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Food Recognition using Convolution Neural Network

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Abstract - *This paper proposes a food recognition system that uses a convolution neural network as a base model for image prediction and then returns nutrition facts such as calories in the given single food image. Knowing the nutrition content of the food that we are consuming helps in maintaining a balanced diet. Our work is organized in two parts. First, we trained and optimized a CNN, state-of-art model using Tensorflow 2.0, we are using CNN as the convolution layers are tweakable and easy to implement. Second, we adapt our model with GUI features as well as nutrition analysis. We also created an extension of FOOD-101 dataset by adding typical Indian food categories. Our model performed extremely well with a mean accuracy of 85% in both normal FOOD-101 dataset and in the extended version.*

***Key Words*: Food Recognition, Convolution Neural Network(CNN), Nutrition Analysis**

1. INTRODUCTION

In this hectic era, taking in high caloric food daily is a serious death trap in disguise. It leads to many diseases such as diabetes, obesity, blood pressure, and other diet-related harmful diseases. In particular, obesity has increased at a tremendous speed in the last few decades as described in a surveillance study [1]. Though this has resulted in sparking the sense of "Body is a Temple" in many, but overall it is still not enough. Nowadays, people are favoring technology more and are inclined to use Food Tracker Apps that demands manual data entry of food items. It is a very time consuming task and has ultimately made people abandon those apps in the long run. In this paper, we propose an approach that uses deep learning algorithms to detect a single food item in an image, and predicting its nutritional content(approx.) to the user. We used Convolution Neural Network in this application as both in speed and accuracy it surpassed classifiers such as Random Forest, Support Vector Machine, K Nearest Neighbor. We used Nutritionix API for the nutritional values and Tkinter, a python library for the GUI (Graphical User Interface) for our application.

This paper is structured as follows. Section 2 explains the related work that has been done in this field. Section 3 describes various methodologies that are used and how they are implemented. Section 4 closes with a conclusion and a summary of the future work.

2. Related Work

With the advancement in the field of computer vision, image processing has been a keen area of interest to work on. Hoashi et al. [2] experimented on 85 food items and achieved 62.5% accuracy for the recognition of Japanese food images that were collected from the Internet. They used multiple kernel learning fused with other kinds of image features such as bag-of-features~(BoF), gradient histogram. They also adapt the model to a prototype that was mobile compatible. Google proposed a system called Im2Calories with a mobile app that can recognize a food object in an image, and then predict its nutritional contents. [3]

Fig 1: Im2Calorie (mobile app)

3. Methodologies

The proposed food detection and recognition model is based on the implementation of the concepts of image processing and computer vision. These concepts are bundled together to get the desired result, the implementation is explained in the below figure 2.

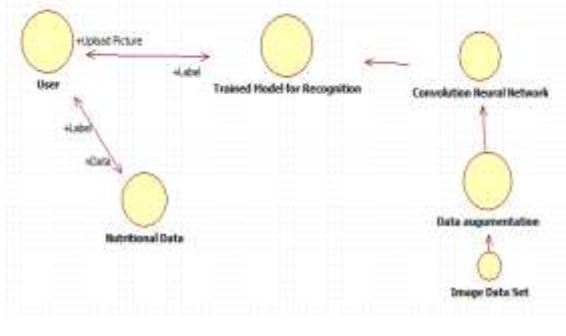

Fig 2: Implementation

3.1 Food Recognition

3.1.1 Convolution Neural Network Architecture

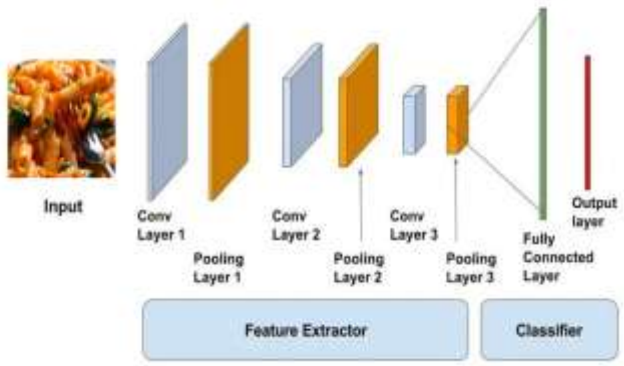

Fig 2: CNN Architecture

The first Convolutional 2D layer consists of 32 kernels of 3x3. Takes an input of size 100x100x3 where 100x100 is the rescaled size of images from Food101 dataset. RGB, the color aspect of the image is denoted by 3. The second layer with a pool size of 2x2 is the max-pooling layer. For better feature extraction, these layers are repeated once again. Then, to get more filtered images for the fully connected layers, the kernel's size is increased from 32 to 64. Two fully connected layers are used next with 128 and 90 neurons respectively. To prevent overfitting, dropouts have been added in between the dense layers. All the convolutional 2D layers and the fully connected layers have an activation function of Rectified Linear Unit (ReLu). The last final layers consist of 101 neurons that are equal to the number of categories in our Food101 Dataset[5]. Each neuron has an output of a probability corresponding to that particular neuron. The model predicts the category to be the one with the highest probability.

3.1.2 Dataset

Figure 3: Food 101 Dataset

We trained the model with 101 food categories available in Food 101 Dataset. Each food categories contain 1000 downscaled images for faster execution of processes, training, and testing. We also tweaked Food101 Dataset by adding 20 typical Indian food categories such as Chole Bhature, Dal Makhani, Dosa. (Single Serve). We mined 500 images of each category. And also created a table by estimating the calories present in each serving as our Nutritionix database does not hold data for some of the typical Indian dishes that we added later.

3.1.3 Python Libraries

Tensorflow 2.0 (*tf.keras*) [6] is a powerful python library for implementing CNN models, training, testing and prediction. The final data has been reformatted as Keras HDF5 Matrix[7], which allows fast and easy file readability.

For Graphical User Interface Tkinter library is handy and can be easily merged with model working at the backend.

3.2 Calorie Estimation

Nutritionix API has been combined with for the Nutritional Analysis. We assume each food is sufficient for 2. It shows data per two servings. We have also added an option that can be used to extract nutritional data (mostly caloric count) for more than 2 serving using Nutrition API.

4. CONCLUSION

In this paper, we trained our model with different test sets and got a mean average accuracy of about 85%. A lot of data augmentation and segmentation that has to be performed to clean pixel values in other classifiers which is not mandatory in CNN. Once our trained model has produced the most probable output, we call the Nutritionix API and return the one serving food item nutrition facts on the user's screen. The whole process takes at most 5 seconds.

The model proposed in this paper is doing well with the given data set both in terms of speed and accuracy but state-of-art models such YOLO can also be integrated with it to get better results and accuracy. To achieve fast multiple object detection with boundary boxes in real time in a single image can also be achieved by using pre-trained models. Also, an effective and reliable system can be developed for real time food recognition and calorie estimation system.

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