A Survey on Feature Extraction using Color, Texture and Shape Features

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***Abstract*—** The previous couple of years, the invention of digital technology has cause increase in the number of an images that can be stored in digital format. Thus searching and retrieving images from massive image databases has become tougher. To overcome this drawback the researcher has become focus on Content based Image Retrieval (CBIR). This paper is mainly concerned with object retrieval based on low level features .The main work is concerned with an extracting features extraction methods like color, texture and shape features from object.

Keywords*—CBIR; feature extraction; color space; RGB; HSV color space; color histogram; GLCM; EHD.*

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I. INTRODUCTION

As stated by a Chinese proverb "A picture is worth a thousand words", therefore the researchers focus a lot of on image retrieval compared to text retrieval. With the generation of the large amount of multimedia information, effective ways are needed for information or object retrieval. Image retrieval techniques are used to get accurate results in lower computational time ensuring good performance.

The main problem faced by user is that the issue of locating his relevant image during massive and varied collection of resulted images. This problem stated as image retrieval problem. A general view for this drawback is shown in Figure 1 below. To recover from this problem, *text-based* and *content-based image retrieval (CBIR)* are the two techniques adopted for search and retrieval in an image database [1].

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Figure.1: General View for Image Retrieval Problem.

TECHNIQUES FOLLOWED BY IMAGE RETRIEVAL SYSTEMS

To recover the problem of image retrieval systems following two techniques adopted for search and retrieval in an image database:

A] Text based image retrieval:

In this technique images were searched based on information of image like caption, tags, keywords, subject headings, or classification codes which are used as retrieval keys throughout search and retrieval from huge collection of database.

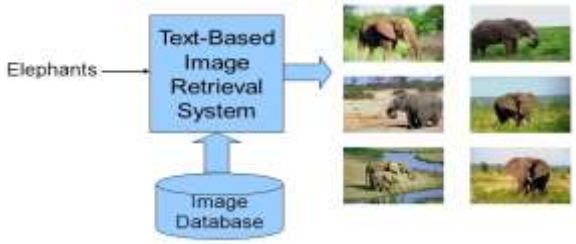

Figure.2: Text Based Image Retrieval System.

But sometimes it is not convenient to used human annotation for retrieving particular object using this system ,Hence to eliminate this problem Content based image retrieval (CBIR) is used based on features of the image, like color, texture and shape that are automatically extracted from the images themselves. Recently the researchers focus on different feature extraction techniques used in CBIR to retrieve low level features like color, texture and shape

B] Content Based Image Retrieval (CBIR)

Content Based Image (CBIR) is the retrieval of images based on their visual features such as color, texture, and shape [2.1]. Content-based image retrieval systems have become a reliable tool for many image database applications. There are several advantages of image retrieval techniques compared to other simple retrieval approaches such as text based retrieval techniques [1].

CBIR system makes direct use of content of the image rather than relying on the human annotation of metadata with the keywords. Current CBIR make use of low level features like shapes, color and texture to retrieve desired images from database. [2]

The main advantage of using CBIR system is that the system uses image features instead of using the image itself. So, CBIR is affordable, quick and efficient over image search methods. [2][3]. Figure 3 shows the basic diagram of CBIR.

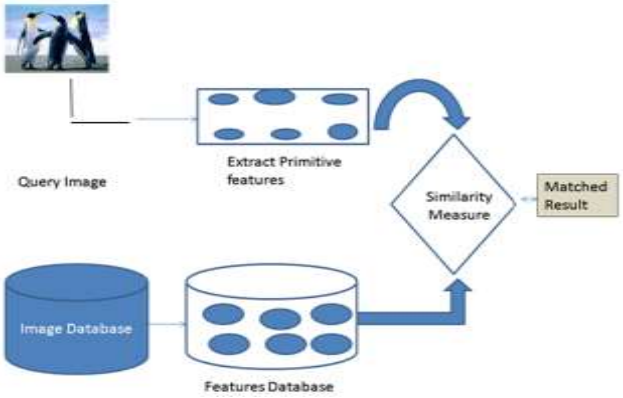

Figure 3: Basic Diagram of Content Based image Search

One of the main ideas of CBIR is to analyze image information by using low level features of an image, which include the features like color, texture, and shape and color layout. The features are stored in image feature information for future use. Once a query image is given, the features of the query image are extracted to match the features within the feature database by a pre-established algorithm, in order that a bunch of comparable pictures to the query image is came because the retrieval pictures [4-6].

