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S. R. Bharamagoudar [1], Geeta R.B. [2], S. G. Totad [3], Feroza D.Mirajkar [4]
[1 4] *Department of Electronics and Communication Engineering*
[2]*Department of Information Technology*
[3]*Department of Computer Science & Engineering*

[14] *Basaveshwar Engineering College, Bagalkot, Karnataka, India*
[23] *GMR Institute of Technology RAJAM, Andhra Pradesh,India*
[1] *srb_bec@yahoo.com*, [2] *geetatotad@yahoo.co.in* , [3]*skumartotad@yahoo.com*

Abstract- The amount of images or the pictorial data is growing day by day with the expansion of internet services. As the network and development of multimedia technologies are becoming more popular, users are not satisfied with the traditional information retrieval techniques. So nowadays the content based image retrieval are becoming a source of exact and fast retrieval. . It is very difficult for the users to retrieve the required images using a operative and efficient mechanism. There are many techniques which are used to retrieve the images depending upon the requirement of different applications. This paper provides an extensive review of various latest research work and methodologies applied in the field of CBIR. Images are retrieved on the basis of automatically derived features such as, texture, shape and color which is generally referred to as Content-Based Image Retrieval (CBIR). Content based image retrieval is an important research area in image processing, with a vast domain of applications like recognition systems i.e. finger, face, biometrics, medical sciences etc. However, the technology still lacks maturity, and is not yet being used on a significant scale. In the absence of hard evidence on the effectiveness of CBIR techniques in practice, opinion is still sharply divided about their usefulness in handling real-life queries in large and diverse image collections. The concepts which are presently used for CBIR system are all under research.

Keywords – CBIR, Feature Extraction, Image Retrieval

I. INTRODUCTION

In many areas of government, academia, commerce, and hospitals, large collections of digital images are being created. Many of these collections are the product of digitizing existing collections of drawings, paintings, analogue photographs, diagrams and prints. Usually, the only way of searching these collections was by keyword indexing, or simply by browsing. Digital images databases however, open the way to content-based searching. In this paper we survey some technical aspects of current content-based image retrieval systems.

Effective and operative retrieval of images from a large data base is a very difficult task. Therefore the retrieval of similar and relevant images based on the similarity between automatically derived content features such as color shape, texture, etc of the query image and that of the images which are stored in the data base and that task is popularly known as content based image retrieval. The term color can be achieved by the techniques histogram and averaging [4]. The term texture refers the use of vector quantization or transforms. The term shape is the use of gradient operators or morphological operators [4].The accuracy of the CBIR system can be improved by the iterative refinement process of the queries and the features that are decided by the users' feedback [5]. An image consists of global and local features. Depending upon the problem we can use the features of our interest to retrieve the images from a database [3]. Some of the major areas of applications of CBIR are: medical diagnosis, Intellectual property, art collections, crime prevention, military and engineering design and geographical information and remote sensing systems.

The steps that are to be followed in the system realization of CBIR are [1]:

1. Image acquisition

2. Feature Extraction

3. Similarity Matching

The query images undergo three stages. A large number of images are stored in the database. Image enhancement takes place where various techniques are applied on the image to improve its quality like histogram manipulation .The enhanced image is then subdivided and segmented to get the color, texture and edge density features forming a feature vector. The resultant feature vector can be compared with the feature vector of the query image [5]. The closest image in comparison with the query image from the feature database is returned. The rest of the paper is organized as follows. Feature Extraction techniques are discussed in section II. Similarity Matching concepts are presented in section III. The correctness of algorithm is deliberated in section IV. Accuracy of different features is discussed in Section V. The statistical comparison of CBIR Processes is conferred in section VI. Section VII & Section VIII presents conclusion and references.

II. FEATURE EXTRACTION TECHNIQUES

In image processing, feature extraction is a special form of dimensionality reduction or it is a process of reducing the dimensions of an object. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction.

A. *Color-based retrieval-*

Color is considered as the most dominant and distinguishing visual feature. Generally, it adopt histograms to describe it. A color histogram describes the global color distribution in an image and is more frequently used technique for content-based image retrieval because of its efficiency and effectiveness.

A.1. Mean and standard deviation features of Color Histogram [4]

In this method the input RGB image is converted to a grayscale image. The Laplacian filter is applied to the grayscale image. The filtered image is quantized into 32 bins. The mean and standard deviation of pixels in each bi is calculated.

$$\mu_j = \frac{1}{N}\sum_{i=1}^{N} x_{ji} \qquad (1)$$

$$\sigma_j = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_{ji} - \mu_j)^2} \qquad (2)$$

Where μ_j is the mean and σ_j is the standard deviation of particular bin j

A feature vector $f_v = \{\mu_1, \mu_2, ...\mu_{32}, \sigma_1, \sigma_2, ...\sigma_{32}\}$ will be calculated for all the images stored in the database and for the query image.

