(224, 224))
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x7f0d0aa0af20>
```




```
1/1 [==============================] - 0s 31ms/step
This image is of : idly
Calorie : 135
```

VI. REFERENCES

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