An Integrated Approach for Image Retrieval Based on Amelioration of Color Mean and Edge Detection using Novel Masks

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Abstract

The growth of computer vision technology in all over the world has led to necessity of the efficient retrieval system. In the proposed system, amalgamation of two features such as color and shape has been implemented which are extracted by amelioration of color mean and edge detection using novel masks respectively. In color feature extraction, row mean, column mean are extracted. These feature vectors are applied on to the original, original with even and original with odd image. In shape feature extraction, the extracted feature vector is magnitude of five types edges (horizontal, vertical, 45, 135 degree and isotropic). Also Hough Transform is used to extract the edge features. Using different types of masks, the feature vector is obtained from the original image. Similarity measurement is performed by Euclidean Distance measure. The performance of the system is analyzed by precision and recall. This system provides the efficient retrieval of images with high precision rate.

1. Introduction

An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images. There are two approaches to image retrieval. In the first conventional approach, the visually extracted attributes are manually entered into the database. This requires a considerable level of effort, and fixes a priori types of queries that can be addressed to the database. In the second approach, where the investigation is the long-term objective of the research program, depends on the features being automatically extracted from the image [10].

Hence CBIR systems extract visual features from the images automatically which is shown in Figure 1. Similarities between two images are measured in terms of the differences between the corresponding features.

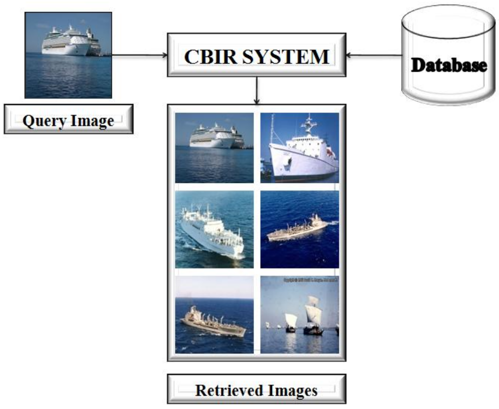


Figure 1. Example of image retrieval system

The most common methods for searching digital image databases are based on employing index terms / keywords, which are entered manually. Retrievals were performed using input keywords provided the content media was manually annotated using text descriptors. A text-based approach is however, both expensive, ambiguous and extremely time consuming. The limitations of text based search schemes motivated the use of content-based media retrieval as a tool for locating relevant items within a large database.

In both approaches, there are two major tasks. The first task is Feature Extraction (FE), where a set of feature vectors is generated accurately to represent the content of each image in the database. A feature vector is much smaller in size than the original image, typically on the order of hundreds of elements (rather than millions). Second task is Similarity Measurement (SM), where distance between the query image and each image in the database using their signatures is computed so that the top 'n' closer images can be retrieved. The similarity measurement is made with the Euclidean distance where there is a need to have different number of regions in the image to compare with every other image. In our proposed system, the images are retrieved based on the color and shape features extracted from the image.

2. Proposed system

In our proposed system, Content based image Retrieval system is exploited. Content defines the low level features such as Color, Shape and Texture. In our proposed system, Color and Shape features are used to retrieve the images from large database.

Table 1 Features and its techniques used in our proposed system

S.No	Low Level Features	Techniques adopted
1.	Color Feature	Amelioration of Color Mean
2.	Shape Feature	Edge Histogram Descriptor Mask Sobel Descriptor Mask Hough Transform

Color feature is extracted by Amelioration of color mean and Shape feature is extracted by Edge Histogram Descriptor (EHD), Sobel Descriptor Mask, and Hough Transform which is shown in Table3.1. Performance of the color feature extraction is analyzed by two types that are whole image and 2 x 2 sub image. Similarly performance of the shape feature is evaluated by the three techniques. Both Color and Shape features are analyzed individually and integratedly.

2.1. Color Content

Color is very important content present in the image which is used as feature for many content based image retrieval techniques. Color is very easily available image feature, which generally is represented in form of color components (Color planes) of digital image. The approaches of 'image color averages' for feature extraction is used in proposed image retrieval methods.

