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Food Classification Using Deep Learning Method: A Review

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ABSTRACT

Image classification has become less complicated with deep learning and availability of larger datasets and computational assets. The Convolution neural network is the most popular and extensively used image classification technique in the latest days. Image classification is performed on diverse food dataset using various transfer learning techniques. The food plays a vital role in human's life as it provides us different nutrients and consequently it is necessary for every individual to maintain a watch on their eating habits. Therefore, food classification is a quintessential thing for a healthier lifestyle. Unlike the traditional methods of building a model from the scratch, pre trained models are used in this project which saves the computation time and cost and also has given better results. The food dataset of many classes with many images in each class is used for training and validating. Using these pre-trained models, the given food will be recognized, and the nutrient content will be predicted based on the colour in the image.

Keywords: Calorie estimation, Convolutional Neural Network (CNN), Deep Learning technique, Food Image classification

1 Introduction

Image classification has become easier by research in Computer vision and machine learning. There is availability of huge data and computational resources. Techniques that can be used for Image classification are KNN classifier on local and global features used in [9], artificial neural networks, SVM and Random Forest technique to classify different classes using different set of features. However, these methods fail when the dataset is huge. Because the convolutional neural network can be easily handled with large amount of data and still provide high classification accuracy, it has gained attention in Image classification recently. Therefore, food classification is a quintessential thing for a healthier lifestyle. In fact, the numbers of people across the world that are suffering from obesity are more than 10%. The rate of obesity is increasing in an alarming rate from the past few years. In this growing digital world, it is very important to keep a track of calorie intake in our food. As the world is growing, problems like obesity and weight gains are also equally growing. It becomes inevitable to maintain a track of food intake. It becomes difficult to keep everything on track in a diary. Statistics show that 95% of the people no longer follow any dietary plan as these restrict the people from consuming their day-to-day food. So, the primary cause for obesity is imbalance of the amount of food intake and energy consumed by the individual, and a healthy meal is necessary. Thus,



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maintaining a healthy diet is an important goal for many people. The process of tracking the number of calories consumed can be very tedious as it requires the user to keep a food journal and perform little messy calculations to estimate the number of calories consumed in every food item. Through this research we try to classify Indian food images into their respective classes. The proposed software model uses machine learning as the base which recognizes the food image that is uploaded as an input by the user, processes the food image, recognizes it, and estimates the calories from the predicted image. People record, upload, and share food images more willingly than ever on websites like Instagram, Facebook etc. So, it is more convenient to locate more data (images and videos) related to food. Consequently, supporting users in diet management and reducing the need for the manual paper approach. Food image recognition and calorie estimation can aid in diet management, food blogging and recognizing the Indian foods. The organization of the paper is as follows: The related works are presented in section II. III deals with the proposed methodology followed by the experimental results, conclusion and future work in section IV and section V respectively. To overcome the manual labour and the erroneous data, various applications were developed to calculate the food intake. One of the latest technological advancements to overcome difficulties in pictures of food items is a variety of e-health applications we “consume with our eyes,” as is often remarked. Our digital experience is becoming more and more photo-driven due to the ongoing growth of social media platforms like Instagram (which has 500 million daily active users as of this writing). Of these, over 360 million of these photos are pictures of food (looking at just food). More than 88% of poll respondents who responded in 2015 believed that food was the defining factor in deciding on travel locations and said that food images almost entirely drive dining experiences, food festivals, culinary lessons, and the emergence of gastro-tourism.

We chose CNN for this project since it appears to perform better than every other algorithm when it comes to object detection in photos than any other approach. Compared to other algorithms, it requires incredibly little processing. Consider brain neurons when attempting to comprehend CNN. The CNN model was developed and taught in a similar manner to how our brains develop over time. We feed the brain information, and the brain uses neurons to train itself to look for key elements of the information. The CNN algorithm trains its neurons in a similar manner.

