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A Review on Computer Vision Based Estimation of Food Calories Using Artificial Intelligence

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Abstract: *For the last few decades, it has been the popular trend in India that people are putting more attention on improving their healthiness and regulating calorie intake for every meal, so that we build a model for calorie estimation of various food. Dieticians and healthcare conventions are concerned with the consumption of accurate quantity and right kind of food. There is no doubt that exercising also plays a vital role but what we are feeding our body plays a major role in obesity and many problems related to health like diabetes, stroke, and many cardio vascular diseases. Also, due to advancement in technology, today's generation can order food just with a click on their mobile devices. Thus, acceleration in obesity is evident. For the people who are concerned with this problem, keeping the records of the consumption of nutrients manually is difficult. To combat this, a variety of health applications and Calorie measurement tools have emerged to reverse or shrink the effect of all the health-related troubles. Some of the applications also utilize state-of-the-art Artificial Intelligence algorithms. In this paper, we presented review of some methods used for food recognition and calorie measurements.*

Keywords: Artificial Intelligence, Calorie Estimation, Deep Learning, Machine Learning

I. INTRODUCTION

Food is the key of human's body. So, a diet plan always needs to take into consideration the total number of calories to be consumed to maintain a fit and healthy life. But, in most cases, unfortunately people face difficulties in estimating and measuring the amount of food intake due to the mainly lack of nutritional information, which includes manual process of writing down this information, and other reasons. As such, it will be useful if there is a system to keep track and maintain the calorie intake. Hence accurate prediction of food calorie is equally important in such cases. In the last three years, object classification and detection capabilities have dramatically improved due to advances in deep learning and convolutional neural networks. Harnessing this technology to accurately classify and detect food objects is significantly essential for a healthy and fit life. But to always refer to the nutritional content in each food item is an extremely tedious task. Food image recognition provides an easy means to estimate the dietary caloric intake and evaluate people's eating habits, by using cameras to stay track of their food consumption. An accurate estimation of daily nutritional intake provides a useful solution for keeping healthy and to prevent diseases.

Recent studies by the WHO show that in 2016, more than 1.9billion adults aged 18 years and older were overweight. Of these over 650 million adults were obese. However, on the other side of the spectrum, a different study reveals that people are also leaning towards a healthy lifestyle more than ever in the view of a disease known as obesity. Collecting food recordings to keep an eye on the daily calorie in-take and maintaining as t diet plan is not a super new concept. It was done even before the time when smart phones and high-tech specialized dietary measurement tools were invented and became popular. Unlike today, people used to physically write their daily meals as well as diet plans on a piece of paper or a notebook. This process was clearly in efficient, dull, and had a great amount of error possibility.

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Modern technology entirely solved the issue and converted this tedious process into an exciting one by transforming the whole food recording process from writing everything down to the matter of clicking just a single picture of the food item on your smartphone or tablet and evaluating almost all of the possible nutritional information. This all has become possible with the advancement in machine learning and deep learning models. Now, taking phone out of the pocket and clicking a picture of the food to calculate the number of calories it contains sounds so simple and magical but in reality, this job requires high skills and lots of complicated calculations. This all should work flawlessly behind the scenes so that the final output has both high accuracy while maintaining great efficiency. That is why there is no single overall best method to perform food recognition. Over the years, so many researchers all around the world developed new and also refined existing methods and algorithms by using cutting edge techniques to achieve better results than before. This paper will propose a review of different techniques used for food recognition and calorie estimation.

II. LITERATURE REVIEW

Ghalib Tahir et.al. [1] discusses the most performing methodologies that have been developed so far for automatic food recognition and volume estimation. First, we will present the rationale of visual-based methods for food recognition. The core of the paper is the presentation, discussion and evaluation of these methods on popular food image databases. Following that, we discussed the mobile applications that are implementing these methods. The survey ends with a discussion of research gaps and open issues in this area.

