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Content Based Image Retrieval using Color, Texture and Shape features for fruit images

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Abstract— **In this paper Color, Texture and shape feature is used for retrieval of fruit images from database .The database contains a wide variety of fruit images. Moreover success of CBIR depends on the choice of the method used to generate feature vector, similarity measure and accuracy of segmentation technique employed. The accuracy of the system can be increased by retrieving images based on their color, texture and shape feature similarity. For color Mean, variance and standard deviation is computed. For texture co-occurrence based entropy, energy, correlation are calculated and for shape, using Seeded Region Growing algorithm and Canny edge detection the images are preprocessed and then Shape features such as extent, eccentricity, equivalence diameter, circularity and solidity is measured. Euclidean distance measure is used for retrieval of images. Experimental results have shown that the proposed system can improve the retrieval accuracy. The system is tested on 250 fruit images downloaded from internet.**

Index Terms - **Content based image retrieval, CIE L*a*b* color space, GLCM, Seeded region growing algorithm, Canny Edge Detection, Euclidean distance**

I. INTRODUCTION

Color, Texture and shape feature are used for retrieving the images from the database according to visual content of images is referred as Content Based Image Retrieval. . A major approach directed towards achieving CBIR is the use of low-level visual features of the image data to segment, index and retrieve relevant images from the image database. To retrieve desired images, user has to provide a query image. The system then performs colour, texture and shape feature extraction procedures on it and represents it in the form of feature vectors. The similarities distances between the feature vectors of the query image and those of the images in the database are calculated and retrieval is performed with the help of indexing schemes. The indexing scheme provides an efficient way to search for the image database.

The rest of the paper is organized as follows: section 2 gives the related research work done in the field of image retrieval. The system architecture of the system is described in section 3.Section 4 provide the details of the feature extraction process used for color, texture and shape. In section 5 experimental evaluation and results were discussed. Finally conclusion is made in section 6 followed by references.

II. RELATED WORK

In 1979, a conference on Database Techniques for Pictorial Applications was held in Florence [4].Since then, the application potential of image database management techniques has attracted the attention of researchers. In the early 1990s, as a result of advances in the Internet and new digital image sensor technologies, the volume of digital images produced by scientific, educational, medical, industrial, and other applications available to users increased dramatically. It is observed that there has been an exponential increase in computing power and storage capacity. The difficulties faced by text-based retrieval became more and more severe. The efficient management of the rapidly expanding visual information became an urgent problem.

M. Flicker et al. [4] have introduced QBIC (Query by Image and Video Content) system in which color features based on histogram, texture features based on improved temura texture representation and the shape information include area, circularity, eccentricity, major axis orientation, and moment invariants. KLT (Karhunen-Loeve transform) was used for dimensionality reduction and R*-Tree was employed for indexing requirement.

J.R. Smith et al. [10] have presented the VisualSEEK system, which supported both query by example and text based query. The system uses the following visual features: color represented by color set, texture based on wavelet transform, and spatial relationship between image regions. A binary tree was used to index the feature vectors.

A. Pentland et al. [11] have presented the Photobook system in which the images were organized in three sub books from which shape, texture, and face appearance features were extracted respectively and used in the retrieval process.

James Z. Wang et al.[8] have presented SIMPLIcity (Semantics sensitive Integrated Matching for Picture Libraries),an image retrieval system, which uses semantics classification methods, a wavelet-based approach for feature extraction, and integrated region matching based upon image segmentation.

P.B Thawari et al. [2] have presented a generalized approach for image retrieval based on color and texture feature extracted from histogram. Users can retrieve images either by combining color and texture features or individually.

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Suresh Pabboju et al. [5] have presented an image retrieval system combining global and region features. Global features like mean, standard deviation ,and edge density are calculated and indexed together with region features using R* trees. Fractional distance measures are then used to retrieve similar images from databases.

S.Nandgopalan et al.[4] have build a universal CBIR system using low level features. These are mean, median, and standard deviation of Red, Green, and Blue channels of color histograms. Then the texture features such as contrast, energy, correlation, and homogeneity are retrieved.