The organization of the paper is as follows. The section I give the introduction about the image retrieval system. An overview of the Different methods for Object retrieval in CBIR like color space, color moments, color histogram GLCM, EHD are presented in section II. The section III gives the similarity measures. In the section IV gives the idea behind performance evaluation. The comparative analysis of these different techniques described in section V and finally the conclusion is discussed in section VI.

II. DIFFERENT METHODS FOR OBJECT RETRIEVAL IN CBIR

CBIR Using Color Feature Extraction

Color is a widely used low level feature and it is a very crucial aspect which is used by humans to differentiate between images. In, CBIR Color feature extraction can done in following ways:

1] Color space

To extract the color features from the content of an image, a proper color space (also known as color models or color systems) and an efficient color descriptor have to be determined. Color of an image is usually expressed through color model. Color model is defined in three dimensional color areas as follows:

a) RGB: RGB colours are referred to as primary colors, they are additive. New colors can be prepared by combining them differently. [3]

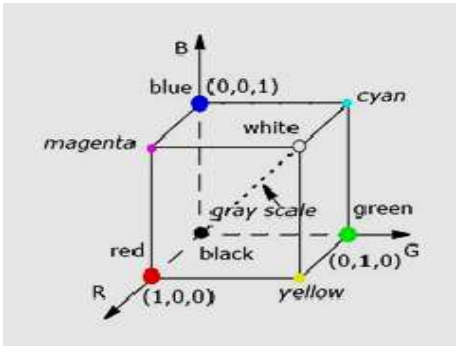

Figure 4: RGB color model

b) HSV:

The HSV space is derived from RGB space cube with main diagonal of RGB model with vertical axis in HSV. As saturation varies from 0.0 to 1.0, the colors vary from unsaturated (gray) to saturated (no white component). Hue ranges from 0 to 360 degrees, with variation beginning with red, going through yellow, green, cyan, blue and magenta.[8, 9]

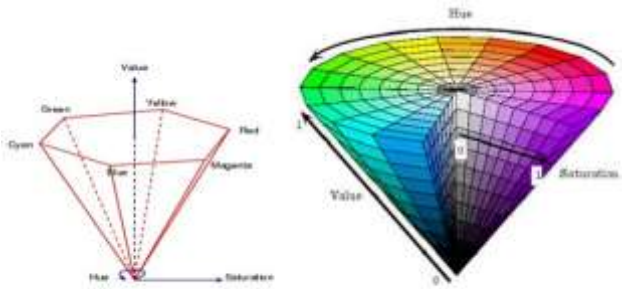

Figure 5: HSV color model

2] Color Histogram:

In Color histogram, after analyzing each image its histogram is created. In that histogram, color proportion for every pixel is shown. Color histogram is that the most universal method for color based image retrieval. The color histogram is obtained by quantizing image colors into distinct levels then counting the number of times each distinct color occurs within the image. Color Histograms are additional divided into two types:
a) Global Color Histograms in GCH, a single image will have a single color histogram. [9]

Advantage: Less computation is required.

Disadvantage: In GCH, less information about an image is extracted. Sometimes we can get inconsistent results.

b) Local Color Histograms in LCH, an image is divided into segments, and further color histograms of those segments are calculated. [9]

Advantage: In LCH, more information about an image is extracted.

Disadvantage: More computation is required because; every segment has to be computed. Accurate results are obtained.