Image averaging techniques [4] are based on taking averages of color content of image, which can be considered as feature vector for image retrieval. The image pixel data can be represented in form of the feature vectors with reduced dimensions as row mean (RM), column mean (CM), forward diagonal mean (FDM), backward diagonal mean (BDM). Use of the color averaging techniques helps in obtaining faster and better image retrieval techniques. The various feature vectors considered for proposed feature vectors are as follows

- Row Mean of image (RM)
- Column mean of image (CM)
- Combination row and column mean (RCM)

Image tiling is dividing image into equal and non-overlapping square parts. Image retrieval techniques uses color averaging methods (like row mean, column mean, row & column mean) combined with image tiling for 4. Then the augmentation of color averaging based CBIR methods is proposed using original also with even and odd part of image.

The row mean vector is the set of averages of the intensity values of the respective rows. The column mean vector is the set of averages of the intensity values of the respective columns.

Row Mean Vector = [Avg(Row 1), Avg(Row 2), …., Avg(Row n)] (1)

Column Mean Vector = [Avg(Col. 1), Avg(Col. 2), …., Avg(Col. n)] (2)

2.1.1 Image Tilling means dividing an image into nonoverlapping cells or fragments. The size of each fragment in the image is divided into some equal parts and also keeping the size of each fragments the same. In our proposed system, four non overlapping tiles as shown in figure 2 are considered [7].

a. Single Tiles b. Four Tiles

Figure 2 a, b Single tile image converted into 4 tiles

2.1.2. Augmentation of Color Averaging CBIR Techniques using Even and Odd part of image

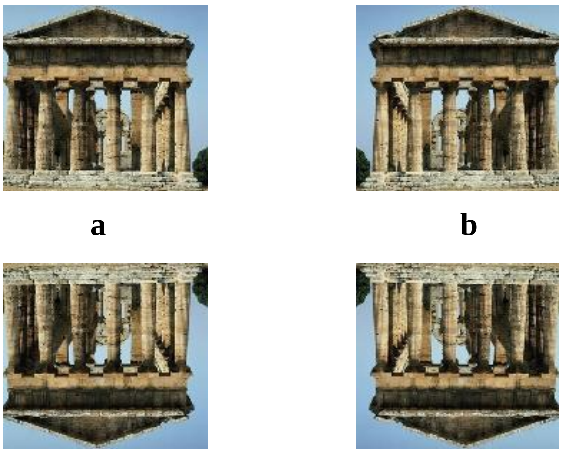
In order to improve the performance of color averaging based image retrieval methods even and odd images are generated for all the images in the generic database. To generate even image and odd image of any original image, first a replica of original image across X and Y axes is created, which is referred to as flip image.

The addition of the flip and the original image gives even image and the subtraction of flip from original results into odd image.

The color averaging techniques like row mean (RM), column (CM), row & column mean (RCM), are computed for original image, even image and odd image. Then the feature vectors of original image are combined respectively with even image feature vectors (Original + Even) and odd image feature vectors (Original + Odd).

Hence the CBIR methods based on color averaging can be divided into three main categories as:

- color averages of original image,
- color averages of original with even image,
- color averages of original with odd image.



a b

c d

Figure 3. a,b,c,d Result of Flip Images

The original image (a) is converted into horizontal flip image (b), Vertical flip image (c) and horizontal + vertical image (d) which is shown in the figure 3. The even part of the image is calculated by *Even= (Original image + Flip image) / 2* and it is shown in figure 4.a.The odd part of the image is calculated by *Odd = (Flip image - Original image) / 2* and it is shown in figure 4.b.

Even Image Odd Image

a b

Figure 4 a,b. Result of Even Image and Odd image

The summation of the original image with even image and odd image is shown in figure 5.

Original + Even image Original + Odd image

Figure 5. Result of Original + Even Image and Original + Odd image

2.2 Shape Features

The shape is one of the primitive features, which characterize the boundary appearance of the image components. The simplest way to detect edges in an image consists of identifying those points with a great change in the intensity gradient of the image.

