# CBIR Using Color, GLCM & Discrete Wavelet Transform

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**Abstract - Color is one of the most important low-level features used in image retrieval and most content-based image retrievals (CBIR) systems use color as an image features. However, image retrieval using only color features often provide very unsatisfactory results because in many cases, images with similar colors do not have similar content. As the solution of this problem this paper describes a novel algorithm for Content Based Image Retrieval (CBIR) based on Color Edge Detection and Discrete Wavelet Transform (DWT). This method is different from the existing histogram based methods. The proposed algorithm generates feature vectors that combine both color and edge features. This paper also uses wavelet transform to reduce the size of the feature vector and simultaneously preserving the content details. The robustness of the system is also tested against query image alterations such as geometric deformations and noise addition etc. Wang's image database is used for experimental analysis and results are shown in terms of precision and recall**

**Keywords – YCbCr; RGB; Canny Edge Detection; Color Edge Detection; Wavelet Transform; Haar; Precision; Recall;**

## I. INTRODUCTION

With the explosive growth in the internet and the image records, retrieving images from a large-scale image database becomes one of the most active research fields. A lot of research work has been carried out on Image Retrieval during last decade [1]. Due to the large number of image records to give all images text annotations manually is become very tedious and impractical and it generates the need of an efficient image retrieval system [2]. Content-based image retrieval measures the visual similarity between a query image and database images, Visual contents, commonly called as features are used by CBIR to search images from large scale image databases according to the requests of the user which is provided in the form of a query image [3]. The main advantage of CBIR is that it does not suffer from the subjectiveness of textual description. CBIR has diverse applications in internet, multimedia, medical image archives, crime prevention, entertainment, and digital libraries and it is an important field in image processing [4].

A number of previous works have been done addressing different techniques for image retrieval [5]. In paper [6], a scalable content-based image indexing and retrieval system is proposed based on vector wavelet coefficients of color images. This system also provide a solution in which query response time is relatively independent of the database size and depends on the number of images similar to the query image. In paper [7], a method for color edge detection with the compass operator is proposed. The compass operator detects step edges without assuming that the regions on either side have constant color. The scheme presented in [8] is based on 3D color feature extraction. Another method of [9] introduces a scheme based on wavelet which includes both color feature and texture feature circular region energy in low frequency band of wavelet transform of an image is used as color feature of the image and the synthesize energy in high frequency bands of multi-scale wavelet transforms is used as texture feature.

## II. PROPOSED ALGORITHM

The generalized CBIR system is shown in figure 1. CBIR system extracts visual attributes (color, shape, texture and spatial information) of each image in the database and stores in a different database called feature database. The users present query image to the system. The system automatically extract the features of the query image in the same mode as it does for each database image, and then find out images in the database whose feature vectors match those of the query image, and sorts the best similar objects based on their similarity value. So, it mainly involves two processes, first is feature extraction process and the second is feature matching process.

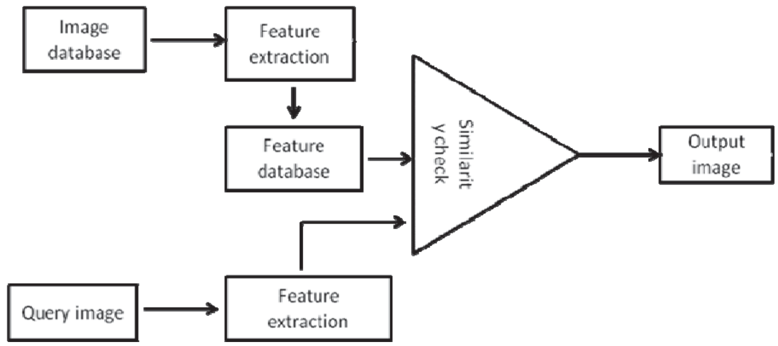



Figure 1. A generalized CBIR System

*A. Feature Extraction Process*

The feature extraction process extracts the image features to a distinguishable extent and prepares a database of feature vectors.

