Query By Image Content using Discrete Cosine Transform

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***Abstract*— The need for Query By Image Content (QBIC) peaked up due to the increase in the size of image database. The proposed method chooses appropriate feature extraction methods to extract the features, shape and color to enhance the retrieval efficiency and accuracy. It employs SRM (Statistical Region Merging) algorithm for segmentation and uses DCT (Discrete Cosine Transform) on the segmented image to obtain the shape feature vector. Color feature is obtained by considering the RGB components in the image. The processed feature vectors are collected in the feature database which is then compared with the query image's feature vector. When the difference matches a specific threshold, the most similar images are retrieved automatically**.

Keywords- QBIC, SRM, DCT, RGB.

I. INTRODUCTION

Retrieval of images can be performed by various approaches. One such approach which uses textual description of images in terms of keywords is a complex process and consumes much time. Yet another ambiguity with retrieval of images is that the level of perception varies with different people where it would be just a prediction. The emanation of QBIC is to enhance the search in case of large database. It reduces the demerits of the existing approaches and provides desirable features like indexing, clustering to enhance image retrieval accurately by content.

There are various approaches for QBIC. One of the most popular methods of QBIC is image retrieval based on feature extraction. Image retrieval is an amalgamation of low set of features and high set of features. Color, shape and texture belong to low level features. High level features cannot be extracted from visual contents. It uses conventional textual descriptor for image retrieval. Fundamental technique of QBIC is visual feature extraction. This is mainly to overcome the semantic gap which is the difference between the interpretation of the user and the information in the visual data. Features that are widely used include spatial relationships, shape, color, texture.

Choosing the appropriate feature extraction method contributes much towards the accuracy of QBIC systems. The proposed method uses shape and color for image retrieval. Shape does not specify the shape of the image instead it refers to a particular region of interest in the shape acquired by segmentation. Color feature extraction is a widely used technique since it does not depend on the size of the image.

II. RELATED WORK

Abdel Rahim et al. [1] proposed a method inorder to minimize the space requirement. Signature bitstrings are used for image abstraction. Color feature is extracted using global color histograms. Chandan Singh & Pooja Sharma [2] performed an evaluation against local and global descriptors and proposed a novel local descriptor based on the histograms of edges by using Hough transform.Kekre et al [3] proposed an integrated content and keyword based image indexing where feature vector is generated using color averaging technique and similarity is measured using Euclidean distance. Ela Yildizer et al. [4] proposed integrated Daubechies wavelet transform and indexing technique to enable automated search and Multi-class Support Vector Regression (SVR) ensemble to handle multi-class image databases.

Ela Yildizer et al. [5] Proposed a method to retrieve the color feature in an efficient and effective way which integrated K-means clustering and B+ tree database indexing technique. Guang-Hai Liu et al. [6] paid more attention towards color, edge orientation, uniform color differences and Integrates low level features as a whole. Jun Yue et al. [7] proposed a method using color histogram and texture features based on co-occurrence matrix, feature vectors are extracted. By using the fused features (texture and color), CBIR system is designed by constructing weights of feature vectors. El Alami et al. [8] aimed at selecting optimal features. It included extracting color and texture features through color histogram and Gabor filter algorithm respectively and GA

was used for feature discrimination and features are selected using preliminary and deeply reduction to extract relevant features.

Manimala Singha & Hemachandran. [9] used WBCHIR (Wavelet Based Color Histogram Image Retrieval) to extract texture and color features. Similarity is ascertained by a distance function. Manimala Singha & Hemachandran [10] proposed a similarity measurement for various images, to enable a model with a wide range of color spaces to find quantized color spaces. RGB, HSV, L*u*v are exhaustively compared. Padmashree Desai et al. [12] used wavelet decomposition method to extract shape feature performed edge detection using Daubechies and coiflets. Ramamurthy & Chandran [14] proposed an efficient method to extract shape feature using canny edge detector and K means clustering for medical images. Rishav Chakravarti & Xiannong Meng [15] proposed a simple color histogram based search and retrieve algorithm for images which used Rank Power measurement for analysis. Swati Sakhare & Vrushali Nasre [16] used color histogram and tammura texture with wavelet transform to extract color and texture features respectively. Region and boundary based Color representation is ascertained through moment invariants and Fourier descriptor respectively. Similarity is measured by direct Euclidean distance. Xiang-Yang Wang et al. [17] used Dominant Color Descriptor , steerable filter decomposition, pseudo-zernike moments to extract color, texture and shape features respectively(multi-resolution feature extraction). Similarity is measured by Euclidean distance.