III. SYSTEM ARCHITECTURE

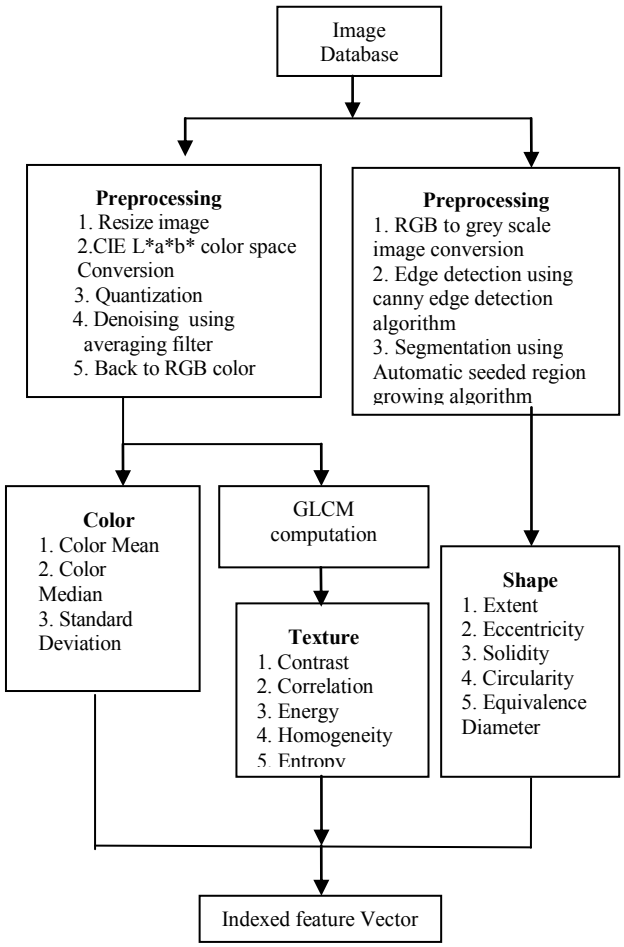

Fig.1. The architecture of the content based image indexing

Fig. 1 shows the architecture of the content based image indexing .The images are stored in database called image database. An image to be stored in database undergoes pre-processing before global features are extracted from them

Pre-processing of images includes image resizing, conversion to CIEL*a*b* color space, Quantization, De-noising using convolution kernel filter, Conversion back to RGB color space. Global color and texture feature are extracted from the enhanced image For each image color feature like mean, variance and standard deviation are calculated to form color feature vector. For texture feature extraction, GLCM is computed and from which features like contrast, correlation, energy, homogeneity and entropy are extracted to form texture feature vector.

Similarly image to be stored in database undergoes pre-processing before region features are extracted from them. For extraction of shape features color image is first converted to grey scale image and filtered using averaging filter to remove noise. Canny edge detection algorithm is then applied for edge detection. Using automatic Seeded Region growing segmentation algorithm [9] image is divided in to multiple regions. The boundaries of these regions are extracted in the form of pixel coordinate values. Out of several regions we have taken the region having the largest connected boundary. The boundary of the largest region is separated from the image. Shape feature vector is constructed by calculating features like extent, eccentricity, solidity equivalence diameter, and circularity for largest connected boundary. These entire feature vector are combined to form a single feature vector.