The proposed scheme is based on Color Edge detection scheme. In this scheme, edge features are extracted by applying canny edge detector on the Y matrix of the YCbCr representation of image. Y matrix has the luminance component. It is independent of the color and carries edge information.

The extracted edge matrix from Y matrix along with unmodified Cb and Cr matrices are combined together to make the complete RCB image. This RCB image contains color as well as edge information. The original image and image obtained after color edge detection are shown in figure 2.

Figure.2. (a) Original RGB image (b) RGB image with edge information (edges extracted from Y matrix)

The overall feature extraction process is shown in figure 3 and the main steps of feature extraction algorithm are as follow.

Step 1: Convert input R CB image (I) of size M X N into YCbCr color space.

Step 2: Apply Canny Edge Detector on extracted Y matrix of the image.

Step 3: Combine edge map as obtained in step 2 with unmodified Cb and Cr to make single RCB image.

Step 4: Find R, C and B matrices of the image which obtained in step 3. Find histogram of each matrix separately. These three histograms H R, H G and H B contain 256 bins. This makes the overall length of the feature vector (f) equals to 768 (256 x 3). This is very large size of feature vector. Thus to reduce the size of the feature vector (f) and to improve the performance of the system, wavelet transform is taken of each of these histograms.

Step 5: Perform 2nd level discrete wavelet transform of HR histogram and consider only approximation coefficients at level 2. This reduces its size from 256 bins to 64 bins. Similarly perform 3rd level DWT of HG and HB and consider only approximation coefficients at level 3, which reduces size to 32 bins. Therefore, size of the total feature vector (f) is 128 bins (64 + 32 x 2 = 128).

Step 6: Calculate feature vector if) for each image in the database and arrange all these feature vectors in a database and arrange all these feature vectors in a database. The size of database is Number of images (Rows) x128 (Columns)

*B. Feature Matching Process*

Once images are indexed into the database using the extracted feature vectors, the retrieval of images is done by determination of similarity between the features of query image and the features of target images in database, which is essentially the determination of distance between the feature vectors representing the images. To perform a similarity check which compares feature vector of query image (rq) with each of the feature vector ($f_d$ ) present in the database, Manhattan Distance is used. This distance can be found as given in equation 1.

$$S=\sum_{i=1}^{n} \left| f_q(i)-f_d(i) \right| \text{ ---------- } (1)$$

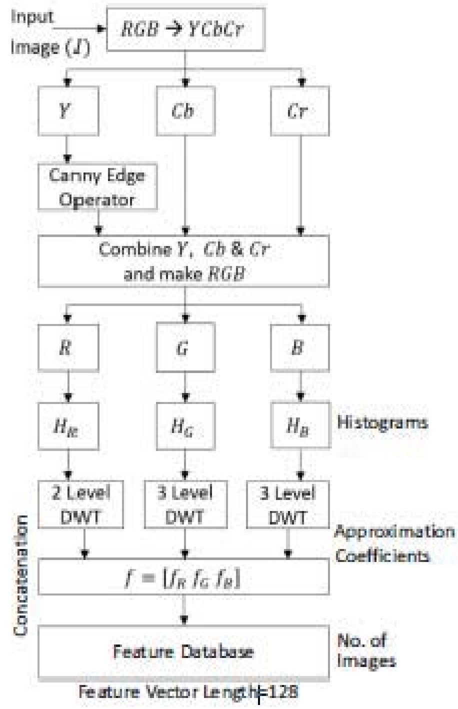



Figure.3. Proposed Feature Extraction Scheme

## III. EXPERIMENT AL ANALYSIS AND RESULTS

This section presents the analysis and evaluation of the proposed scheme. Wang's Image Database [IS] is used for experiment. This database contains total of 1000 images of 10 different classes. Each image class consists of 100 images. Out of the total 1000 images, SOO images (SO images from each class) are used for the training purpose and 200 images (20 images from each class) are used for testing. A query image is provided by the user. Then similar images from database are selected and displayed. For testing purpose, total 5 test images are randomly selected from the database to show the performance of the proposed scheme. These test images are shown in figure 4.