III. ALGORITHM

The proposed work on image retrieval aims at extracting the feature vectors of shape and color which is then used to match the images in the database with that of the query image. The steps involved in the proposed work are given below:

Step 1: Consider an input image.

Step 2: Image segmentation is performed by SRM (Statistical Region Merging) algorithm on the input image.

Step 3: DCT is applied on the segmented image to extract the shape feature vector

Step 4: RGB component values are obtained in order to extract the color feature vector

Step 5: The obtained feature vectors are collected in the feature database.

Step 6: Feature vector is also calculated for the query image to enable the search in the database.

Step 7: Euclidean distance measure is evaluated to obtain the similarity measurement to obtain the analogy between the query image and the images in the database.

IV. PROPOSED WORK

A QBIC system retrieves the images that are similar from the database by comparing the feature vectors of the database images and the query image. In the proposed method, shape and color is used to extract the features which form the visual content of the image. It uses DCT for shape feature extraction and RGB color component for color feature extraction. Segmentation plays a vital role in analyzing images.

Initially, the input image is segmented using SRM. Feature extraction procedure is applied to the segmented image to extract the feature vectors. Feature database collects the extracted feature vectors.Similarity measurement with respect to a threshold value is incorporated. The system overview is illustrated in Fig 1. ,

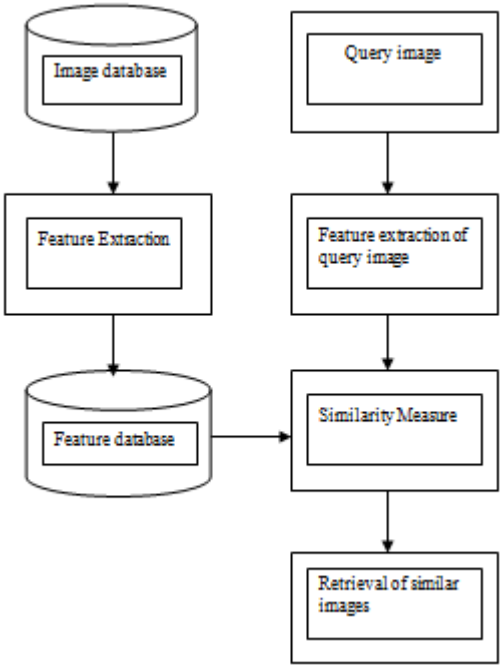


Fig 1: QBIC SYSTEM

A. System Requirements

The proposed system was implemented using MATLAB R2010a on a 32 bit windows based PC.

B. Image Database

The proposed work considers a sample dataset of 186 leaf images from http://www.vision.caltech.edu with different background along with shape and color variations. Out of 186 images, 25 images are considered for processing shown in Fig 2.

C. Image analysis

Segmentation forms the basic step in analyzing images. Segmentation finds its importance in recognition of objects in images. To identify the features of interest in an image, segmentation partitions the image into regions. The two major properties of segmentation forms

- Discontinuity
- Similarity

One such property used in the proposed work is similarity, which uses region merging technique for segmenting images. It depends on two prerequisites.

- Region merging predicate, which determines the merging criteria between two undetermined regions.
- Order in merging, which determines the order to be followed to satisfy the merging predicate.

It makes use of Statistical Region Merging (SRM) algorithm which is advantageous with properties of robustness and faster processing capability. SRM partitions an image into regions with similar color or intensity. Using SRM, the scale of segmentation can be controlled. It mainly depends on the segmentation tuning parameter. On setting the segmentation parameter to a smaller value, the statistical estimation is harder to evaluate and therefore the number of regions in the segmentation will be less and vice versa. In this work, the segmentation parameter ranges between 1 and 256 (1, 2, 4, 8…256) which displays images at different scales. Output is a segmentation map with 9 segmentations shown in Fig 4.b. SRM provides a list of pixel belonging to each segmented region and its relative mean color. Edge detection is performed by using SRM with Sobel convolution filter since the color variations should be smaller within regions rather between regions shown in Fig 4.c.