One important group of Edge Detectors consists of applying different Gaussian kernels to an image in order to approximate the gradient of the image intensity function. Belonging to this group we have Prewitt, Roberts and, perhaps the most well-known of all of them, the Sobel Edge Operator.

Original Prewitt Robert Sobel

Figure 6. Result of gradient Operator

The Generalized Hough Transform (GHT) is used to represent any arbitrary shape, whose template shape has to be defined a priori.

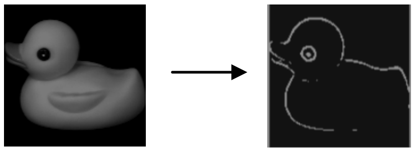


Figure 7. Result of Hough transform

3. System Design

Architecture of our proposed system is shown in figure 8. It describes the process of the proposed retrieval system. If the user gives a query image to the system, the database image description sector analyze the content of the image such as color and shape. Color feature is extracted by the ACM and Shape Features are extracted by Edge descriptor techniques. Similarly the database images also processed and obtain the feature vector set. Using the feature vector set and similarity measurement (Euclidean distance), find the highest similar images and display the retrieved images to the user.

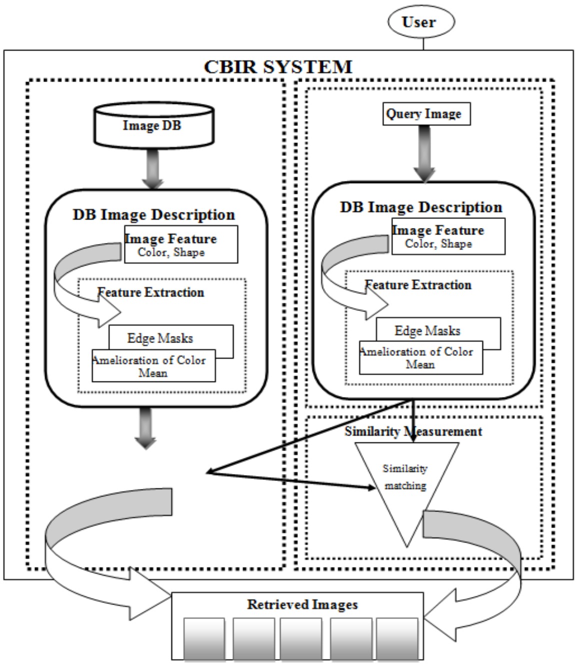


Figure 8. System Design of proposed system

4. Experimental Results

The performance of our proposed system is evaluated in Wang database (7 categories) and COIL database (20 categories). The low level features such as color and shape are evaluated. Precision and Recall rates are used for the analysis of the performance of the system.

System Performance: The performance of the system is evaluated by the precision and recall rate. The formula for the precision and recall rate is given below.

$$Precision = \frac{No.\,of\ relevant\ images\ retrieved}{Total\ no\ of\ items\ retrieved} \quad (1)$$

$$Recall = \frac{No.\,of\ relevant\ images\ retrieved}{No.\,of\ relevant\ images\ in\ database} \quad (2)$$

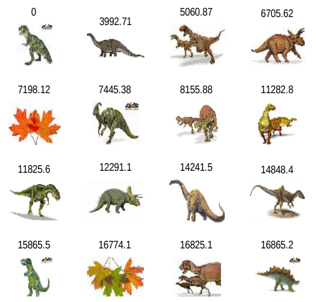
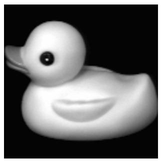
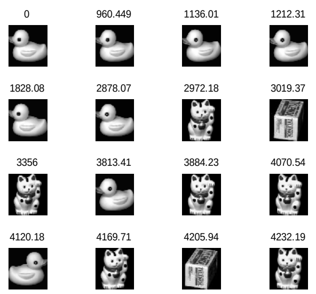
4.1 Results for Color Feature Extraction

Color feature is extracted by amelioration of Color mean method. In our proposed method, Image is subdivided into '4 x 4'. The images retrieved by using color mean method which is subdivided into 4 x 4 in Wang database and COIL database extracted is shown in table 3.