A.2 Efficient CBIR using Color Histogram processing [8]

In this approach two methods are investigated for describing the contents of images. The first method characterizes images by global descriptor attributes and the second is based on the color histogram. The cross correlation value and image descriptor attributes are calculated prior to the histogram implementation to make CBIR more efficient.

A.3. Quantized Histogram Color Features [14]

In this method the input RGB image is converted to intensity (grey scale) image. It is then converted to histogram equalized (HE) image and Laplacian filter is applied to the HE grey scale image to sharpen the image. The statistical quantized color histogram features are extracted from sharpened grey scale image using different number of quantization bins.

B. The retrieval based on texture feature-

Texture feature in an image is achieved primarily by modeling texture as a two-dimensional gray level variation. Textures are characterized by differences in brightness with high frequencies in the image spectrum. They are useful in distinguishing between areas of images with similar color A variety of methods has been used for measuring texture similarity; the best- established depend on comparing values of what are well-known as second-order statistics estimated from query and stored images.

C. The retrieval based on shape feature-

Shape information's are extracted using histogram of edge detection. Techniques for shape feature Extraction are elementary descriptor, Fourier descriptor, template matching, Quantized descriptors, Canny edge detection etc. Shape features are less developed than their color and texture counterparts because of the inherent complexity of representing shapes.

D. Feature extraction using Color and Texture –

D.1 Wavelet Based color histogram [9]

In this method the color features are extracted through color histogram and the texture features are obtained by using wavelet transformation. Wavelet transforms extract information from signal at different scales by passing the signal through low pass and high pass filters. Haar wavelets are used mostly because it enables us to speed up the wavelet computation phase for thousands of sliding windows of varying sizes in an image. The Haar wavelet's mother wavelet function Ψ(t) can be described as:

$$\psi(t) = \begin{cases} 1, 0 \le t \le \frac{1}{2} \\ -1, \frac{1}{2} \le t < 1 \\ 0, \text{otherwise} \end{cases} \quad (3)$$

Scaling function φ(t) is given as:

$$\phi(t) = \begin{cases} 1, 0 \le t \le 1 \\ 0, \text{otherwise} \end{cases} \quad (4)$$

D.2. Feature extraction based on class signature of image [10]

In this method local descriptors are used to describe the visual contents of the image. The circular sectors are used to represent local first order moments for color feature extraction. Local direction technique is used for texture feature extraction. The hash indexing of images, color properties are used to map the database images into classes. Hash indexing speeds up the search and enhances the system scalability for large databases.

E. Feature extraction based on color and shape [12]-

In this approach color and shape features are combined to improve the performance of the CBIR systems. HSV color quantization and curvlet transform are integrated to extract the features. Color histogram is generated by quantizing the HSV color space into 24 non-uniform bins based on HSV soft decision. Digital curvlet transform is used to extract the shape features. The generated HSV color histogram and the curvlet features are then combined and weighted for retrieving the images.

F. Feature extraction using color and Edge[15]-

In this approach image histogram feature is extracted by converting an image to grey color space and the formulae of Eq.(5) is applied. So the histogram value matrix holds only values between zero and one.

n =sum (mi) when i=1to k (5)

where mi is the histogram, n is the total number of observations and k is total number of bins
Image is segmented to extract red, green and blue color values and these values are stored in the matrix. Canny's edge detection technique is used to detect edges and stored into a 2D matrix. The maximum value of each column is taken from the generated matrix and the values are stored in a new matrix. For final matching all the data is accumulated into a single matrix.

G. Feature extraction using Edge and Texture [7]
In this technique, the edges of the image are extracted by applying slope magnitude method on gradients of the image in horizontal and vertical directions. The transforms is applied on each of the column of obtained "mask shape'. The row mean of these transformed column mask shape is obtained and treated as image signature for CBIR. The row mean for individual R, G and B planes forms the feature vector. It is possible to obtain 24 variations of this CBIR technique by using four gradient operators namely Roberts, Sobel, Prewitt and canny with seven orthogonal image transforms namely DCT, Haar, Walsh, slant, Kekre, DST and Hartley.