3] Color moment

The first-order (mean), the second (standard deviation),and the third-order (skewness) color moments have been proved to be efficient and effective in representing color distributions of images[1][2][11]. If the value of the i^{th} color channel at the j^{th} image pixel is Pi j, then the color moments are as follows:

Moment 1: Mean

$$E_i = \frac{1}{N}\sum_{j=1}^{N} p_{ij} \quad (1)$$

Moment 2: Standard Deviation

$$\sigma_i = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(p\,ij - Ei)^2} \quad (2)$$

Moment 3: Skewness

$$S_i = \sqrt[3]{\frac{1}{N}\sum_{j=1}^{N}(p\,ij - Ei)^3} \quad (3)$$

CBIR Using Texture Feature Extraction:

In the computer vision and image processing field, to analyzing texture content of an image is the most vital method to image region description. There is no clear-cut definition available for texture; however we can say that it provides the measures of properties like directionality smoothness, coarseness, and regularity. Texture can be thought of as repeated patterns of pixels over a spatial domain. Some common methods are used for texture feature extraction such as statistical, model-based, and transform-based methods.

Gray level Co-Occurrence Matrix

This is most popular statistical method of texture analysis introduced by Haralick in 1973[17][18]. Haralick stated two steps for texture feature extraction that is beginning with computing the co-occurrence matrix and the second step is calculating texture feature based on the co-occurrence matrix. This method is beneficial in wide range of image analysis applications from biomedical to remote sensing techniques.[18]

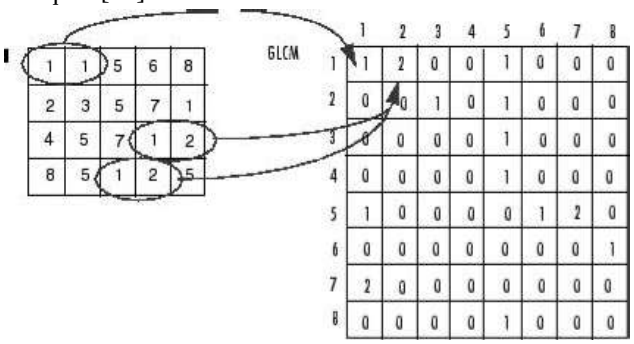

Figure 6: Working of GLCM

Element (1, 2) in the GLCM contains the value 2 because there are two instances in the image where two, horizontally adjacent pixels have the values 1 and 2. The GLCM matrix has been extracted for input dataset imagery. Once after the GLCM is computed, texture features of the image are being extracted successively.

CBIR Using Shape Feature Extraction:

In the field of image processing, object shape features provide a powerful clue to object identity. Shape is well known to play a vital role in human recognition and perception to object identity.

Edge Histogram Descriptor

Edge is a local shape feature and it captures the general shape information in the image [18].

Since edges play a vital role for image perception because it is usually used as a feature descriptor in image retrieval. the edge histogram Descriptor, EHD, is such an example; that represents the spatial distribution of five varieties of edges, namely four directional edges and one non-directional edge. To increase efficiency of the proposed system, edge features that include these five categories are used as shape features.

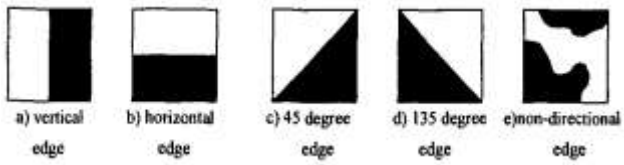

Figure 7: Five Types of Edges in the EHD. [19]

III. Similarity Measures

After extracting the features from images, a function is used that measure the similarity among the query image and database images in CBIR systems. Generally, the similarity measure function used is distance metric. The value of distance metric indicates the extent of similarity among the query image and database image. A database image is said to be the same as query image if the calculated distance is 'small'. A number of the strategies for similarity measuring are Euclidean Distance, Mean square Error, sum of Absolute differences, NN Classifiers, K-Nearest Neighbor algorithm, Mahalanobis Distance, Bhattacharya Distance [15].

IV. Performance Evolution

The idea behind performance analysis is to make a prediction on the CBIR system performance with reference to retrieval rate. The common ways used to measure the performance are User comparison, rank of best match, Average rank of retrieval pictures, Recall and exactitude, Error rate etc. [15].