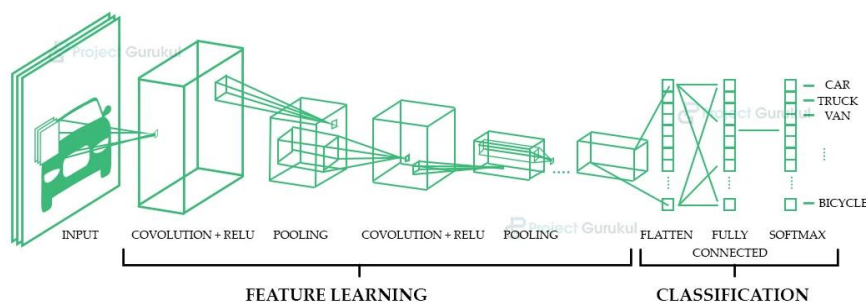


Figure 1: CNN (Convolutional Neural Networks)



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A machine learning algorithm known as a convolutional neural network may predict the item in an image based on how it has been trained.

- Four layers are used to generate CNN the input layer, which is the first layer. The Convolution layer is the next layer. The pooling layer is the third one.
- Input Layer: This layer's input is a simple 2D image. This image is perceived as a matrix of pixels by the computer. as a computer only recognizes an image as a collection of pixels
- Convolutional Layer: A convolutional layer is created by a group of filters.

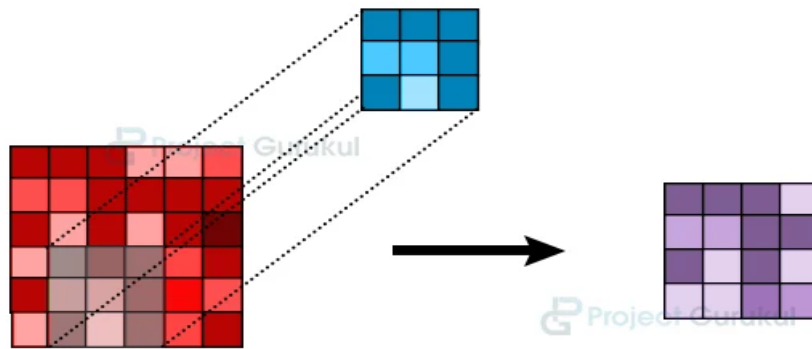


Figure 2: Matrix using CNN

As shown in the picture up top (Fig1.2 Matrix using CNN). The M1 matrix is 6×6 . There is a 3×3 matrix M2 which is called the filter. We will slide the M2 matrix over the M1 matrix until every pixel is scanned at least once. As we slide the M2 over M1, we will have a 3×3 scanned matrix M3 which is just a patch of M1. Now from this M3 matrix, our convolutional layer will find important features from the M3 matrix in numeric form. It is calculated by multiplying the weight of the filter with the M3 matrix. The result is stored in matrix M4 as seen in the picture.

2 Related Works

2.1 [1] Indian Food Image Classification with Transfer Learning

In 2019, Raja yogi J.R., Manjunath, G. and Shobha, G demonstrated a new topic, image classification has become easier with deep learning and availability of larger datasets and computational resources. The Convolutional neural network is the most popular and widely used image classification technique in the recent days. In this paper image classification is performed on Indian food dataset using different transfer learning techniques. The food plays important role in human's life as it provides us different nutrients and hence it is necessary for every individual to keep a watch on their eating habits. Therefore, food classification is a quintessential thing for a healthier life style. Unlike the traditional methods of building a model from the scratch, pre trained models are used in this project which saves the computation time



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and cost and also has given better results. The Indian food dataset of 20 classes with 500 images in each class is used for training and validating. The models used are InceptionV3, VGG16, VGG19 and Res Net. After experimentation it was found that Google InceptionV3 outperformed other models with an accuracy of 87.9% and loss rate of 0.5893.

