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Image Recognition using Visual Features

Rajivkumar Mente[1*] and B V Dhandra[2]

[1]Department of Computer Science, Solapur University, Solapur, India
[2]Department of Computer Science, Gulbarga University, Gulbarga, Karnataka

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***Abstract*—** Content-based image retrieval (CBIR) is a method which uses visual contents to seek images from large size image databases according to the choice of the users. Human intervention in the text based image retrieval makes the system cumbersome, labor intensive and time consuming. Hence, there is a need to design the algorithms to retrieve the desired images from the database without human intervention, to enable for fast, accurate and reliable retrieval of the desired images. The challenge of the CBIR system is to identify the suitable features of images to retrieve image from image database. The algorithm presented in this paper uses color, texture and shape features to form the feature vector of training images and test images. These feature vectors and the k-NN classifier is used to search the test image in the database of training images. A database of 2732 fruit images from six different classes is used to test the proposed algorithm. The higher recognition accuracy achieved for the proposed algorithm is 98.43%.

***Keywords*—** CBIR, k-NN, Color, RGB, Texture, Entropy, Shape, Eccentricity

I. INTRODUCTION

In text based image retrieval system a human intervention is necessary to describe every image. Therefore, human intervention makes the system cumbersome, labor intensive and time consuming [1-2]. Hence, there is a need to design the algorithms to retrieve the desired images from the database without human intervention, which enables fast, accurate and reliable retrieval of the desired images. Content Based Image Retrieval (CBIR) system has helped users to retrieve relevant images based on their contents In CBIR systems the low level features like texture, color and shape are used to seek images from large size image databases. Architectural and Engineering Design, Law enforcement and criminal investigation, Health Diagnosis, Publicity, Fashion and Interior design, E-Education, Remote Sensing and GIS, Web Searching etc. are some of the application areas of CBIR. A typical CBIR system contains preprocessing of the images for noise removal, feature extraction and classification. The challenge of the CBIR system is to identify the potential and the suitable features to retrieve images.

Color is one of the visual features applied in image retrieval systems. It is independent of image size and orientation. Color histogram is the most common method used for extracting the color features of images [3].

An image object is retrieved by evaluating the shape of objects. The overview of shape description techniques and recognition are given by Ritendra Datta et al. [3]. Shape based techniques can be broadly categorized in two types viz. boundary based and region based. Boundary based methods or external methods of shape extraction use only the contour or the border of the shape of object and ignore its interior. The proposed algorithm in this paper uses the shape feature called eccentricity.

Texture is specified in order to retrieve a specific pattern appearing in an image. This is used for retrieving and objects that shows a certain texture on its surface. This form of specification is applied for retrieving an object, one of whose property is texture. QBIC makes the query-by-texture flexible [4].

According to Niblack et al., Pentland et al. and Gong et al. color, texture or even geometric properties are required to identify objects. It is necessary to combine color features with texture and / or shape features to retrieve images from image database [4-6].

By considering only the color features in different regions of an image, the image retrieval accuracy achieved is up to 93.53 percent (Mente, Dhandra and Mukarambi, 2011) [7]. Shape and texture are important features for perceptual object recognition and classification of images. These features can be used in CBIR in conjunction with color for retrieval of image. For achieving efficient and effective retrieval performance and to increase the accuracy in the image retrieval, the proposed method in this paper uses the shape descriptor-eccentricity, texture descriptor-entropy and mean of pixel values in the red, green and blue color space as features of image.

