Food Analyzer: Food Classification using Deep Neural Networks

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Abstract. Food has been an essential element of human life and has been the concern of conventional mindset of health. These days new tools such as dietary assessment and nutrition analysis enable more ways to help people understand their daily eating patterns, exploring nutrition habits for maintaining a healthy diet. Therefore, we develop a CNN model based food recognition and nutrition analysis system to study and analyze food items from daily meal images. Specifically, we propose a two-step algorithm to recognize food images by detecting candidate regions and using deep convolutional neural network (D-CNN) for food classification. It identifies each image by mapping them into feature maps by performing matrix multiplication between an image and kernel or filter (convolving), and classifies them into different food categories. It is also called as feature extraction. Finally, the system will analyze the nutritional ingredients based on the recognition results and color of the food to generate a dietary assessment report by calculating the amount of calories, fat, carbohydrate and protein. In the evaluation, we conduct extensive experiments using our datasets and also with different epoch values. The model is evaluated through different evaluation metrics. The experimental findings depicts that the system is able to effectively recognize the food items and generate the dietary assessment report efficiently, which will benefit the users with a clear insight of healthy diet and guide their daily recipe to improve body health and wellness.

Keywords: Food recognition · Convolutional neural networks · Calorie Estimation · Classification

1 Introduction

Calories are a requirement for the body, as they generate energy. But it is known that an excess of anything is bad and the same applies to the intake of calories too. If there are more calories in our body, it gets stored within the sort of fats, thus making us overweight. Adult calorie requirements differ from that of a child and in the same way, the daily calorie requirement of Body Mass Index (BMI) is a person's weight in kilograms divided by the square of their respective height in meters. It is one of the foremost commonly used ways of estimating whether an individual is overweight or not. The rate of obese people is increasing at an alarming rate from a previous couple of years. There are also many chances for obese people to face insignificant health problems like hypertension, attack, diabetes, obesity, hypertension, high cholesterol, etc. So the main cause for obesity is the imbalance of the amount of food intake and energy consumed by the individual since it is necessary to have a healthy meal. As the like for trend and sort of nutriment items is increasing, people also are becoming more aware and conscious about calorie intake because the higher number of calorie intake creates a lot of problems that invoke the needs of medical consultancy. People suffering from such problems require an easy way to control their calories whereas others take it as a step towards prevention. Thus, Maintaining a healthy diet is an important goal for many people. One way to achieve this is by tracking the number of calories consumed and checking on the food's nutritional value. Nutritional values such as protein, carbohydrates, fat, sugar, vitamins, and minerals are important along with calories. In order to accomplish that, food must also be classified. We provide some kind of general structure and give the

computer the opportunity to learn from experience, similar to how we humans learn from experience. This fascinating classification can be achieved by this technology of deep convolution neural networks. In this project, the proposed to alleviate for the user to identify and know the nutritional data of the food with images.

2 Problem Statement

- The majority of the population suffers from obesity and overweight that presents risk to health.
- It is a major concern that leads to serious life threatening illness like heart disease, stroke, high BP and diabetes.
- How can we combat this through technical methods such as Machine Learning by automating the Calorie Estimation ?

3 Literature Survey

Viswanath.C.Burkapalli [1], proposed a method to classify Indian food images by adopting a Google Inception - V3 based Convolutional Neural Networks (CNNs) model. The Max-Pooling functions used for features extraction from the data and help to train the CNN model. All the food images are separated into their respective class folder and labelled properly. The proposed model utilizes the custom Inception-V3 weights which are pre-trained using ImageNet and it considers the reshaped size of 150*150*3 for all images. Proposed model has been tested on self collected cuisine dataset and manages to get 96.27% classification accuracy.