V. COMPARISION OF TECHNIQUES FOLLOWED BY CBIR

YEAR	AUTHOR	TITLE	DATABASE	NO OF FEATURES	FEATURE EXTRACTION TECHNIQUE	Similarity Measure	ACCURACY %	DRAWBACKS
March 2016	Kaipravan, Muhsina, and R. Rejiram	A novel CBIR system based on combination of color moment and Gabor filter[10]	Wangs image database	2(Color, Texture)	Color moment, Gabor Filter	Manhattan distance measure	75-80	only color or only texture features are not sufficient to describe an image
August 2015	Zhang, He, and Xiuhua Jiang.	An improved algorithm based on texture feature extraction for image retrieval[16]	Database Caltech256	1(Texture)	Gabor Filter and EHD	Based on using Gabor wavelet transform and EHD algorithm	Precision for EHD=0.35 Gabor Filter =0.43	--
August 2012	Chadha, Aman, Sushmit Mallik, and Ravdeep Johar.	Comparative study and optimization of feature-extraction techniques for content based image retrieval[11]	WANG database	2(Color, Texture)	Color moment, GLCM, Local Color Histogram, Global Color Histogram and Geometric Moment	--	81.69	when used individually precision value not satisfied and considerably long retrieval time.
May 2012	Jiayin Kang1, Wenjuan Zhang2	A Framework for Image Retrieval with Hybrid Features[12]	WANG database	3(Cplor, Texture, Shape)	Color model, global color histogram, GLCM, Zernike moments	Euclidean distance measure	60-70	Limited benchmark image dataset Used.
December 2012	Afifi, Ahmed J., and Wesam M. Ashour	Content-Based Image Retrieval Using Invariant Color and Texture Features[1]	WANG database	2(Color, Texture)	color moment, HSV color space, Ranklet Transform	Euclidean distance measure	70	Combination of color and texture feature extraction are not sufficient
March 2012	M R. Rasli, T. Muda, Y. Yusof and J. Abu Bakar,	Comparative Analysis of Content Based Image Retrieval Technique using Color Histogram. A Case Study of GLCM and K-Means Clustering[13]	9960 images are used	4(Texture, Shape, Color and Location)	Color Histogram, Gray Level Cooccurrence Matrix(GLCM), K-Means Clustering	GLCM, KMeans	Precision= 0.867-0.900	Proper & correct database needed to achieve better efficiency
November 2011	N. K. Patil, R. M. Yadahalli,J. Pujari,	Comparison between HSV and YCbCrColor Model Color Texture based Classification of the Food Grains[14]	Food Grains Images	1(Color)	HSV and YCbCr color models	K-NN Classifier	25-50	Limited Query images used
March 2011	S.Selvarajah and S.R. Kodituwakku	Analysis and Comparison Of Texture Features for Content Based Image Retrieval[17]	--	1(Texture)	Gabor Transform, GLCM	--	Precision: Gabor=0.76 GLCM=0.44	Feature sets not sufficient for retrieving object
July 2010	Huang, Zhi-Chun, et al.	Content-based image retrieval using color moment and gabor texture feature[21]	WANG database	2(color, texture)	Color moment, RGB to HSV, Gabor Filter	Euclidean distance	63.6	--

July 2009.	Kong, Fan-Hui.	Image retrieval using both color and texture features[20]	Corel database	2(color, texture)	HSV, GLCM; CCM	Euclidean distance measure	Color=36.8 color+GLCM=39.2 color+CCM=44.1	Precision level not satisfied and long retrieval time.
February 2014	Anusha, Ms V., Ms V. Usha Reddy, and T. Ramashri	Content Based Image Retrieval Using Color Moments and Texture[7]	--	2(color, texture)	Color moment, GLCM	Euclidean distance measure	98.4	Limited dataset used
2011	Kavitha, Ch, et al.	Image retrieval based on local histogram and texture features[22]	1000 Corel images	2(color, texture)	Local Histogram, GLCM	Euclidean distance measure	Precision: Gabor=0.315 GLCM=0.326	To be evaluated for more various databases.

VI.CONCLUSION

In this paper, a survey of current research work in feature extraction techniques followed by CBIR and detail description about the various concepts included in extracting low level features like color, texture and shape has been discussed. This paper describes briefly about what are the techniques followed by image retrieval systems. It also describes the different methods for object retrieval in CBIR. In addition, it also presents a brief survey about comparison of different methods of feature extraction. This study aimed to provide a simple guide to the researcher for those carried out their research study in the image retrieval system in CBIR.

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