D. Feature Extraction

1) *Extraction of Shape Feature*

Shape feature can be represented in one of the following ways

- Region based

- Boundary based

The basic representation of shape is given by Fourier transformations. There are several other transformations for shape representation other than Fourier transform [11]. One such method is representing the shape feature by Discrete Cosine Transform (DCT) which is advantageous for its shift variant property and energy compaction. It transforms the image from spatial domain to frequency domain which works on cosine basis. The proposed work uses DCT in the segmented image to represent the shape feature given by [13],

$$c(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)cos\left(\frac{\pi(2x+1)u}{2N}\right)cos\left(\frac{\pi(2y+1)v}{2N}\right)$$

,

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}}, & for\ u = 0 \\ \sqrt{\frac{2}{N}}, & for\ u \neq 0 \end{cases} \quad (1)$$

where,

u -denotes regular frequency spatially,

v- denotes perpendicular frequency spatially,

f(x, y) - is the pixel value at (x, y),

C(u, v) -DCT coefficient at (u, v).

With DCT, the image is partitioned into 8x8 blocks. Each block is processed with DCT to achieve the DCT coefficients. Without IDCT (Inverse DCT), image can be extracted by reconstructing the image from the DCT coefficients of all the blocks.Each block of 8x8 pixels consists of one pixel where the DC (Discrete cosine) images will be smaller in size. By applying DCT repeatedly on the DC image, the image size is reduced so that its size reaches 8x8. DCT is then applied on this block to extract the desired features and the resultant quantized DCT is stored as the feature vector for the images in the database.

2) *Extraction of Color Feature*

Color content is yet another way of representing images. With respect to its content, it can be of either

- Intensity image
- Color image

A RGB color image comprises of Red (R), Green (G), Blue (B) component images. The proposed work contributes each individual color component from the images to determine the color feature of the images in the database. The use of RGB color representation provides a simplified system design.

The total and the mean intensities of the three component values(R, G, and B) are extracted from the images and stored in the feature database ranging from 0 to 255.

The total intensities in R component is given by,

$$R_T = \sum_{i=1}^{N} R_i \quad (2)$$

and is the same for Green and Blue components respectively.

E. Image Matching

This is mainly to determine the affinity between images in the database with that of the query image. A threshold is set to measure the similarity between the feature vector (FV) of the query image and the database images. The image that coincides with the threshold is retrieved. The distance measure is given by [13],

$$D_{QI} = \sqrt{\sum_{i=1}^{n} (FQ_i - FI_i)^2} \quad (3)$$

where,

D denotes the distance,

FQ denotes the FV of the query image,

FI denotes the FV of the database images.

With the above measure, the proposed work displays the subsystem of similar images in comparison with the query image.

V. RESULTS AND DISCUSSION

A.Sample Database

Database consists of 186 images of three different categories with different shapes and color variations, out of which 25 images are considered for processing shown in Fig 2,