Zhidong Shen et.al. [2] proposed a method which improves the accuracy of the pre-training model. The paper designs a prototype system based on the client server model. The client sends an image detection request and processes it on the server side. The prototype system is designed with three main software components, including a pre-trained CNN model training` module for classification purposes, a text data training module for attribute estimation.

Chang Liu et.al. [3] propose a new Convolutional Neural Network (CNN)-based food image recognition algorithm to address this problem. We applied our proposed approach to two real-world food image data sets (UEC-256 and Food-101) and achieved impressive results. To the best of our knowledge, these results outperformed all other reported work using these two data sets. Our experiments have demonstrated that the proposed approach is a promising solution for addressing the food image recognition problem. Our future work includes further improving the performance of the algorithms and integrating our system into a real-world mobile and cloud computing-based system to enhance the accuracy of current measurements of dietary intake.

Yanchao Liang et.al. [4] presented a novel food image dataset with volume and mass records of foods, and a deep learning method for food detection, to make a complete calorie estimation. Our dataset includes 2978 images, and every image contains corresponding each foods annotation, volume and mass records, as well as a certain calibration reference. To estimate calorie of food in the proposed dataset, In this paper, they presented a novel food image dataset with volume and mass records of foods. To estimate calorie of food in the proposed dataset, a deep learning method using Faster R-CNN is used to detect the food and calibration object ; GrabCut algorithm is used to get each food's contour. Then they estimate each food's volume and calorie. The experiment results show our estimation method is effective. Our dataset is the first released food image dataset, which can be used to evaluate computer vision-based calorie estimation methods. M. Cabatuan et.al. [5] presented the design and development of a food recognition smartphone application which can also display the estimated calorie/s of the food itself. It is intended for people who would like to monitor their diet through food calorie intake measurement (i.e. user's daily calorie intake record). It is equipped with a food database consisting of typical fruits and vegetables commonly found in the Philippines. As part of the study, it also includes some of the meals in food chains (i.e. McDonald's, and The Healthy Corner) found in the Philippines where the calorie information is readily available. The result shows 82.86 % accuracy for the top-1 category, and 99.29 % for the top-5 category. The algorithm being used in this project is Artificial Neural Network (ANN) wherein the recognition process must properly be achieved. Furthermore, the aforementioned database is supported by TensorFlow which is an open-source software library for Machine Intelligence.

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Takumi EGE et.al. [6] proposed estimating food calorie from a food photo by simultaneous learning of food calories, categories, ingredients and cooking directions using deep learning. Since there exists a strong correlation between food calories and food categories, ingredients and cooking directions information in general, we expect that simultaneous training of them brings performance boosting compared to independent single training. To this end, we use a multi-task CNN. In addition, in this research, we construct two kinds of datasets that is a dataset of calorie-annotated recipe collected from Japanese recipe sites on the Web and a dataset collected from an American recipe site. In the experiments, we trained both multi-task and single-task CNNs, and compared them. As a result, a multi-task CNN achieved the better performance on both food category estimation and food calorie estimation than single-task CNNs. For the Japanese recipe dataset, by introducing a multi-task CNN, 0.039 were improved on the correlation coefficient, while for the American recipe dataset, 0.090 were raised compared to the result by the single-task CNN. In addition, we showed that the proposed multi-task CNN based method outperformed search-based methods proposed before.

Keiji Yanai et.al. [7] propose estimating food calorie from a food photo by simultaneous learning of food calories, categories, ingredients and cooking directions using deep learning. Since there exists a strong correlation between food calories and food categories, ingredients and cooking directions information in general, we expect that simultaneous training of them brings performance boosting compared to independent single training. To this end, we use a multi-task CNN [1]. In addition, in this research, we construct two kinds of datasets that is a dataset of calorie-annotated recipe collected from Japanese recipe sites on the Web and a dataset collected from an American recipe site. In this experiment, we trained multi-task and single-task CNNs. As a result, the multi-task CNN achieved the better performance on both food category estimation and food calorie estimation than single-task CNNs. For the Japanese recipe dataset, by introducing a multi-task CNN, 0.039 were improved on the correlation coefficient, while for the American recipe dataset, 0.090 were raised compared to the result by the single-task CNN.