H. .Feature Extraction using Color, Texture and Edge [11]
In this method color features are extracted using histograms. Four texture features namely Tamura (i.e. coarseness, contrast, and directionality) and energy are used.
Directionality is given by Eq.6:

$$\theta = \frac{\pi}{2} + \tan^{-1}\frac{\Delta h(n_0, n_1)}{\Delta h(n_0, n_1)} \qquad (6)$$

Energy for an image is calculated by the following formulae:

$$E = \sum_{i=1}^{M}\sum_{j=1}^{N} p^2(i, j) \qquad (7)$$

I. Feature extraction using Color, Shape and Texture

I.1Feature extraction using GLCM [6]

In this approach, the grey level co-occurrence matrix (GLCM) is used to extract the texture features. The features obtained using GLCM are contrast, correlation, energy and homogeneity. Histogram is used for color feature extraction.

I.2. Feature extraction using image and its complement [16]
In this approach color, texture and shape all are combined to achieve higher retrieval efficiency using image and its complement. The image and its complement are partitioned into non-overlapping tiles of equal sizes. The features are extracted from conditional co-occurrence histograms between image tiles and corresponding image tiles in RGB color space.

I.3. Feature extraction using Dominant color [18]
In this method each image is divided into 8-coarse partitions of the RGB color space. The centroid of each partition is selected as the dominant color. The texture features are obtained from GLCM. Invariant moments of gradient vector flow fields are used to extract shape features. A combined feature vector for color, texture and shape is constructed.

III. SIMILARITY MATCHING

The CBIR process is used for general applications like recognizing patterns biometric data. We need to compare two images and check whether they are similar or they match or not. To compute this, it is required to have certain techniques by which one can statistically evaluate if two images are similar or not. It is for this reason that similarity measurement is done. Once we extract a set of features, we need compare the extracted feature for similarity for; it is believed that if good sets of features are extracted, the similarity between 2 images is given by how close the extracted features are of the two images.

A. Sum-Of-Absolute Difference (SAD) [4]-

The sum-of-absolute difference (SAD) between the extracted query feature vector Fq and database feature vector Fp will be calculated for all features, as given be Eq.8.

$$\Delta s = \sum_{i=1}^{n} |(F_p(i) - F_q(i))| \qquad \text{where i=1,2,…n} \qquad (8)$$

B. Mean Squared Error (MSE) [7]-

If Vpi and Vqi are the feature vectors of image 'P' and Query image 'Q' respectively with size 'n', then the MSE can be given by Eq. 9.

$$MSE = \sum_{i=1}^{n} (V_{pi} - V_{qi})^2 \qquad (9)$$

C. Histogram Intersection Distance [9]

The color histogram intersection was proposed for color image retrieval. The intersection of histograms ***h*** and ***g*** is given by Eq.10:

$$d(h,g) = \frac{\sum_A \sum_B \sum_C \min(h(a,b,c), g(a,b,c))}{\min(|h|,|g|)} \qquad (10)$$

where |***h***| and |***g***| gives the magnitude of each histogram, which is equal to the number of samples

D. Euclidean Distance [10]-

The Euclidean distance is mostly used because of its simplicity. The smaller the distance, the more similar the image is. The Euclidean distance between two points *T*=(*t1*, *t2*,…*tn*) and *Q*=(*q1*, *q2*,…*qn*), in Euclidean n-space is given as Sqrt(Sum((*ti*-*qi*)2)).

E. Manhattan Distance [12]-

The Manhattan distance measure is given by Eq.11:

$$D_M(q,i) = \sum_{j=1}^{n} | f_{qj} - f_{ij} | \qquad (11)$$

Where DM(q, i) is the Manhattan distance between the feature vector of the query image and every image in the database. fq and fi are normalized feature vectors for the query image and database image respectively, and n is the number of dimensions of both fq and fi.

F. Canberra Distance [16]-

The Canberra distance is often used for data scattered around an origin. The generalized equation is given in the form

$$d(Q,R) = \sum_{i=1}^{N} \frac{|Q_i - R_i|}{|Q_i| + |R_i|} \qquad (12)$$

G. Histogram Euclidean Distance-

Let ***h*** and ***g*** represent two color histograms. The Euclidean distance between the color histograms ***h*** and ***g*** can be computed as:

$$d^2(h,g)=\sum_A\sum_B\sum_C(h(a,b,c)-g(a,b,c))^2 \qquad (13)$$

IV. MEASURING THE CORRECTNESS OF AN ALGORITHM

The performance of retrieval of the system can be measured in terms of precision and recall [7]. The precision and recall can be calculated by using Eq.14 and Eq.15.