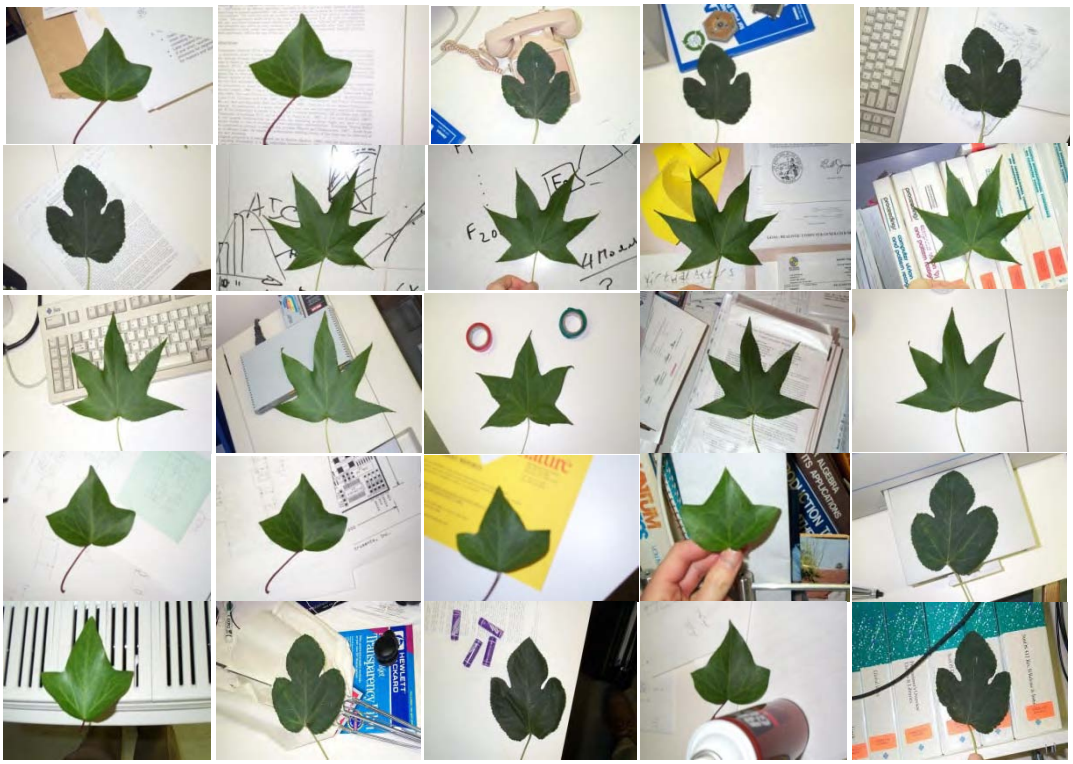


Fig 2: Sample Database with 25 images out of 186 images

B.Sample Query images

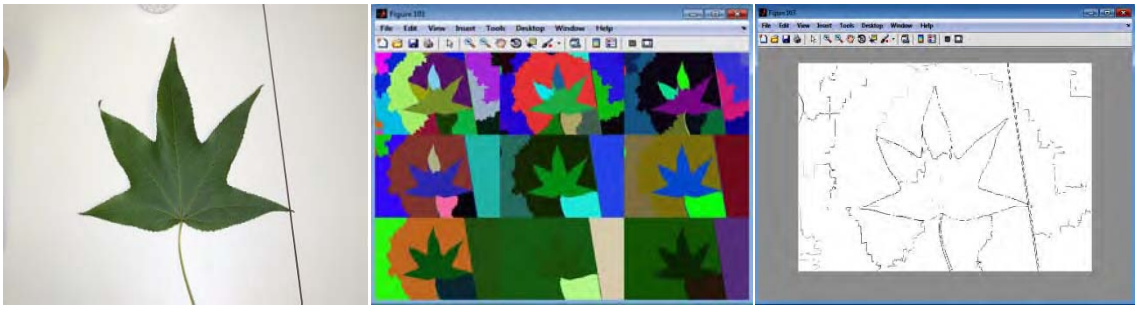
Considering three query images from each category to obtain the images similar to that of query image from the database which is shown in Fig 3,

Q1 Q2 Q3

Fig 3: Query images of three different categories

C.Image Preprocessing using SRM

Image preprocessing requires image segmentation of the query image which uses SRM algorithm to generate a segmentation map and edge is detected by using SRM with sobel filter which is shown in Fig 4,