II. IMAGE DATABASE

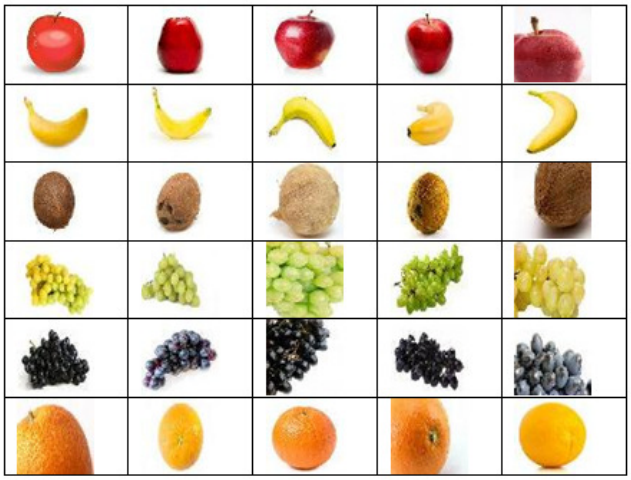
In experimentation a large image database consisting of 2732 images are considered. These images are single fruit images from six different classes of fruits. These images are obtained from the internet. The Table 1 presents the image descriptions and Table 2 represents some sample fruit images from image databases.

Corresponding Author: *Rajivkumar Mente rajivmente@rediffmail.com*

Table 1. Single Fruit Image Descriptions

Image Classes	Class Name	No. of Images
1	Apple	627
2	Banana	405
3	Coconut	316
4	Green Grapes	387
5	Black Grapes	538
6	Orange	459
Total images		**2732**

Table 2. Sample Images from Each Class



III. FEATURE EXTRACTION METHOD

- *Major Axis* : It is the segment of the straight line joining the two points on the border farthest away from each other.
- *Minor Axis* : It is perpendicular to the major axis and of such length that a rectangle with sides parallel to major and minor axes that just encloses the boundary can be formed using the lengths of the major and minor axes.
- The length of Region Of Interest (ROI) is characterized by Eccentricity. The ratio of the minor axis to the major axis is referred as Eccentricity [8].

Figure 1 shows that

$$Eccentricity = b / a.$$

The value of eccentricity is between 0 and 1. A value of 1 indicates that the ROI is a circle, and values close to zero indicate more stretched ROI. Eccentricity by itself is invariant to translation, rotation, and scaling.

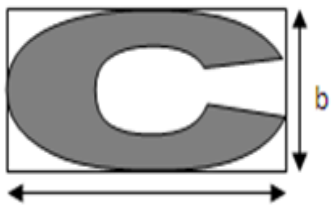


Figure 1 : Shape Descriptors

Various definitions of texture are compiled and described by Coggins [9] in the literature of computer vision and some definitions are as given below.

- "One may view texture as a macroscopic section. Its structure is attributed to the repetitive patterns in which elements or primitives are arranged according to a placement rule." [10]
- "A region in an image has a constant texture if a set of local statistics or other local properties of the picture function are constant, slowly varying, or approximately periodic." [11]
- "The image texture we consider is nonfigurative and cellular. An image texture is described by the number and types of its primitives and the spatial organization or layout of its primitives" [12].

Texture is one of the main feature used in an image processing to describe the surface and structure of a given object or region. An entity consisting of mutually related pixels or group of pixels is referred as texture. This group of pixels is called as texture primitives or texture elements (texels). A quantitative measure of the arrangement of intensities in a region is refereed as texture. Entropy is one of the statistical measures used for characterizing the texture of the input image.

The shape feature eccentricity, texture feature entropy can be used in CBIR system in conjunction with color to improve the percentage of accuracy of image retrieval. In this paper eccentricity, entropy and three mean intensity values of the red, green and blue color space are considered as the features for identification and retrieval of the input image. In the following an algorithm is designed to extract these features.

Algorithm 1 : VisualFeatureExtract(input_image)

Step 1 : Start
Step 2 : Input the color training / test image.
Step 3 : Calculate the eccentricity value
Step 4 : Calculate the entropy value of the image.
Step 5 : Calculate mean of each red, green and blue color space.
Step 6 : Store eccentricity, entropy and mean of Red, Green and Blue color spaces as vector in the feature matrix.
Step 7 : Label the image.
Step 8 : Store image labels and their index as vector in the other matrix.
Step 9 : Repeat step 2 to step 8 for each training / test image.
Step 10: Stop

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The Algorithm 1 is executed on a database consisting of 2732 different single fruit images downloaded from the internet. The details of the types of images and number of images are presented in Table 1 and sample images downloaded from standard database is presented in Table 2.

