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Segmentation and Classification of Indian food items from Images

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ABSTRACT
Now people are interested in food analysis with advanced technologies in many areas. In this paper we proposed a food identification system for South Indian food images. The system is based on segmenting the food images and classifies them to recognize what type of food it is. We are used region growing and region merging methods for segmenting a food images into multiple segmentation. Color and texture features are extracted by histogram and efficient LBP. Then radial filter is used with multiSVM for classification.

Keywords - Classification, Food image, Recognition, Segmentation.

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I. INTRODUCTION

Food is most important part of human's lives. Now there is increasing attention in food image recognition due to the advances of Internet, multimedia image techniques and improved social Medias. In trending technologies there is a high interest in accurate food image mining and analysis for a variety of applications which belongs to disease control, personal health-care and also in food industry. People are more conscious about their health. They known that food intake helps in dietary, obesity and other such problem prevention. This leads to research many application related to recognition of food for calorie, nutrition and carbohydrate measurements, volume estimation, and food log system. The methods proposed by [1, 2,3,4], relates to only single item in food images. [5] Recognizes the multi food images.

[6] Considered identification and classification of sugary food objects. For identification texture features are extracted by gray level co-occurrence matrix method and multilayer neural network is developed to classify food objects. [7] Developed a image analysis tools for identification and quantification of food consumed at meal. Connected component analysis, active contours and normalized cuts segmentation methods are used. [13] Presented a recognition and classification of images of agricultural/horticultural food items. They developed a classifier based on BPNN which uses the color, texture and morphological features to recognize and classify the different Food Grains, Fruits and Flowers Using Machine Vision. [5] Developed a effective two-step method for recognition of multiple-food images. In first step, they detected several candidate regions by deformable part model, circle detector and JSEG region segmentation. Feature fusion based food recognition method in second step. [8] Proposed a novel SVM based food recognition method for calorie measurement applications. They considered characteristics such as shape, color, size and texture for recognition algorithm. With the combination of above feature they achieved a better classification result. After food recognition, by nutrition table appropriate calorie is calculated and result is reported to user.
[9] Proposed a image analysis tools to image segmentation, feature classification and weight estimation. Regular and area-based shape template is used to weight estimation. The method used in this work improved the accuracy of segmentation and identification.

[10] proposed a Thai food recognition and calorie analysis method. They first segmented a food area, by using bag of feature (BOF) feature vector, then segmentation-base fractal texture analysis and color histogram is used. SVM is used to food recognition and classification. [11] Proposed a method to automatically identify and locate food for dietary assessment. The developed method records the food using mobile devices to provide an accurate count of daily food and nutrient intake. Based on local and global features the set of segmented items are partitioned into single item class. Automatic segmented regions are classified using multichannel feature classification. [12] Proposed a food image recognition method using super pixels segmentation. They considered a mid level approaches to segment a food part successfully.

Then it determines to mid level super pixel food parts to class similarity. For evaluation they considered a UEC food dataset.

From the literature survey it is observed that little work is carried out in concerned segmentation and classification of Indian food items. Hence we considered a method for recognition and classification of Indian food items.

II. PROPOSED METHODOLOGY

Food comes in many different forms and it is naturally deformable, hence representative dataset should contain different variability's. Many works is carried out on food image recognition in different fields. Less work is considered on Indian food items. Here we considered a five different south Indian food items for segmentation and classification. Some sample food images are shown in figure 1.

Figure 1: South Indian food images.

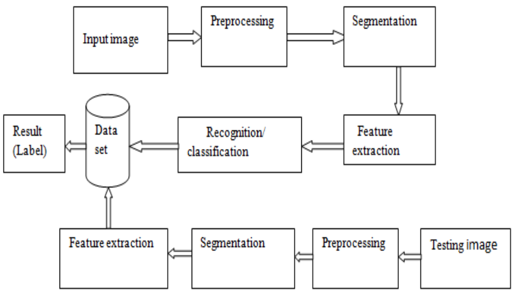

Figure 2. Block diagram of segmentation and classification method.

Figure 2: shows a block diagram of idle methodology used in the present work. This works contains segmentation, recognition and classification phases. The input is a food image on a circular plate and output is a mapped with specific label of the different food classes. The followings are used as segmentation and classification process.

1.Segmentation of food image: In our work Food image segmentation considers the following steps:

CIELAB conversion: The input image is converted to the perceptually uniform CIELAB color space. The Euclidean distance between two colors in CIELAB is considered more representative of their visual color difference. This color space is better suited to many digital image manipulations than the RGB space, which is typically used in image editing programs. For example, the Lab space is useful for sharpening images and the removing artifacts in JPEG images or in images from digital cameras and scanners. Moreover, the separate lightness channel (L) provides useful properties.

Pyramidal mean-shift filtering: Mean shift defines a window around pixels and computes the mean of data point. It shifts the center of window to the mean and repeats the algorithm till it convergence. It is an iterative process for feature space cluster analysis which has been applied with great success to image segmentation. We considered this image segmentation problem for feature space, the joint space-color hyperspace of five dimensions, the two spatial coordinates (*X*, *Y*) and the three color channels (*L*, *A*, *B*). At every pixel p=[(x,y)(l,a,b)] of the image, a neighborhood is defined in the hyperspace by the points:

$$[(x,y),(l,a,b)] : \begin{cases} |X - x| \le sth, \\ |Y - y| \le sth, \\ \|(L,A,B),(l,a,b)\| \le cth \end{cases} \qquad (1)$$

where $$\|(L,A,B),(l,a,b)\| = \sqrt{|L - l| + (A - a)^2 + (B - b)^2} \qquad (2)$$

and, *s*th *c*th are parameters experimentally estimated. Mean vector P` is calculated over the neighborhood.