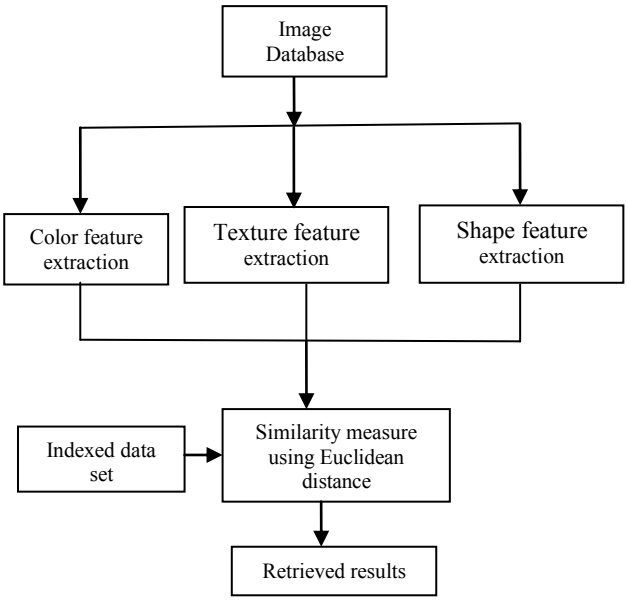

Fig. 2 The architecture of Content Based Image Retrieval

Fig. 2 shows the architecture of CBIR .Similar preprocessing and feature extraction steps are applied to the query image and Color, Texture and Shape feature is extracted .By combining these features single feature vector is formed. Feature vector of query image and feature vector of images in database are compared using Euclidean distance .Images having low Euclidean distance than specified threshold value are retrieved and presented as output.

IV. FEATURE EXTRACTION

A. Color

The major statistical data that are extracted are mean, standard deviation, and variance for each color channel i.e. Red, Green, and Blue.. All the segments need not be considered, but only segments that are dominant may be considered, because this would speed up the calculation and may not significantly affect the end result [4].

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1) Mean

All the pixels of a particular layer are added and divided by the total number of pixels of the image and this is performed for each of the channel.

$$\text{Mean}=\sum_{i=1}^{n}\sum_{j=1}^{m}\frac{Xij}{mn} \quad \ldots\ldots (1)$$

Where Xij is the pixel value of the i^{th} row and j^{th} column.

2) Variance

The variance is a measure of how far a set of numbers is spread out. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value).

$$\text{Variance}=\frac{1}{mn}\sum_{i=1}^{n}\sum_{j=1}^{m}(Xij-Mean)^2 \quad \ldots\ldots (2)$$

3) Standard deviation:

Standard Deviation shows how much variation or "dispersion" exists from the average (mean, or expected value). A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data points are spread out over a large range of values. Three values of standard deviation for each of the color layers would exist since we utilize the RGB color space. Mathematically standard deviation is given by

$$\text{Standard Deviation } (\sigma)=\sqrt{Variance} \quad \ldots\ldots (3)$$

B. Texture feature extraction

1) Correlation

A measures of how correlated a pixel is to its neighbor over the entire image. Range of values is 1 to -1, corresponding to perfect positive and perfect negative correlations. This measure is not defined if either standard deviation is zero.

$$\text{Correlation}=\sum_{i,j}\frac{(i-\mu i)(j-\mu j)pij}{\sigma i\sigma j} \quad \ldots\ldots (4)$$

2) Energy

A measures of uniformity in the range [0, 1].Uniformity is 1 for a constant image.

$$\text{Energy}=\sum_i\sum_j pd^2(i,j) \quad \ldots\ldots (5)$$

3) Entropy

Entropy is a measure of the uncertainty associated with a random variable.

$$\text{Entropy}=\sum_i\sum_j pd(i,j)logpd(i,j) \quad \ldots\ldots (6)$$

4) Contrast

A measure of intensity contrast between a pixel and its neighbor over the entire image. The range of values is 0(when G is constant) to $(K-1)^2$

$$\text{Contrast}=\sum_i\sum_j(i-j)^2pd(i,j) \quad \ldots\ldots (7)$$

5) Homogeneity

Homogeneity means "being similar throughout"(like same color can be said to one part segmentation can also be done through this).

$$\text{Homogeneity}=\sum_i\sum_j\frac{pd(i,j)}{1+|i-j|} \quad \ldots\ldots (8)$$

C. Shape feature extraction

1)Extent:

It gives the proportion of the pixels in the bounding box that are also in the region. It is computed as the area divided by the area of the bounding box.

$$Extent=\frac{Area}{Bounding\ \ Area} \quad \ldots\ldots (9)$$

2)Eccentricity

It is the ratio of the minor axis to the major axis of the best fitting ellipse of the shape. Its value lies between 0 and 1.