Priya Gupta et.al. [8] aimed at determination or classification of food using image processing in conjunction with other intelligent algorithms, with the ultimate aim of determination/estimation of calorie intake our work acts as basis of modern computer assisted, remote dietary management systems. Our system comprises of segmentation of food in the image, then extracting image parameters such as area, major axis, minor axis convex area from the segmented food area, & then using an already trained artificial neural network to classify the food on basis of these parameters. Multiple methods have been combined using weighted averaging to achieve food segmentation, such as surface feature/ bag of features detection; background removed using HCV processing etc. High detection accuracy is obtained by combination of multiple image processing techniques with leven barg marquard function flitting neural network.

V.Subapriya et.al. [9] provided a greater green manner of estimating calories. First, it desires the top view and aspect view photographs of the meals being analysed. Then, it's going to use Faster R-CNN to locate the food and calibration object, after which, a GrabCut algorithm is an image segmentation method, by using this algorithm we can estimating the quantity of food and also estimate the amount of energy.

Madhubala Kamble et.al. [10] proposed a deep learning model consisting of a convolutional neural network that classifies food into specific categories within the training a part of the prototype system. The most purpose of the proposed method is to enhance the accuracy of the pre-training model. The paper designs a prototype system supported the client server model. The client sends a picture detection request and processes it on the server side. The prototype system is meant with three main software components, including a pre-trained SVM model training module for classification purposes, a text data training module for attribute estimation models, and a server-side module. We experimented with a spread of food categories, each containing thousands of images, and thru machine learning training to realize higher classification accuracy.

Dhanalakshmi S et.al. [11] proposed system which not only detects varieties of fruits & vegetables but also provides per serving calories of each food detected in a single image. To achieve this, we will take the input of the food image from the user. This food item is detected with the help of the CNN algorithm. In the next step, we do image segmentation

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with the help of morphological functions of OpenCV. After Segmentation, the Volume of the food is calculated. After this, with the help of formulas calories of the food are calculated.

Anita Chaudhari et.al. [12] develop an application for estimating food calories and improve people's consumption conducts for fitness. It provides the users, patients with the convenient solutions for food intake.

S. Karthika Devi et.al. [13] presents a prospective view of how much calories is consumed by a person before and after a meal. From the calorie intake project, the management gets to know whether the person consumed the necessary amount of calorie. Although the hospital diet can provide adequate energy and nutrients, many patients may not consume sufficient food to meet their needs. The estimated energy intake of about one-third of patients was very low, and vitamin C, calcium and zinc intakes were also of concern. At least one-third of patients arriving at the hospital are malnourished. This can mean a patient's diet does not provide the right amount or appropriate ratio of calories, macronutrients, or micronutrients to promote adequate healing. If this continuous then it may be a risk to the patient's health and may not be a good sign. In this project, we proposed a deep learning system to monitor the nutrient intake for hospitalized patients. A Camera will scan the amount of food given to the patient, when the patient finishes the meal again the camera will again scan the amount of food the patient has taken. It will also note down the number of calories the patient has intake and the amount of calories the patient has left. This will help hospitalized patient to be healthy and will also help hospital staffs to monitor with ease.

Garima Koushik et.al. [14] developed and designed an efficient food nutrition detection system that is built using deep learning and fuzzy logic. An android application will be designed as a user interface for displaying the results to the user. The proposed system gives an advantage of the least user efforts over the other report based/questionnaire system where the user is required to manually give input about their food intake habits regularly.

III. CONCLUSION

Most of the authors developed convenient and easy to use software's for the user to simply take pictures with their device in real time and obtain nutritional information and calorie estimation of the food. Additionally, the accuracy of these systems will continue to improve from here including the more accurate volume estimation and better coverage of a variety of food categories. In practice, the traditional models in machine learning are not attaining much accuracy when it comes to image classification. In this paper, we have surveyed numerous methods of food recognition, some are traditional which uses machine learning and others are more advanced and hence quicker and more precise.

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