4. a) Query Image 4.b) Segmented Image 4.c) Edge Detection

Fig 4: Image Segmentation

D.Image retrieval from the image database

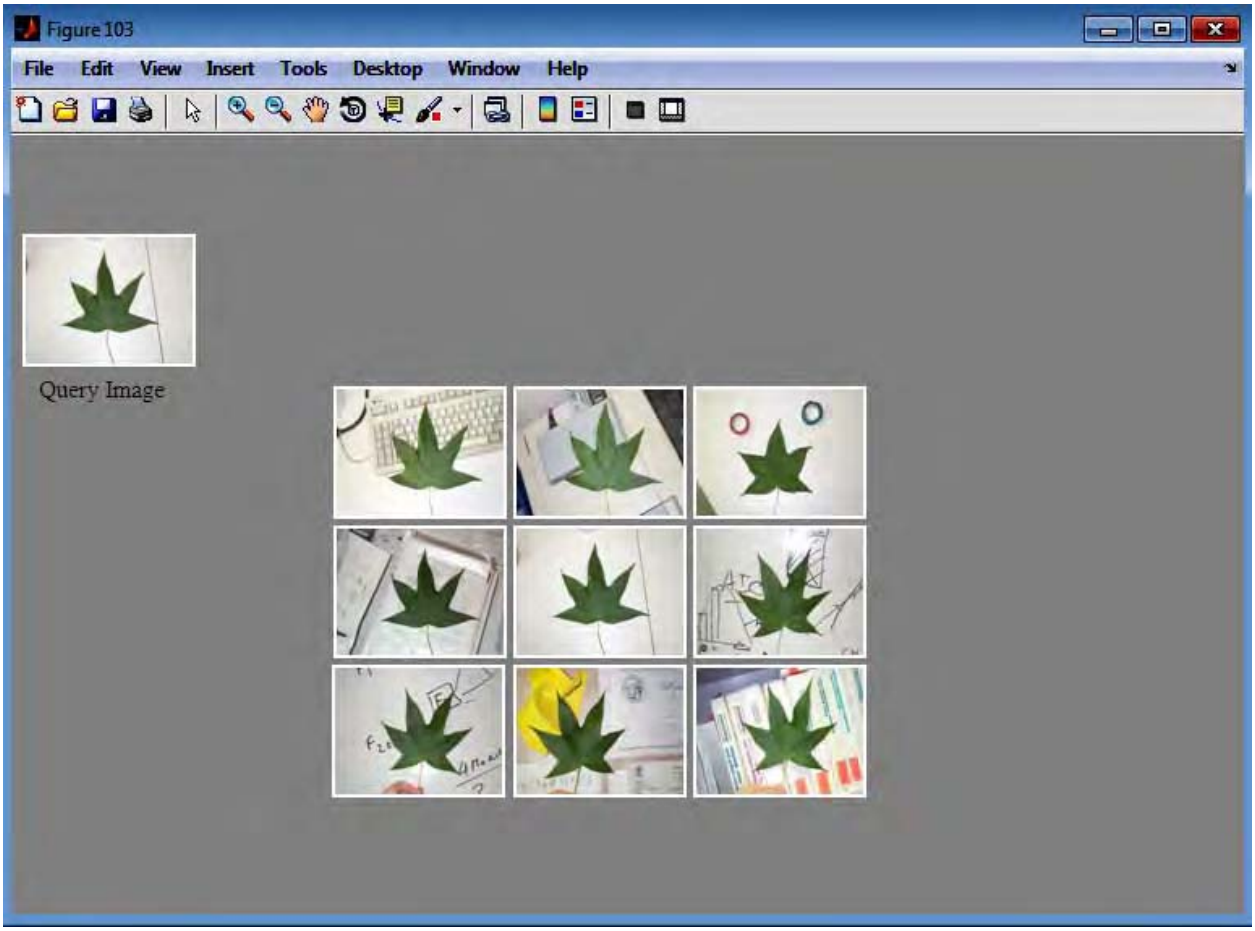


Fig 5: Retrieved images of category 1 (C1) from database

Performance analysis

Retrieval performance is evaluated by using,

$$\text{Precision} = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ images\ retrieved} \quad (4)$$

$$\text{Recall} = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ relevant\ images\ in\ Database} \quad (5)$$

Table 1 depicts the mean precision of three categories of the query image C1, C2 and C3. Average precision and recall of the three different categories of the query image using DCT is depicted in Table 2.

TABLE 1: Average precision for C1, C2 and C3 using DCT

Category	**C1**	**C2**	**C3**
Q1	9	8	8
Q2	8	7	8
Q3	7	8	8
MINIMUM	7	7	8
MAXIMUM	9	8	8
AVERAGE	8.0	7.6	8.0
PRECISION IN %	80	76	80

TABLE 2: Average precision and recall comparison of three categories of query images using DCT

Category	**Upon Using DCT**	
	Precision	**Recall**
Q1	8.0	0.080
Q2	7.6	0.076
Q3	8.0	0.080

Average precision using all the three categories C1, C2 and C3 is 78.6

VI. CONCLUSION

This work uses Statistical Region Merging (SRM) algorithm for image segmentation. It makes use of DCT (Discrete Cosine Transform) to determine the shape and color feature vectors are obtained by RGB component values. These feature vectors are used to retrieve the similar images from the image database in analogy with the query image. The efficiency of the proposed work is compared with the efficiency of image retrieval based on color feature where it lags in accuracy. The proposed work enhances the retrieval efficiency by retrieving the images based on both shape and color where the retrieval is refined with most similar images. Further, by using DWT (Discrete Wavelet Transform) in the place of DCT retrieval efficiency can be improved.

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