$$\text{Precision}=\frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}} \qquad (14)$$

$$\text{Recall}=\frac{\text{Number of relevant images retrieved}}{\text{Total number of relevant images in database}} \qquad (15)$$

A. Average Precision and Average Recall [10]-

If R is the number of images relevant for the query image and A is the total number of retrieved images, then the Precision of result is fraction of retrieved images that are truly relevant to the query image. Precision is given by the Eq.16. For r runs of different query images the average precision is calculated by Eq.17.

$$P=R/A \qquad (16)$$

$$P_{avg}=Sum(P_i)/r \qquad i=1,2,\ldots..,r \qquad (17)$$

Recall is calculated by Eq.18. for r runs ,the average precision can be calculated using Eq.19.

$$L=R/C \qquad (18)$$

$$L_{avg}=Sum(L_i)/r \qquad i=1,2,\ldots..,r \qquad (19)$$

Table-1. Overall Average Precision-Recall [10]

Measure [0..1]	**MADS(Minimum accepted degree of similarity)**				
	0.00	**0.25**	**0.50**	**0.55**	**0.60**
Average Precision	**0.39**	**0.40**	**0.50**	**0.55**	**0.73**
Average Recall	**0.39**	**0.38**	**0.21**	**0.13**	**0.07**

V. ACCURACY TABLES FOR DIFFERENT FEATURES

Accuracy table for different features is shown in Table-2.

Table- 2.Accuracy table for different features

Features	Precision	Recall	Accuracy
Texture Based[6]	**50%**	**70%**	**60%**
Color Based[6]	**50%**	**70%**	**62%**
Shape Based[6]	**40%**	**80%**	**60%**
Combination of Color, Texture and Shape Based[6]	**30%**	**70%**	**50%**

VI. COMPARISON OF RESULTS

The statistical comparison of CBIR Processes is as shown in the Table 3.

Table - 3. Statistical comparison of CBIR Processes

Application	Feature extraction method	Feature vector generated	Similarity measuring Technique	Performance measuring Technique	No of Images in database	No of queried images	Accuracy Rate
Retrieving images from a heterogeneous database[3]	Saliency estimation from local property	Fuzzy compactness vector	Fuzzy compactness	-	-	-	-
Retrieving images from a database[4]	Color histogram and Laplacian filter	Mean and Standard Deviation of pixels	Sum of absolute difference(SAD)	Precision and Recall	1000	-	Good
Image retrieval from a database[6]	Low level features like color,texture and shape	GLCM,histogram and shape features (Area,eccentricity, euler number, filled area)	Euclidean distance	Precision and Recall	90	10	Better as obtaining with single feature
CBIR using seven image transforms and four gradient operators[7]	Gradient operator and slope,magnitude technique with image transforms	Edge texture row means for individual R,G,B planes	Means squared error(MSE)	Average precision and recall	1000	55	
Enhanced efficiency of retrieval system[8]	Color histogram processing	Cross correlation value and image and image descriptor attributes	L1-norm (histogram comparison)	Precision and recall	-	-	-
Retrieval of images from database[9]	Color and texture	Color histogram and wavelet based histogram	Histogram intersection distance	Precision and recall	1000	-	Increase in the retrieval speed
Semantic image retrieval[11]	Color, texture and shape features and reducing feature database	Color histogram, Tamura, energy ,edge detection and Zernike moments	Hue comparison	-	-	-	-
To improve the performance of CBIR[12]	Color quantization with curvelet transform	Combined HSV color histogram and curvelet feature	Mahantan distance metric	Precision	565	20	57.5
For robust CBIR[14]	Quantized histogram color features based on laplacian filter	Statistical color features from bins, laplacian sharpened images, mean and standard deviation	Sum of absolute difference(SAD)	-	1000	-	good
To provide robust feature set for CBIR[17]	Dynamic dominant color, shape and texture	Dominant color, GLCM, gradient vector flow field	Weighted Euclidean distance	Precision and recall	1000	-	-

VII. CONCLUSION

This paper provides an overview of the functionality of content based image retrieval systems. Most systems use color and texture features, few systems use shape feature, and still less use layout features. This paper discusses about various feature extraction methods, similarity measurement techniques and the various applications. It has been found that variation in feature extraction methodologies can ensure the better and more accurate retrieval of relevant images from the large database. Similarity measuring parameters play a major role by providing the faster mechanism for comparison such as Sum of Absolute Difference, which is computationally very less than the widely used Euclidean Distance along with retrieval of relevant images. In many cases it has been found that Sum of Absolute Difference provide better retrieval comparing to other distances like Euclidean Distance, Bhattacharya Distance and Mahalanobis Distance. The CBIR system also depends on the size of the database.

