Calorie Measurement Of Food From Food Image

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Abstract — As people across the world are becoming more focused on their health it is necessary to keep the diet management. In this paper we proposed a semi automatic system which is used to measure the calorie for the food intake for that purpose a nutrition table is used. Our system uses a camera to record a photo of the food before and after eating it for the calculation of the calorie value. After taking the food image the color, shape, size and texture features are extracted and it is given to the Support Vector Machine (SVM) for recognizing the food portion and then the calorie value is measured with the help of nutrition table.

Keywords — Calorie measurement, Food image, Support Vector Machine

I. INTRODUCTION

Obesity is becoming a major health problem, for both adults and children. A Person is said to be obese if the body mass index is higher than or equal to 30(kg/m²)[1]. The number of obese young people is increasing, it is a huge problem and it is linked to an increase in type 2 diabetes[2]. In the year 2008, one in ten of the world’s adult population was obese in where as in 2012 this figure had risen to one in six adults an abrupt growth rate[3]. Recent researches have shown that obese people are more likely to have serious health conditions such as hypertension, heart attack, type 2 diabetes, high cholesterol, breast and colon cancer, and breathing disorders. The main cause of obesity is the imbalance between the amount of food intake and energy consumed by individuals. So, in order for the obese to lose weight in a healthy way, as well as for normal people to maintain a healthy weight, daily food intake must be measured[4]. Obesity treatment needs the patient to note the amount of the daily food intake, but in most cases, it is not simple for the patients to measure or control their daily intake due to the lack of nutrition, education or self-control. Therefore, by using a semiautomatic food intake monitoring system, we can assist the patient and provide an effective tool for the obesity treatment. Nowadays, new technologies such as computers and smartphones are involved in the medical treatment of different types of diseases, and obesity is considered as one of these common diseases. In the last few years, a numbers of food intake measuring methods have been developed. But most of these systems have drawbacks such as large calculation errors and it is not an user friendly. In addition, most of these methods are applied just for experimental practices and not for a real life usage.

One example is the 24-Hour Dietary Recall. The idea of this method is the listing of the daily food intake by using a special format for a period of 24 hours. This method is really hard for a person to remember the contents and the amount of the daily food intake, especially obese patients, because in most cases they cannot estimate the amount of food intake. Another method to calculate the food intake involves the capturing a photo of the dish and it uses neural network. This method might be difficult to follow by the user because the user must capture the photo in a tray in order to extract the shape of the food. Moreover, in this method the food image needs to be analyzed by computers and this is impractical for everyday usage measurement system. Our goal is to develop and implement an instrument that measures daily food intake using mobile devices with a built-in camera to capture a photo of the food intake before and after eating, in order to estimate the amount of consumed calories.

The proposed system depends on a new technique: the usage of the thumb as a calibration reference to estimate the amount of food from the captured photo. In this paper, we propose a personal software instrument to measure the value of calorie and nutrient intake using a smartphone or any other mobile device equipped with a camera. Our system uses image processing and segmentation to identify food portions (i.e., segregating portions such as egg, rice, vegetables, fruits and so on, from the overall food image) and measures the volume of each food portion, and calculates nutritional facts of each portion by calculating the mass of each portion from measured volume and matching it against existing nutritional fact tables.

While a primary description of our work has been presented in [5], In this work we extend it by proposing a more accurate measurement method for estimating food portion volume, which also works for food portions with an irregular shape, and by evaluating our approach with more food items. More importantly, the segmentation features are enriched by involving texture as well as color, shape, and size of the objects. The results show reasonable accuracy in the estimation of nutritional values for food types for which our system has been trained. Color and texture are the fundamental characters of natural images, and play a vital role in visual perception. Color has been used in identifying objects for many years. Texture is one of the most active topics in machine intelligence and pattern analysis since the 1950s which tries to discriminate different patterns of images by extracting the
dependency of intensity between the pixels and their neighboring pixels [6], or by obtaining the variance of intensity across pixels [7]. Recently, different features of color and texture are combined together to measure food nutrition more accurately [8].

II. PROPOSED WORK

The overall design is shown in Fig. 1. As the figure shows, at the early stage, images are taken by the user with a mobile device followed by a preprocessing step. Then, at the segmentation step, each image will be analyzed to extract various segments of the food portion. It is known that without having a good image segmentation mechanism, it is impossible to process the image appropriately. Hence we employed color and texture segmentation tools. We will show how these steps lead to an accurate food separation scheme.

For each detected food portion, a feature extraction process has to be performed. In this step, various food features including size, shape, color, and texture will be extracted. The extracted features will be sent to the classification step where, using the support vector machine (SVM) scheme, the food portion will be identified. Finally, by estimating the area of the food portion and using some nutritional tables, the calorie value of the food will be extracted. The thumb of the user and its placement on the plate is a one-time calibration process for the thumb, which is used as a size reference to measure the real-life size of food portions in the picture. We reported the concept of using the thumb for calibration, as well as its implementation. An example of food picture capturing and thumb isolation and measurement.

A. K Means Clustering

Clustering is a way to separate group of objects. K means treats each object as having a location in space. It finds partitions such that objects within each cluster are as close to each other as possible and as far from objects in other as possible. K means clustering requires number of clusters to be partitioned. In this case the numbers of clusters are three hence three image clusters are formed.

Step 1: Label every pixel in the image using the results from the k means clustering.

Step 2: Create image clusters. Since the numbers of clusters are 4 image clusters are formed. The results are given below.