$$\text{Eccentricity}=\frac{Minor\ \ axis\ of\ Ellipse}{Majaor\ \ Axis\ of\ Ellipse} \quad \ldots\ldots (10)$$

3) Equivalence Diameter

It is defined as the diameter of a circle with the same area as the region.

$$\text{Equivalence Diameter}=\sqrt{\frac{4*Area}{\pi}} \quad \ldots\ldots (11)$$

4) Circularity

It gives the extent to which the shape is a circle. This parameter is 1 for circle and 0 for long bar.

$$\text{Circularity}=4\pi\left(\frac{Area}{Perimeter^{\ 2}}\right) \quad \ldots\ldots (12)$$

5) Solidity

It gives the extent to which the shape is convex or concave. Solidity for full convex contour is always 1.

$$\text{Solidity}=\frac{Area}{Convex\ \ Area} \quad \ldots\ldots (13)$$

a. Similarity Measure

For similarity comparison, we have used Euclidean distance, d using equation 14[4].

$$D=\sqrt{\sum_{i=1}^{N}(Fq[i]-Fdb[i])^2} \quad \ldots\ldots (14)$$

Where FQ[i] is the i^{th} query image feature and Fdb [i] is the corresponding feature in the feature vector database. Here, N refers to the number of images in the database.

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V. EXPERIMENTAL SETUP AND RESULTS

The proposed system is implemented and tested for fruit images. The database consists of 250 fruit images, which were downloaded from internet. All the images are in JPEG format. A Computer system having Pentium Dual Core (3.06 GHz) and 2GB RAM is used. The MATLAB 7.10.0 software tool is used.

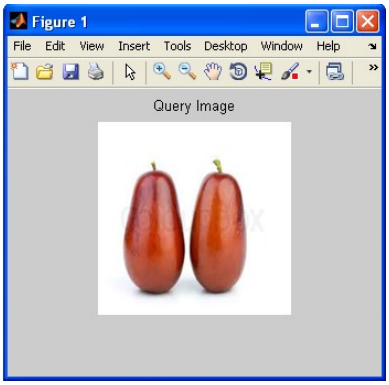


Fig.3 Query Image

Figure 3 shows the query image used in conducting the experiment. Query image is uploaded randomly from the database .

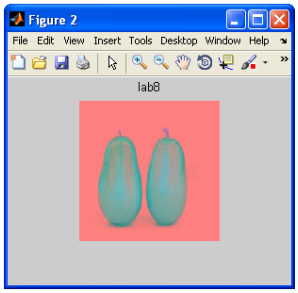


Fig4(a) L*a*b* image

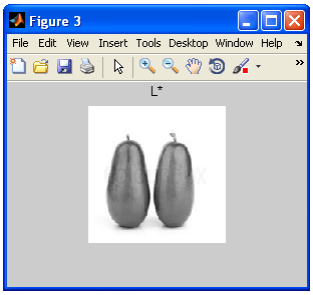


Fig 4(b)L* image

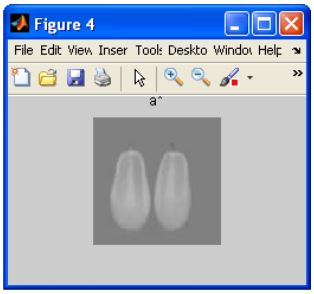


Fig 4(c) a* image

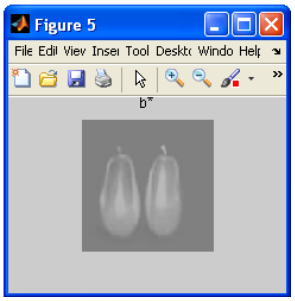


Fig4.(d) b* image

Figure 4 shows the output of RGB to CIE L*a*b* image conversion process. After conversion, The 24 bit CIE L*a*b* image is quantized to 8 bit image. The quantized image is filtered to remove blur by using averaging filter.