2.2 [2] Food Recognition and Calorie Measurement using Image Processing and Convolutional Neural Network

In 2019, Reddy, V.H., Kumari, S., Muralitharan, V., Gigoo, K, and Thakare, B.S., demonstrated the ease with which food is being delivered at our doorsteps has lead to an outbreak of a major chronic disease known as obesity. As the necessity of the food arose among people, the apprehension related to their diet also simultaneously increased. In this paper we propose a calorie measurement system whereby the user is made to upload the image of food item and as a result, number of calories present in the uploaded food image will be predicted. It is a multi-task system which also displays the weekly statistics on how much calorie is consumed by the user and how more/less calories must be consumed to avoid obesity related diseases such as heart attack, cancer etc. We built a dataset of food images collected from existing datasets to detect complex images consisting of 20 classes and each class containing 500 images each. We have curated our own Convolutional Neural Network architecture of 6 layers to extract the features and classify the images. Our experimental results on food recognition showed 78.7% testing accuracy with 93.29% training accuracy.

2.3 [3] A Deep Convolutional Neural Network for Food Detection and Recognition

In 2018, Subhi, M.A and Ali S.M., demonstrated to propose a new deep convolutional neural network (CNN) configuration to detect and recognize local food images. Various types of food with different color and texture reflect the fact that the food image recognition is considered a challenging task. However, deep learning has been widely used as an efficient image recognition method, and CNN is the contemporary approach for deep learning to be implemented. CNN has been optimized to the tasks of food detection and recognition with few modifications. We present a new dataset of the most consumed local Malaysian food items which was collected from publicly available Internet sources including but not limited to, image search engines. For evaluation of recognition performance, CNN achieved significantly higher accuracy than traditional approaches with manually extracted features. Additionally, it was found out that convolution masks show that the features of food color dominate the features map. For the process of food detection, CNN also exhibited considerably higher accuracy than other conventional methods.



2.4 [4] Transfer Learning: Inception-V3 Based Custom Classification Approach for Food Images.

In this paper, the Google Inception-V3 model is considered as a base, in top of that Burkapalli, V C and Patil, P.C., demonstrated on Deep-learning approach has become more popular in the field of image processing. When it is concerned with health issues, there are lots of improvements in applications of food image classification by deep learning methods. Transfer learn has become one of the popular techniques used in inception V3 for image classification, it is the reuse of a pre-trained model on a new model, where it uses a small amount of dataset to reduce the training time and increases the performance fully connected layer is built to optimize the classification process. In the model building process, convolution layers are capable to enough learn on its own convolution kernel to produce the tensor outputs. In addition, the separately obtained segmented features are concatenated with our custom model before the classification phase. It enhances the capability of important features and utilizes in the process of food classification. Here, the dataset of 16 class food images is considered and it contains thousands of images. The 96.27% classification accuracy has been obtained at the testing phase which is compared with different state-of-art techniques.

2.6 [5] Food Image Recognition with Convolutional Neural Networks

In 2019 Zhang, W., Zhao, D., Gong, W., Li, Z., Lu, Q. and Yung, S., demonstrated to propose a food image recognition system with convolutional neural networks (CNN), which has been applied to image recognition successfully in the literature. A CNN which consists of five layers has been built and two group of controlled trials have been processed on it. Two datasets are prepared: one is UEC-FOOD100 dataset which is an open 100-class food image dataset including about 15000 images and the other is a fruit dataset that established by ourselves including over 40000 images. We have achieved the best accuracy of 80.8% on the fruit dataset and 60.9% on the multi-food dataset. In addition, we validate the method on two groups of controlled trials and discover the effect of color under various conditions that the color feature is not always helpful for improving the accuracy by comparing the results of two group of controlled trials. As future work, we will combine image segmentation with image recognition to get a better performance

3 Conclusion

In this paper different strategies for food classification using deep learning is studied. As far as the future enhancement is concerned, the task of classification can be improved by removing noise from the dataset. The same research can be carried out on larger dataset with a greater number of classes and a greater number of images in each class, as larger dataset improves the accuracy by learning more features and reduces the loss rate. The weights of the model can be



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stored and used to design a web app or mobile app for image classification and in addition calories extraction of the classified food.

The proposed system would be improved when the calorie measurement will be done for multi-food and complex food items which would help people who will be using our application to apprehend deeply the complexities of food. Additionally, the expansion of dataset with more variety of food types which will improve the result and accuracy of the system. As fast response is one of the most crucial elements these days, the computational part of the model which takes longer time can be offloaded to the cloud. With the use of cloud, a model which takes less time to produce the result by performing large computations can be obtained.

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