Manpreetkour Basantsingh Sardar [2] ,proposed an algorithm for fruit recognition and its calorie measurement based on their shape, color and texture along with histogram of gradients and GLCM with local binary pattern algorithms for texture segmentation scheme recognizing fruits and area, major axis, minor axis are calculated by using shape feature to get more accurate calorie value. For obtaining the accurate features appropriate segmentation scheme is used. All the features of each fruit item are extracted during the segmentation phase and then used as training vectors and stored database for the multiclass SVM. The result of recognition rate is calculated with the help of equation : RR=No of correctly recognized samples 100 Total samples Average RR of model was 97%. The average Accuracy of calorie measurement is 98.82%.

Szegedy .C [5], proposed an automatic food detection system that detects and recognizes varieties of Indian food. The proposed food recognition system is developed in such a way that it can classify the Indian food items based on two different classification models i.e. SVM and KNN. Parameters such as food density tables, color and shape acknowledgment as a part of image processing and classification with the SVM and KNN have been considered. They have considered around 200 images sample with cluttered food and individual food items. They have considered two combined features for these 200 samples we have considered 80% of images as training set and 20% of them as the testing set. SVM had an average accuracy of 82% and KNN had accuracy of 75.6%.

David J. ttokaren [8], proposed a model which focuses on estimation of number of calories in the food item by just taking its image as input using SVM. The proposed model applies a techniques of image processing followed by feature extraction. The features extracted for all images are then applied to the classifier support vector machine (SVM) which classifies the images in different classes as specified in the learned algorithm. Here the dataset includes images from PFID(Pittsburgh Fast Food Image Dataset) and website of Shutterstock and calorie information from nutrition. The model achieved an accuracy of 90.66%.

4 Methodology

4.1 Convolutional Neural Networks

Convolutional neural framework is one of the principal category for the photos affirmation and pictures portrayals. Articles disclosures, affirmation faces, etc., are a bit of the regions where CNNs are commonly utilized. The Figure.1 shows the Neural Network with various convolutional layers. 1n certainty, the possibility of significant learning CNN models can be used for train and attempted, every data picture will be adhered to the course of action of convolution layers with procedures (Kernals). The invention of the CNN in 1994 by Yann LeCun is what propelled the field of Artificial Intelligence and Deep learning to its legacy. The first neural network named LeNet5 had a very less validation accuracy of 42% and then, later on, a lot of research and development has been performed in the respective field. Nowadays almost every giant technology firms rely on CNN for more efficient performance. There are 4 different layers in CNN.

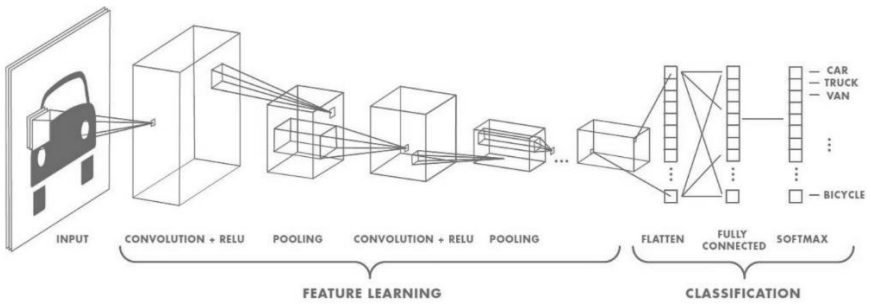

Figure 1. Different layers of CNN

Convolution Layer. This layer involves going through the whole image for patterns and formulating it in the form of a 3x3 matrix. This convolved feature matrix of the image is known as Kernel. Each value in the kernel is known as weight vector. Basically the image matrix is multiplied with a specialized filter to obtain sharp filters.