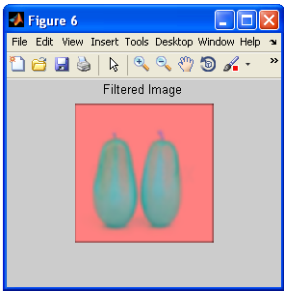


Fig.5 Filtered Image

Figure 5 shows Quantized and filtered image.CIE L*a*b* image is again converted to RGB image . Figure 6 (b), (c) and (d) shows Red(R),Green(G) and Blue(B) plane respectively with intensity values.

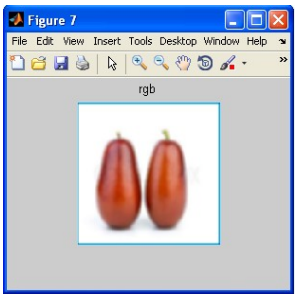


Fig 6(a) RGB image

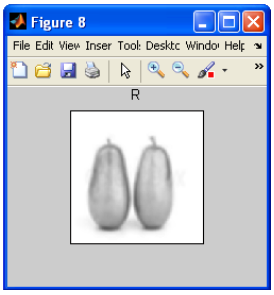


Fig6(b) R image

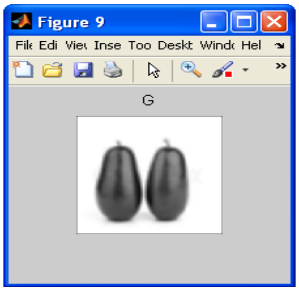


Fig 6(c) G image

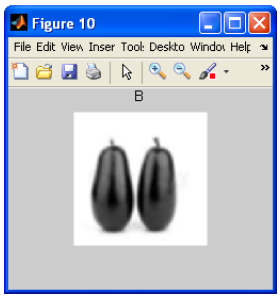
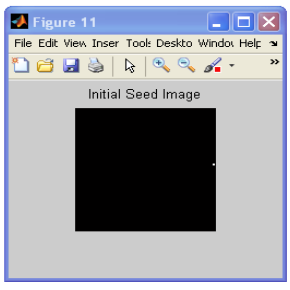


Fig6(d) B image

For Shape feature extraction, RGB image is converted to Grey scale image.Thresholding operation is applied to grey scale image and by using Canny edge detection algorithm, edges are detected. Automatic Seed Growing Algorithm is used for seed selection. Finally, region with largest boundary area is selected and formulas are applied. Results are shown in Figure 7



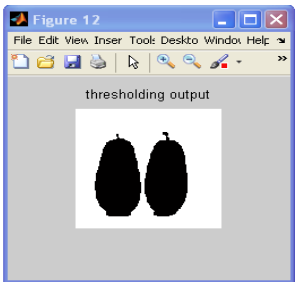


Fig 7(a) Initial seed selection image Fig 7(b) Thresholding output

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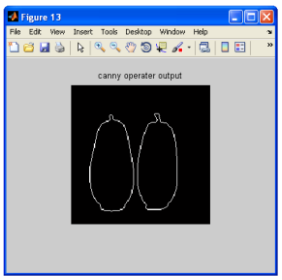