Figure.4. Test images

The query test image number 602.jpg of class 'Rose' from Wang's database and first 15 retrieved images are shown in figure 5. Similarly the first 15 retrieval results of query image 7S3.jpg of class 'Horse' is shown in figure 6


Fig.5. Retrieval results for query image 602. jpg (Rose)


Fig.6. Retrieval results for query image 783.jpg (Horse)

The retrieval performance of proposed technique is shown in terms of Precision and Recall. These two measures are given by equations (2) and (3) respectively.

$$Presicion = \frac{No.of\ relevant\ images\ retrived}{Total\ no.of\ images\ retrived} \qquad (2)$$

$$Recall = \frac{No.of\ relevant\ images\ retrived}{Total\ no.of\ relevant\ images} \qquad (3)$$

High precision and recall values represent a good performance of the retrieval process. The quantitative results showing performance of CBIR system are given in table 1 and graphically shown in figure 7 and 8.

TABLE I: COMPARISON OF PRECISION AND RECALL

| **Images** | **Precision (%)** | | | | **Recall (%)** |
|---|---|---|---|---|---|
| | $N_R = 10$ | $N_R = 20$ | $N_R = 30$ | $N_R = 40$ | |
| **Rose** (602.jpg) | 100.00 | 100.00 | 93.33 | 85.00 | 68.75 |
| **Horse** (783.jpg) | 100.00 | 100.00 | 96.66 | 95.00 | 72.50 |
| **Dinosaur** (488.jpg) | 100.00 | 100.00 | 96.66 | 97.50 | 85.00 |
| **Food** (989.jpg) | 100.00 | 95.00 | 96.66 | 92.50 | 73.75 |
| **Bus** (382.jpg) | 100.00 | 95.00 | 90.00 | 82.50 | 65.00 |

$N_R$: Number of images retrieved.

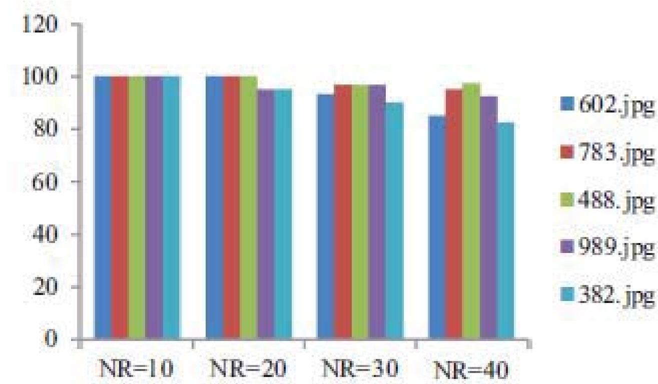



Fig 7. Precision rates for test images

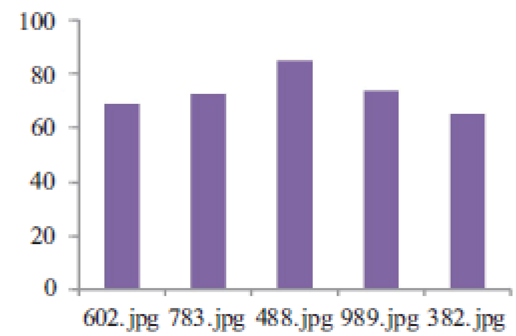



Fig.8. Recall rates for test images

The results of proposed scheme are also compared with other techniques presented in, which also use Wang's database. The proposed scheme provides better results in terms of both precision and recall for the same class of images. Experiments to judge the robustness of the proposed scheme is also performed. Results show that the system is fairly robust to image alterations such as intensity variation, sharpness variation, other intentional distortions, cropping, shifting, and rotation. Table 2 shows some distorted query images and corresponding top 5 retrieval results. On average, the system is robust up to alterations in form of 60% brightening, 80% darkening, blurring with a 17 x 17 Gaussian filter, 80% sharpening, random spread by 10 pixels, pixelization by 20 pixels, Gaussian noise, 50% cropping and rotations