Table 2. Sample images in Both Database

DB Name	Sample Images				
Wang					
Coil					

Table 3. Retrieved results of color feature in the Wang and Coil Database

Query Image	Retrieved Images
	
	

The following table 4 shows the Precision and Recall using Color Feature for the Wang database.

Table 4. Precision and recall rate using Color feature for Wang Database

Test	Precision	Recall
T1	0.625	0.5222
T2	0.5	0.489
T3	0.375	0.5763
T4	1	0.7
T5	0.625	0.4252
T6	0.875	0.6544

Average Precision Value = 0.6667
Average Recall Value = 0.561183

Table 5. Precision and recall rate using Color feature for COIL Database

Test	Precision	Recall
T1	0.5	0.5333
T2	0.75	0.5768
T3	0.4375	0.3740
T4	0.9333	0.875
T5	0.6923	0.7
T6	1	0.96
T7	0.375	0.2293
T8	0.5	0.4573
T9	1	0.884
T10	0.9375	0.7534
T11	0.6875	0.82
T12	0.375	0.5333

Average Precision Value = 0.6823
Average Recall Value = 0.6414

It is observed that when comparing Precision using Color feature for the Wang and COIL databases, the Precision rate is found to be high in Coil database and also the Recall is high.

It is noted that in Wang database, the recall rate is found to be low which is clearly defined in the table 4, and 5.

The performance chart which shows the comparison of Precision and Recall rate for the Wang and Coil databases are shown the figure 9 and in figure 10 respectively.

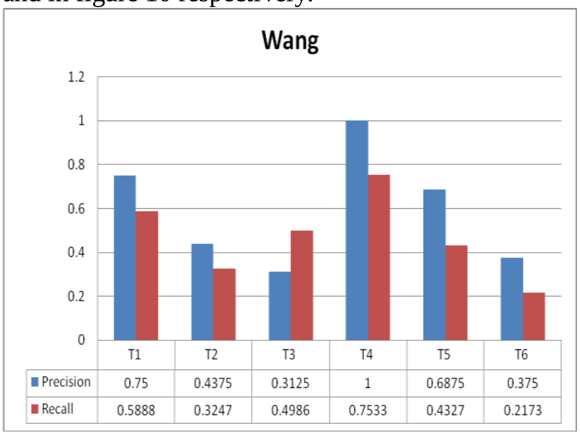


Figure 8. Performance chart for Wang Database using Color Feature

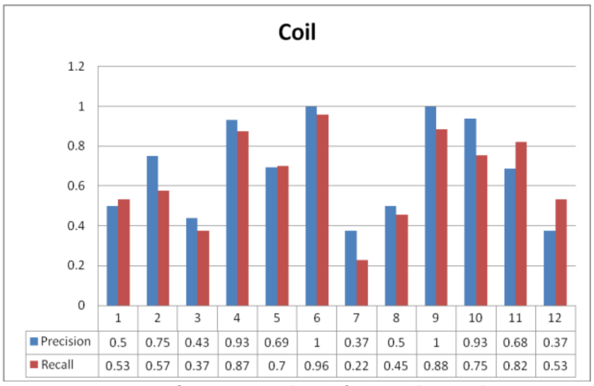


Figure 9. Performance chart for Coil Database using Color Feature

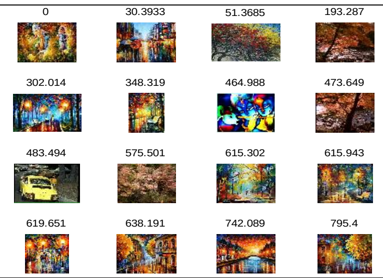
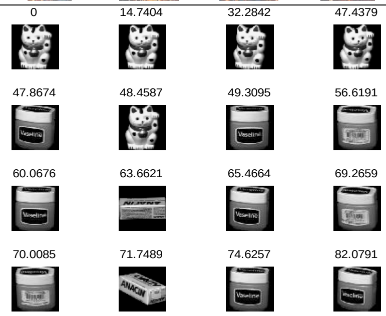
4.2 Results for Edge Feature Extraction using Edge Histogram mask

Edge feature is extracted by using Edge Histogram Descriptor Mask whose filter coefficient values for the five types of edges are as follows:

- Vertical - [1 -1; 1 -1]
- Horizontal - [1 1; -1 -1]
- 45 degree - [sqrt(2) 0; 0 sqrt(2)]
- 135 degree - [0 sqrt(2); -sqrt(2) 0]
- Isotropic - [2 -2; -2 2]

Thus the edge feature vectors are obtained using the above filter coefficients. By using it to create the feature vector set for image retrieval which is shown in the table 6.