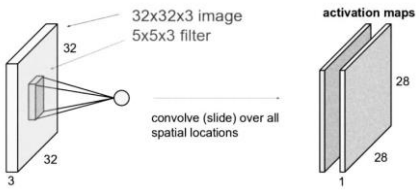

Figure 2. A pictorial representation of Convolution layer results

Pooling Layer. Here the image matrix is broken down into the sets of 4 rectangular non-overlapping segments. There are two types of pooling, Max pooling and average pooling. Max pooling gives the maximum value in the relative matrix region which is taken. Average pooling gives the average value in the relative matrix region. The main advantage of the pooling layer is that it increases computer performance and decreases over-fitting chances.

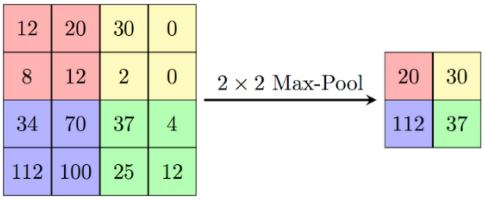

Figure 3. Output through Pooling Layer

Activation Layer. It the part of the Convolutional Neural Networks where the values are Normalized that is, they are fitted in a certain range. The used convolutional function is ReLU which allows only the positive values and then rejects the negative values. It helps us achieve low computational cost.

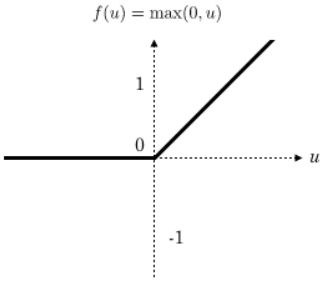

Figure 4. ReLu Depiction

Connected Layer. Here the features are compared with the features of the test image and associate similar features with the specified label. Generally, labels are encoded in the form of numbers for the computational ease, they will be later converted into their respective strings.

4.2 System Design

The framework can be comprehensively sorted into following significant stages and are depicted in the Figure 5.

Acquisition of image. Images are obtained either by lens or by secretly deleting them from the contraction. Whatever the source may be, it is very important that the image of the data is transparent and cautious. An incredible picture is needed for this.

Pre-Processing of image. In this process, the photo is standardized by clearing the commotion, as it may confuse the evaluation. Similarly, the image given as the information may not be of standard size as required by the figure, so it is vital that the image size needed is obtained.

Data storage aspect to preserve information images for testing and training. If controlled learning occurs, as is the case here, it is important to prepare data sets. The sample database is the images collected during the photo procurement process.

Classifier to classify the food. The classifier used here is the last layer of the system which gives the true probability of each experience. The project involves two major parts Image preparation unit and grouping unit. The object processing system improves the sample input images by removing the noisy bits. The Food image will then be isolated into different segments to isolate the image from running the mill after the image features are evacuated to check whether or not the Food is contaminated.

Noise reduction unit. The unwanted color saturation is removed in this stage.

Image enhancement unit and segmentation. carries the affected part to the middle by improving the area and dividing the area into different segments in order to isolate it from the normal Scanned Image.

Feature Extraction Component. One of the notable developments in any gathering centered issues is highlighting extraction. Looks are the cornerstone for both purposes of planning and screening. This feature contains noteworthy image information that will be used to identify the Food.

Input Attributes. For example, all noteworthy attributes such as, asymmetry, edge, concealment, distance, progression, etc. that have been removed from the image are now provided as a dedication to next part, which is the classifier part.

Classifier engine. characterizes the images by grouping the calculation into one of the predefined Food.