VIII. REFERENCES

1. Dr. H.B. Kekre ,Mr Dhirendra Mishr,,Mr Aniruddha Kariwal, *"A survey of CBIR techniques and semantics"*, International Journal of Engineering Science and Technology (IJEST), pp. 4510-4517,Vol. 3 No. 5 May 2011.
2. Pushpa B. Patil, Manesh B. Kokare, *"Relevance Feedback in Content Based Image Retrieval: A Review"* Journal of Applied Computer Science & Mathematics, pp. 41- 47,no. 10 (5) /2011, Suceava.
3. Minakshi Banerjee, Malay. K. Kundu, "*Content Based Image Retrieval with Multiresolution Salient Points Machine Intelligence Unit"* , INDIA.
4. Fazal- E-Malik *"Mean and Standard Deviation Features of Color Histogram using Laplacian Filter for Image Retrieval"*, Journal of Theoretical and Applied Information Technology,1-7, Vol. 34 No.1, 15th December 2011.
5. Nidhi Singhai, Prof Shishir K. Shandily, *"A Survey on: Content Based Image Retrieval Systems"* , International Journal of Computer Applications (0975 – 8887), pp. 22-26, Volume 4 – No.2, July 2010, India.
6. Amanbir Sandhu, Aarti Kochhar ,*"Content Based Image Retrieval using Texture, Color and Shape for Image Analysis"* International Journal of Computers & Technology, pp. 149-152,Vol 3,No.1,AUG,2012 INDIA.
7. Dr.H.B.Kekre,Priyadarsini Mukherjee,Shobhit Wadhwa "Edge Texture Based CBIR using Row Mean of Transformed Column Gradient Image", International Journal of Computer Applications(0975-8887), pp. 12-17, Vol.7, No.10,October 2010.
8. Neetu Sharma , Paresh Rawat and jaikaran Singh, *"Efficient CBIR Using Color Histogram Processing"* , An International Journal(SIPIJ), pp. 94-112, Vol.2, No.1, March 2011.
9. Manimala Singha and K. Hemachandran, *"Content Based Image Retrieval using Color and Texture"*, An International Journal (SIPIJ), pp.39-57, Vol.3, No.1, February 2012, Silchar India.
10. Samia G. Omar, Mohamed A. Ismail and Sahar M. Ghanem,, *"A CBIR System Based on Class Signature of the Images, Color and Texture Features"*, IEEE 2009 , pp. 464-471, Alexandria University Alexandria 21544, Egypt.
11. Nishant Singh, Shiv Ram Dubey, Pushkar Dixit, Jay Prakash Gupta, "*Semantic Image Retrieval by Combining Color, Texture and Shape Features"* International Conference on Computing Sciences, pp. 116-120, 2012 Uttar Pradesh, India.
12. Yungang Zhang, Lijing Gao, Wei Gao and Jun Liu, "*Combining Color Quantization with Curvelet Transform for Image Retrieval"*, International Conference on Artificial Intelligence and Computational Intelligence,pp. 474-479, 2010 China.
13. Jayant Mishra, Anubhav Sharma and Kapil Chaturvedi, *"An Unsupervised Cluster-based Image Retrieval Algorithm using Relevance Feedback"* International Journal of Managing Information Technology (IJMIT),9-16, Vol.3, No.2, May 2011, Bhopal.
14. Fazal Malik and Baharum Bin Baharudin, *'Feature Analysis of Quantized Histogram Color Features for Content-Based Image Retrieval Based on Laplacian Filter"*, International Conference on System Engineering and Modeling (ICSEM 2012) IPCSIT, pp. 44-49, vol. 34 (2012) IACSIT Press, 2012 Singapore.
15. Poulami Haldar,Joydeep Mukherjee "Content based Image Retrieval using Histogram, Color and Edge", *International Journal of Computer Applications (0975 – 888),25-31, Volume 48– No.11, June 2012,* Jadavpur University Kolkata, India.
16. P. S. Hiremath ,Jagadeesh Pujari, *"Content Based Image Retrieval based on Color, Texture and Shape features using Image and its complement"* , International Journal of Computer Science and Security, pp. 25-35,Volume (1):Issue(4) Gulbarga, Karnataka, India.
17. M.Babu Rao, Dr.B.Prabhakara Rao, *Dr.A.Govardhan,"Content Based Image Retrieval Using Dominant Color, Texture And Shape"*, International Journal of Engineering Science and Technology (IJEST), pp.2887-2896,Vol. 3 No. 4 Apr 2011,A.P, India.