Table 6. Retrieved results using Edge Histogram feature for Wang and Coil Database

Query Image	Retrieved Images
	 0, 30.3933, 51.3685, 193.287, 302.014, 348.319, 464.988, 473.649, 483.494, 575.501, 615.302, 615.943, 619.651, 638.191, 742.089, 795.4
	 0, 14.7404, 32.2842, 47.4379, 47.8674, 48.4587, 49.3095, 56.6191, 60.0676, 63.6621, 65.4664, 69.2659, 70.0085, 71.7489, 74.6257, 82.0791

Edge features performance also is evaluated by the precision and recall rate in both database which is given in following table 7 and 8.

Table 7. Precision and recall rate using Edge Histogram feature for Wang Database

Test	Precision	Recall
T1	0.75	0.5888
T2	0.4375	0.3247
T3	0.3125	0.4986
T4	1	0.7533
T5	0.6875	0.4327
T6	0.375	0.2173

Average Precision Value = 0.59375
Average Recall Value = 0.46923

Table 8. Precision and recall rate using Edge Histogram feature for COIL Database

Test	Precision	Recall
01	1.91667	0.8214
02	1	0.7143
03	1.3125	0.7143
04	1.0625	0.8173
05	1	0.57143
06	1.75	0.85
07	1.75	0.85
08	1.75	0.85
09	1.1667	0.6191
10	1.25	0.7143

It is observed that when comparing Precision for the Wang and the COIL databases, the Precision rate is found to be high and the Recall rate is low in Wang database. The performance chart which shows the comparison of Precision and Recall rate for the Wang and Coil databases are shown the figure 9 and in figure 10 respectively.

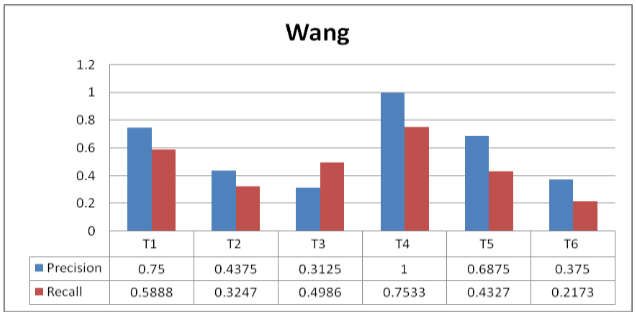


Figure 9. Performance for Wang using Edge Feature

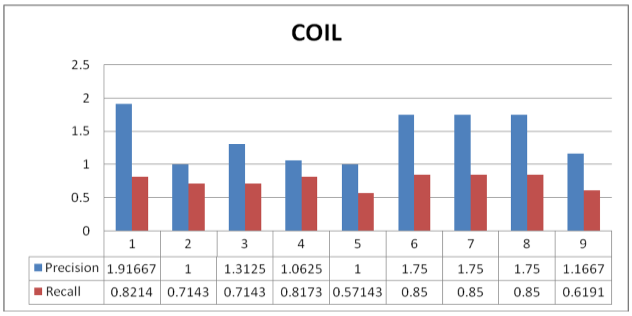


Figure 10. Performance for Coil using Edge Feature

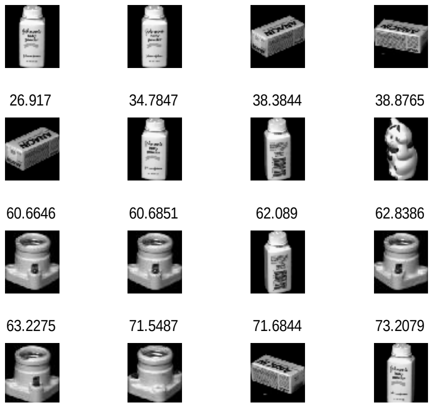
4.3. Results for Edge Feature Extraction using Sobel mask