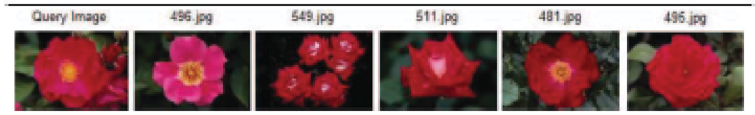
## IV.CONCLUSION

In this paper, a novel approach for Content Based Image Retrieval is presented which combines the color and shape features. The proposed algorithm uses color edge detection technique and wavelet-based feature extraction. The proposed approach extracts the edges from Y matrix of YCbCr using Canny edge detection technique and the RGB histogram is computed as global statistical descriptor that represents the distribution of colors in an image. Manhattan distance is used as a similarity measure to detect the final image rank. The experimental results show that the proposed method performs better even in the case of query image alterations. Moreover, the computational steps are effectively reduced with the use of simplest Haar Wavelet transformation which helps in improving the search speed

TABLE II: ROBUSTNESS OF THE PROPOSED SCHEME
(Only top five matches are shown due to space limit. First image is the query image)


Brighten by 60%


Darken by 80%

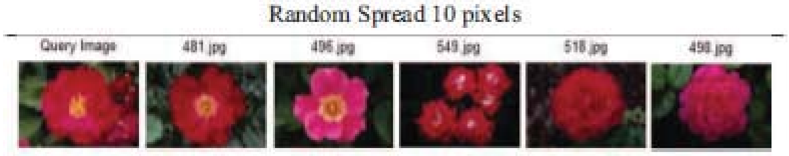



Blur with a 17×17 Gaussian filter

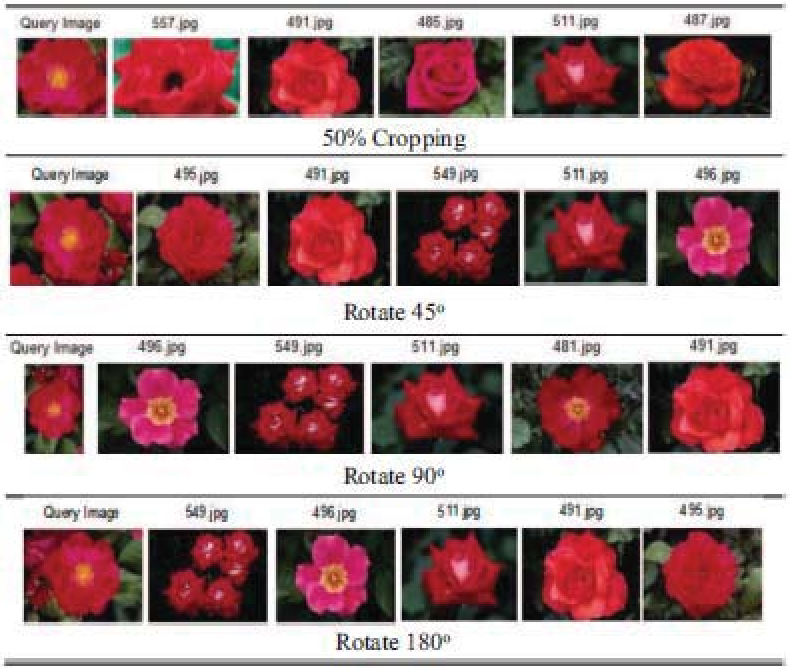

Sharpen by 80%


Gaussian Noise


Random Spread 10 pixels




Pixalize at 20 pixels

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