P` is used as center point the next iteration. A Gaussian pyramid is constructed with four levels to enhance the method's efficiency, and the algorithm is applied on the smallest scale first. Further the results are propagated to the larger scale and the iterations are carried out again only on pixels with a color distance. Then, the fine-grain texture is smoothed without losing though the dominant color edges. Pixels of the same segment ideally have similar colors and it differs from the rest of the segments. If the previous assumption is true then a region growing algorithm could grow any seed pixel to the entire area of the corresponding segment.

Region Growing and merging: Here the process chooses seeds randomly from the pixels which have not been assigned yet to any segments, and expands them to all directions when the color distance of a neighboring pixel is less than the average segment color. Many of the produced segments are too small and assuming there is a minimum size of food item we can proceed with a region merging step. K-means clustering is used perform different cluster operations. Here every region with an area with lower threshold is merged with the adjacent segment with the minimum color distance.

Plate Detection: locate the plate in the image is done by using an ellipse detector. An edge map is created, edge components with less than 16 pixels are discarded and then the RANSAC paradigm is applied given the ellipse-generating property of single components. Each segment with more than

10% of its area outside the ellipse is considered background. Furthermore, each of the remaining segments that shares borders with the background for more than 10% of its contour's length is labeled as plate region and it is also discarded.

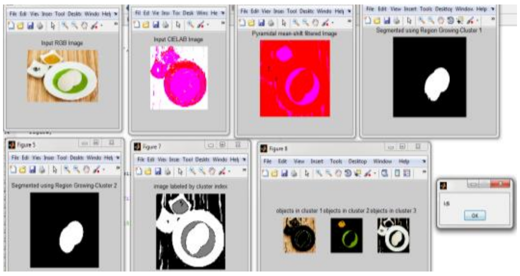

Figure 3. Proposed segmentation and identification of food image.

2. Recognition of food image: The recognition also considered in two parts: description and classification. We considered a color and texture feature sets for the food description and both sets are histogram-based. For color features, the histogram of the 1024 most dominant food colors was used. And hierarchical version of the k-means algorithm is applied to cluster the color space created by the training set of food images. For texture features the efficient Local Binary Pattern (LBP) operator was used. The LBP operator consists of a 3x3 kernel where the centre pixel is used as a threshold. Then the eight neighbors are multiplied by the respective binomial weight producing an integer in the range [0-255]. Each of the 256 different 8-bit integers is considered to represent a unique texture pattern.

3. Classification of food image: After combining color and texture features, a vector is created and fed to a multi SVM with a Radial Basis Function (RBF) kernel that will assign to the segment five predefined food classes.

III. RESULT DISCUSSION

In this proposed work we considered a five different types of food namely idli, vada, dosa, chapati and rice. These food items categorized in single and multiple food items. The figure 4: shows the single and multiple food identification and figure 5: shows the multiple food items.

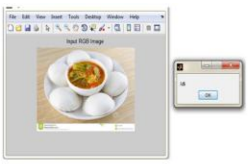

Figure 4. Single item food image identification.

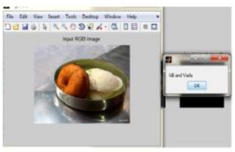

Figure 5. Multiple items food image identification.

To verify quality of a segmented image, compared a segmented image with ground truth, then taking the ground truth image as base of comparison and can make assumption of taking foreground as "white" pixels and background as "black" pixels in ground-truth. The terms are as follows: True positive (TP) : pixels correctly segmented as foreground. False positive (FP) : pixels falsely segmented as foreground. True negative (TN) : pixels correctly detected as background. False negative (FN) : pixels falsely detected as background. These metrics are then used to calculate sensitivity, specificity and accuracy for classification performance. The sensitivity tells us how likely the test is come back positive in someone who has the characteristic. This is calculated as TP/(TP+FN). The specificity tells us how likely the test is to come back negative in someone who does not have the characteristic. This is calculated as TN/(TN+FP). Finally accuracy is (TP+TN)/(TP+FP+TN+FN)

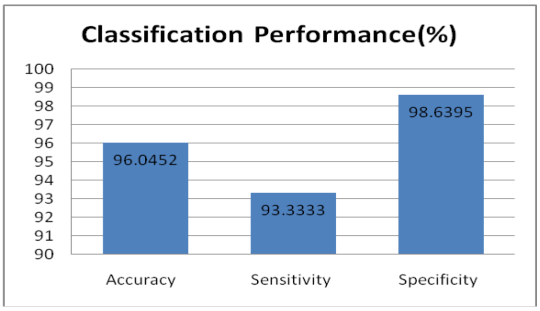

Figure 6. Classification Performance of the proposed system.

IV. CONCLUSION

The recognition of food items from food images is gain more important in our daily life. The proposed system presents an automatic segmentation and classification of five different south Indian food items. We have considered a nearly 150 single and multiple food items of South Indian food images. Accurate segmentation leads to accurate recognition/classification results. Hence we achieved 96% accuracy, 93.3% and 98.6% of sensitivity and specificity respectively for the performance of classification food images.

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