Edge feature is extracted by using Sobel mask. The filter coefficient values of the five types of edge masks are as follows:

- Horizontal - [1 2 1; 0 0 0; -1 -2 -1]
- Vertical - [-1 0 1; -2 0 2; -1 0 1]
- 45 degree - [2 2 -1; 2 -1 -1; -1 -1 -1]
- 135 degree -[-1 2 2; -1 -1 2; -1 -1 -1]
- Isotropic - [-1 0 1; 0 0 0; 1 0 -1]

Using these filters coefficients, the maximum value of magnitude and gradient values are calculated. Thus the edge feature vectors are obtained. The retrieved images using Sobel masks are shown in table 9.

Table 9. Retrieved results using Edge feature using Sobel Mask for Wang and Coil Database

Query Image	Retrieved Images
	 0, 146.257, 159.966, 289.16, 294.168, 305.321, 326.453, 344.891, 362.95, 386.146, 507.227, 580.465, 663.914, 668.918, 683.861, 864.593
	 0, 15.0571, 15.1169, 16.9086, 26.917, 34.7847, 38.3844, 38.8765, 60.6646, 60.6851, 62.089, 62.8386, 63.2275, 71.5487, 71.6844, 73.2079

Edge feature performance is evaluated by the precision and recall rate for both the databases which is given in following table 10 and 11 respectively.

Table 10. Precision and recall rate using Edge feature Sobel Mask of the Wang Database

Test	Precision	Recall
T1	0.75	0.5436
T2	0.375	0.4329
T3	0.3125	0.2111
T4	0.4375	0.5667
T5	0.5625	0.4397
T6	0.375	0.2587

Average Precision Value = 0.46875
Average Recall Value = 0.4088

Table 11. Precision and recall rate using Edge feature Sobel Mask of the Coil Database

Test	Precision	Recall
01	0.625	0.5322
02	0.25	0.2786
03	0.6875	0.5733
04	0.4375	0.3791
05	0.375	0.2576
06	0.25	0.2786
07	1	0.8547
08	0.25	0.2786
09	0.8125	0.6724
10	0.6875	0.5733