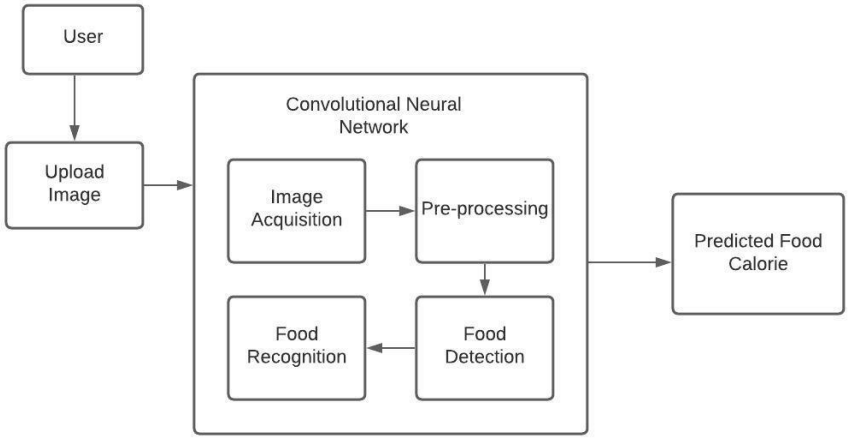

Figure 5. System Architecture and Design

4.3 Results and Testing

There are two models prepared to be tested to obtain result of their efficiency. Image is first rendered in 225x350 format to minimize the space it takes on the GUI. From related works of AlexNet and VGG methods, they give 47.8% and 60.81% accuracy respectively. These methods were used to classify Japanese food. Our models, Model1 was modelled using 3150 images of fruits and vegetable datasets of 12 categories and Model2 was modelled using 18511 image datasets of 12 categories of Desi food that consists of foods like biriyani, samosa, etc. Table 1 shows that DCNN model which we have used does slightly better than AlexNet and VGG in the top 1 accuracy. Main reason for this is that the number of training images plays a key role in higher accuracy. Also, that the training images are more complex in desi food than fruits and vegetables. Testing images with more than just the food tend to give wrong classification. Here, we have tested variety of images that do not look like training images and hence the accuracy.

CNN Models	DCNN	AlexNet
Classified	70.56%	65.91%
Misclassified	29.44%	35.09%

Table 1. Percentage of classification on DCNN and AlexNet based top 1 accuracy.

Project passed unit testing, integration test, system testing, acceptance testing and validation testing. These tests prove that project is developed in the way it was designed to be. Below is the graphical representation of the same.

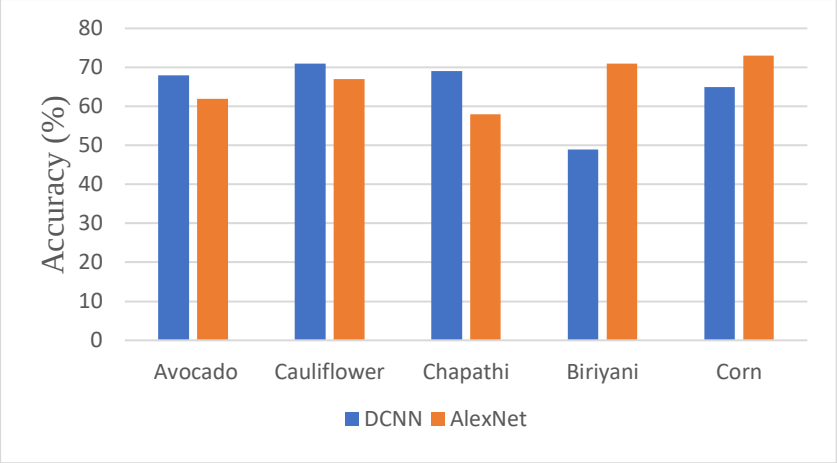

Figure 6. Graph – Some comparison of accuracy found between different foods

The Graph shows the accuracy achieved between DCNN (the method described in this paper) and the AlexNet.

5 Conclusion

In this research study, we address the need for food classification and give its nutritional value using the Convolutional Neural Network, a Deep learning technique is used to classify the food images into their respective classes and print the calories of the food image.

Keeping future enhancement in mind, the task of classification can always be improved by removing noise from the dataset. This research can also be carried out on a much larger dataset with a greater number of classes and a greater number of images in each class, as greater dataset improves the accuracy by learning increased features that reduces the loss rate. Furthermore, we have identified two more methods of Linear and Logical Regression which deliver even more better results. Therefore further planning for improvement has been kept in mind.

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