B. Texture feature extraction

We used a Gabor filter-bank for texture feature extraction. The fig. 3. shows the result of feature vector. It is highly suitable for our purpose where the texture features are obtained by subjecting each image to a Gabor filtering operation in a window around each pixel. We can then estimate the mean and the standard deviation of the energy of the filtered image.

C. Support Vector Machine

The next step is classifying the extracted features in order to recognize each food portion. To do so, we used SVM which is one of the popular techniques used for data classification. A
classification task usually involves training and testing data which consist of some data instances. Each instance in the training set contains one class label and several features. The goal of SVM is to produce a model which predicts the target value of data instances in the testing set which are given only by their attributes. To increase accuracy, after the SVM module has determined each food portion type, the system can optionally interact with the user to verify the kind of food portions. For instance, it can show a picture of the food to the user, annotated with what it believes are the portion types, such as chicken, meat, vegetable, etc. The user can then confirm or change the food type. This changes the system from an automatic one into a semi-automatic one; however, it will increase the accuracy of the system. In our model, we used the RBF kernel, which maps samples into a higher dimensional space in a non-linear manner.

D. Food Portion Volume Measurement

To measure the size of the food inside the dish, two pictures must be taken: one from the top and one from the side, with the user’s thumb placed beside the dish when taking the picture from the top. The picture from the side can be used to see how deep the food goes, and is needed for measuring the food portions’ volumes. The system, which already has the dimensions of the user’s thumb, can then use this information to measure the actual area of each food portion from the top picture, and can multiply this area by the depth (from the side picture) to estimate the volume of food. Let us see this in more details in the following paragraphs.

To calculate the surface area for a food portion, we propose to superimpose a grid of squares onto the image segment so that each square contains an equal number of pixels and, therefore, equal area. First, compared with other methods, the grid will more easily match with irregular shapes, which is important for food images because most of the food portions will be irregular. Naturally, there will be some estimation error, but this error can be reduced by making the grid finer. Second, depending on the processing capabilities of the user’s mobile device and the expected system response time from the user’s perspective, we can adjust the granularity of the grid to balance between the two factors. If the grid is made finer, measurements become more accurate but will take longer time, and if the grid is made coarser, measurements become less accurate but the response time will be faster.

\[
TA = \sum_{i=1}^{n} Ti
\]

(1)

where \(n\) is the total number of squares in the food portion’s area. After that, and using the photo from the side view, the system will extract the depth of the food, \(d\), to calculate the food portion’s volume, \(V\), using the following:

\[
V = TA \times d.
\]

(2)

E. Calorie and Nutrition Measurement

The volume measurement method described above is really just an interim step to measure the mass of the food portion. Mass is what we really need since all the nutritional tables are based on food mass. Once we have the mass, we can use these tables to calculate the amount of calories and other nutrition, as described next. It is known that the nutritional facts database is an important component for a useful and successful food recognition system. The data of nutritional values of foods are stored in these tables and are available from national and international health organizations. At this point, we have the measurement for the volume of each food portion, and we can use the following general mathematical equation to calculate their mass:

\[
M = \rho V
\]

where \(M\) is the mass of the food portion and \(\rho\) is its density. Food density can also be obtained from readily available tables.

\[
\text{Calorie from the photo}= \text{Calorie from the table} \times \frac{\text{Mass in the photo}}{\text{Mass from the table}}
\]

(3)

Table I shows the calorie values of the food items given by the health organization.

<table>
<thead>
<tr>
<th>Food Name</th>
<th>Measure</th>
<th>Weight (grams)</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple with skin</td>
<td>1</td>
<td>140</td>
<td>80</td>
</tr>
<tr>
<td>Potato, boil, no skin</td>
<td>1</td>
<td>135</td>
<td>116</td>
</tr>
<tr>
<td>Orange</td>
<td>1</td>
<td>110</td>
<td>62</td>
</tr>
<tr>
<td>Tomatoes, raw</td>
<td>1</td>
<td>123</td>
<td>30</td>
</tr>
<tr>
<td>Bread white, commercial</td>
<td>1</td>
<td>100</td>
<td>17</td>
</tr>
<tr>
<td>Cake</td>
<td>1</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Egg</td>
<td>1</td>
<td>150</td>
<td>17</td>
</tr>
<tr>
<td>Cucumber</td>
<td>1</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Banana</td>
<td>1</td>
<td>100</td>
<td>105</td>
</tr>
<tr>
<td>Orange</td>
<td>1</td>
<td>110</td>
<td>62</td>
</tr>
</tbody>
</table>

III. RESULTS AND DISCUSSION

TABLE II

<table>
<thead>
<tr>
<th>CALORIE VALUE</th>
</tr>
</thead>
</table>

The results will be the values given in the TABLE II.
IV. CONCLUSION

In this paper, we proposed a measurement method that estimates the amount of calories from a food’s image by measuring the volume of the food portions from the image and using nutritional facts tables to measure the amount of calorie and nutrition in the food. As we argued, our system is designed to aid dieticians for the treatment of obese or overweight people, although normal people can also benefit from our system by controlling more closely their daily eating without worrying about overeating and weight gain and identifying food items in an image using image processing and segmentation, food classification using SVM, food portion volume measurement, and calorie measurement based on food portion mass and nutritional tables. An obvious avenue for future work is to cover more food types from a variety of cuisines around the world. In addition, more work is needed for supporting mixed or even liquid food, if possible.

REFERENCES