Average Precision Value = 0.5375
Average Recall Value = 0.4678

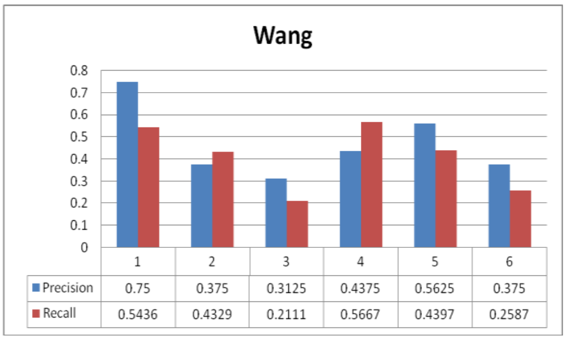


Figure 12. Performance chart for Wang Database using Sobel Feature

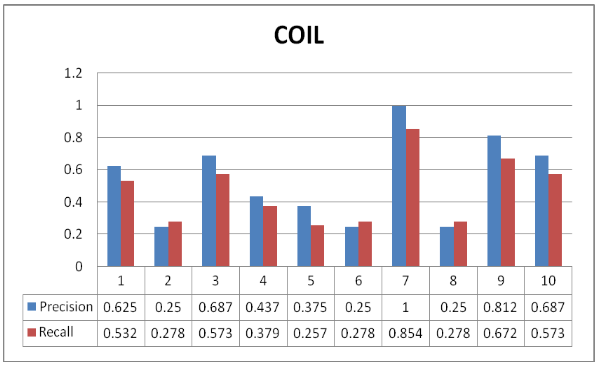


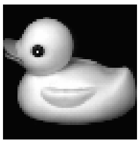
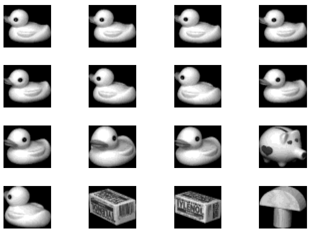
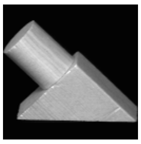
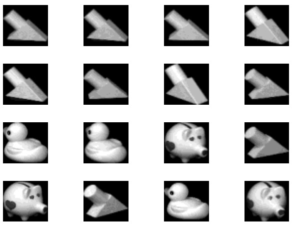
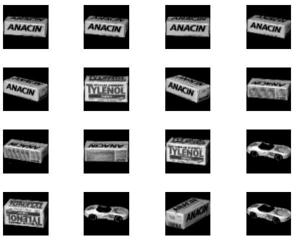
Figure 13. Performance of COIL using Sobel Feature

The performance of the Sobel mask in the color image is very low which is indicated by the low precision rate and also its recall rate is nearer to the precision value.

4.4 Results of Edge Feature Detection using Hough Transform

The results for retrieving images using Edge Feature Detection using Hough Transform for Coil Database is shown in table 12.

Table 12. Retrieved results of Edge feature using Hough Transform of Coil Database

<table>
<tr><th>Query Image</th><th>Retrieved Images</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>
</td><td></td></tr>
</table>

The features extracted using Hough Transform are radius, angle, and magnitude. This Hough transform is suitable for Coil Database. It provides high precision rate, but recall rate is too low. The precision rate is given in the following table.

Table 13. Precision rate of Edge feature using Hough Transform of Coil Database

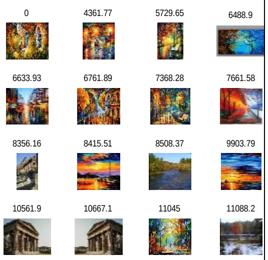
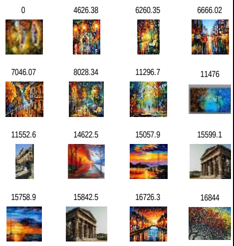
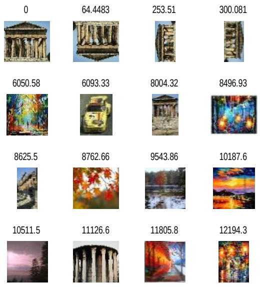
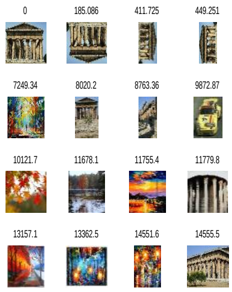
Test	Precision
T1	0.75
T2	0.625
T3	0.8125
T4	0.625
T5	0.9375

Average Precision Value = 0.75

4.5 Results of Integrated Features

The results for retrieving images using Integrated Features of Color and Edge Masks, Color + Sobel masks for Wang and Coil Databases are shown in table14.

Table 14. Retrieved results using integrated features for Wang and Coil Database

<table>
<tr><th rowspan="2">Query Image</th><th colspan="2">Retrieved Images</th></tr>
<tr><th>Color + Edge Mask</th><th>Color + Sobel Mask</th></tr>
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td></td><td>
</td><td>
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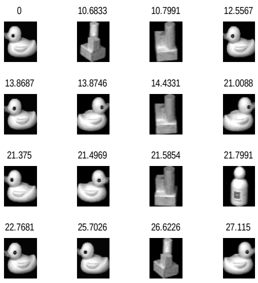
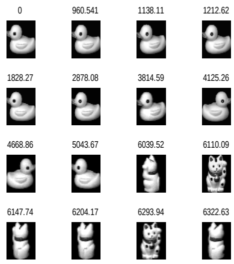
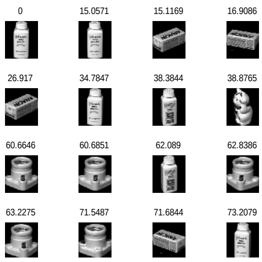
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td></td><td>
</td><td>
</td></tr>
</table>