Figure 2 presents the flow of the proposed algorithm. k-nearest neighbor algorithm is a part of supervised learning algorithm used for classification of objects. In this experiment the similarity comparison is

performed with respect to the Euclidean distance and kNN classifier. k =1 is the best possible value found for this experiment.

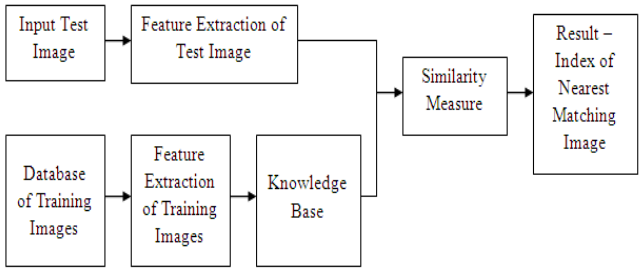


Figure 2: Flow of Comparing Test Image and Training Images

The experimental results obtained from the proposed algorithm are presented in Table 3 and Table 4.

Table 3: Percentage of retrieval accuracy for 50% training images and 50% test images

Image Class Name	No. of Training Images	No. of Test Images	No. of Matches (k=1)	Percentage of Accuracy
Apple	314	314	298	94.90
Banana	203	203	194	95.57
Coconut	148	148	146	98.65
Grapes	194	194	180	92.78
Black Grapes	269	269	266	98.88
Orange	230	230	218	94.78
Total	1358	1358	1302	95.93

The input images are single fruit images. The average percentage of accuracy is 95.93 and which is reasonably high. 98.88% is the maximum recognition accuracy and 92.78% is the minimum recognition accuracy which leads to the smaller deviation and confirming the constancy of the results.

Table 4: Percentage of retrieval accuracy for 75% training images and 25% test images

Image Class Name	No. of Training Images	No. of Test Images	No. of Matches (k=1)	Percentage of Accuracy
Apple	470	157	156	99.36
Banana	303	102	100	98.04
Coconut	222	94	94	100.00
Grapes	290	97	92	94.85
Black Grapes	403	135	135	100.00
Orange	345	114	111	97.37
Total	2033	699	688	98.43

In case of Coconut and Black Grapes the recognition accuracy is 100% and which is the maximum. The minimum recognition accuracy is 94.85%. This shows the consistency of the proposed algorithm. The average recognition accuracy obtained for 75% training and 25% testing sample images is more than the average accuracy obtained for 50% training and 50% testing sample images. This is obvious because as the training sample images increases the characterization/description of underlying image also increases.

V. CONCLUSION

In this paper an image retrieval system is presented based on the eccentricity, entropy and three mean of intensity values in red, green and blue color space. The percentage of accuracy in retrieval of query images is 98.43%. The grouping of the color, shape and texture features provides a strong feature set for image retrieval. The retrieval time is faster and more accurate.

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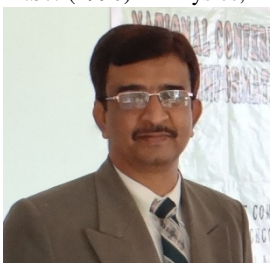
AUTHORS PROFILE



Rajivkumar S. Mente has completed B.Sc. (1990) in Physics, M. C. A. in 1993. Presently working in the capacity of Assistant Professor in School of Computational Sciences, Solapur University, Solapur. He is also working as Head of Department of Computer Science, He has total teaching experience of 20 years at UG and PG level. His research area is Content Based Image Retrieval (CBIR) He has published 15 research articles in national and international journals.