Fig 7(c) Canny edge detection algorithm output

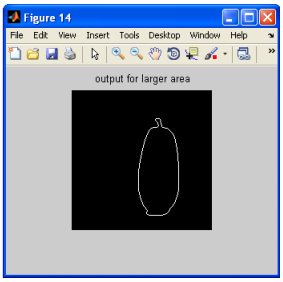

Fig7(d) Output for larger area

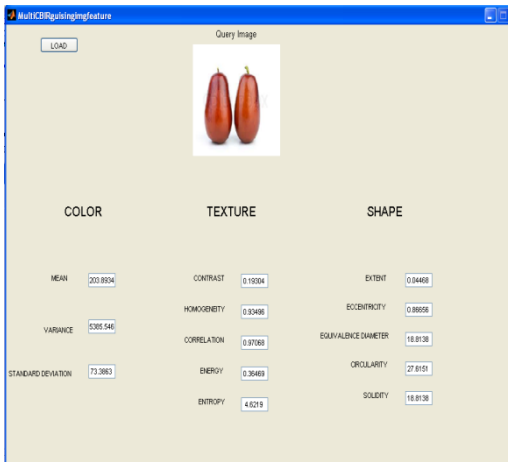

Fig. 8 GUI for feature extraction or query image

Figure 8 shows the GUI (Graphical User Interface) for color, texture and shape feature for query image. GUI is buildup by using MATLAB GUI Builder. Single pushbutton (LOAD), at the left hand side of GUI, is used to uploading and selecting the query image from the database. The 3 axes, in the right hand side, are used to show color feature such as Mean, variance and standard deviation. The 5 axes, in the middle, are used to show texture feature such as contrast, homogeneity, correlation, energy, entropy and 5 axes, in the right hand side, are used to show shape feature such as extent, eccentricity, equivalence diameter, circularity, solidity. Table I shows the values of color, Texture and shape features of the query image.

Fig. 9 Images from database(1 to 5)

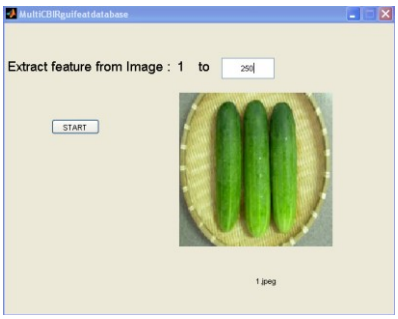

Fig. 10 GUI for feature extraction for images in database

Figure 9 shows the randomly selected query images.Figure 10 shows the GUI for feature extraction for images in database. Single pushbutton (START), at the left hand side of GUI, is used to start uploading the images from the database and saving the feature results in the database. Single axes, at the right hand side of GUI, are used for specifying the numbers of query image to be extracted from the database. String field, at the bottom, displays the name of image.

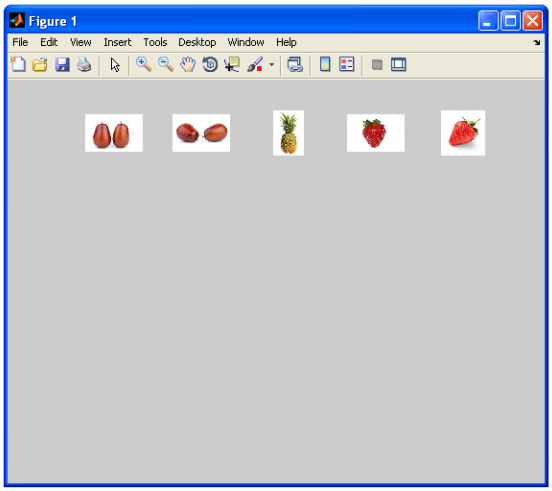

Fig. 11 Retrieved images for query image

a. Retrieval Efficiency

The retrieval efficiency, namely recall and precision were calculated using 250 color fruit images (10 in each category) from database. Figure 11 shows the screenshot of the retrieved images. Standard formulas have been used to compute the precision and recall for query image.

$$\text{Precision} = \frac{No.of\ relevant\ \ images\ \ reterived}{Total\ \ numbers\ \ \ of\ image\ \ reterived}$$

$$\text{Recall} = \frac{No.\ of\ relevant\ \ images\ \ reterived}{Total\ \ no.of\ \ relevant\ \ \ images\ \ in\ the\ database}$$

By loading query images from Database, the system was tested and the result is shown in Table 1.

TABLE II PRECISION AND RECALL ANALYSIS

Sr.No	Image	Precision	Recall
1	Image 1	40%	20%
2	Image 2	50%	30%
3	Image 3	30%	10%
4	Image 4	40%	20%
5	Image 5	30%	20%

In table 1, the first column indicates precision and the second column indicates recall. Figure3 shows the query image used in conducting the experiment. The relationship between precision and recall is inversely proportional. The different images of the same class give results ranging from 30% to 60% [14]

VI. CONCLUSION

The paper presents Color, Texture and Shape features extraction for fruit images using GUI. In order to improve

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the functionality and retrieval efficiency of the system Fuzzy logic can be used for same or different class of images. Preprocessing, Segmentation method and features used for retrieval may be more or different for different classes of images.

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