Table 15. Precision and recall rate using Integrated features for Wang Database

Test	Precision	
	Color + Edge	**Color + Sobel**
T1	0.625	0.8125
T2	0.7175	0.5
T3	0.375	1
T4	1	0.625
T5	0.5	0.375
T6	0.9	0.875
Average	0.68625	0.697917

Table 16. Precision and recall rate using Integrated features of the Coil Database

Test	Precision	
	Color + Edge	**Color + Sobel**
T1	0.5	0.625
T2	0.75	0.6875
T3	0.8125	0.5
T4	0.6875	0.5
T5	0.625	0.6
T6	1	1
T7	0.8125	0.4375
T8	0.5625	0.5
T9	1	1
T10	0.9375	0.9375

Average Precision of Color with EHD mask = 0.68020

Average Precision of Color with Sobel mask = 0.71815

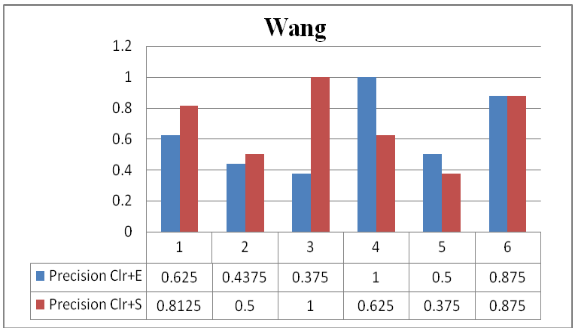


Figure 15. Performance chart of Integrated features for Wang Database

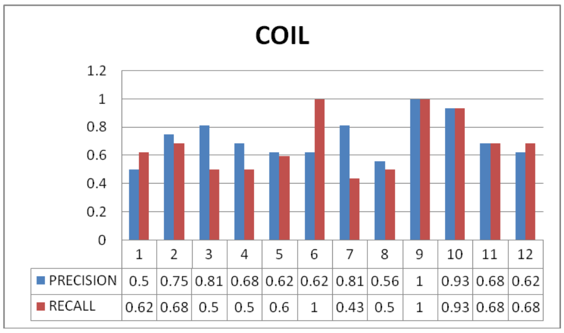


Figure 16. Performance chart of Integrated features for Coil Database

The performance of integrated features such as Color with Edge mask and Color with Sobel mask are shown in figure 15 and 16 respectively. The proposed novel edge histogram descriptor mask values are analyzed and retrieved images by individually and integratedly from the database. Its performance is found very nearer to the Sobel mask in Wang Database. For the Coil Database, the similar edge mask values provide the better results.

5. Conclusion

In this paper, we have proposed an integrated features image retrieval system which is based on color and shape features. The proposed system is based on the two features which are extracted by Amelioration of Color Mean, Sobel descriptor mask, Edge Histogram Descriptor mask and Hough Transform. The use of these two methods ensures that the proposed image retrieval system provide the highest similarity images which is highly relevant to the content of the query image by taking into account the two features of the image. Similarity metrics is based on Euclidean Distance Measure. Amelioration of Color Mean is used to extract the color feature using Row mean and Column mean of the subdivided image (4 x 4) also with even part of the image and odd part of the image. Hence we obtain 36 feature values in color feature extraction. The Sobel Mask and EHD mask values are used to extract the shape features by using the maximum values of magnitude and gradient. Also Shape features are extracted by another one technique called Hough Transform. Performance of the features is analyzed by two ways such as Integrated features and Individual features in two databases such as WANG and COIL database. The evaluation is carried out by using the standard precision and recall measures. Analysis of Individual features namely the color feature and the EHD mask values provide higher precision value in both databases. In the integrated features, Combination of Color with EHD mask and Color with Sobel Mask is analyzed. In COIL database (gray images), performance of color with Sobel mask provides highest similarity images. In Wang Database (color images), performance of both integrated features provide more or less similar precision values. The presented results show the proposed approach produce better results and well suited for color image.

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