Improved approach for Content Based Image Retrieval using Color and Texture features

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Abstract- *CBIR system that works on the basis of low level image semantics cannot be directly related to the expressive semantics that is used by human for deciding image similarities. The low-level semantic of the image consists of color, texture and shape of the object inside an image. Now-a- day, one type of feature extraction technique cannot provide the fulfilled result because in the latest trained used the combination of feature techniques. There is generous increase in retrieval precision when combinations of these techniques are used in an effective way. In this paper, propose method an improved CBIR system using different feature extraction methods; three features based on color(i.e HSV Histogram, Color Moment and Color autocorrelogram) and another two feature computed by applying the texture feature using Gabor Wavelet and Wavelet Transform of the image. For similarity matching between the query image and database images Manhattan distance or City Block or L1 distance is used. The experimental results on WANG database showed higher retrieval efficiency (in terms of precision) when compared with existing methods using color and texture features.*

Keywords- Content based image retrieval, HSV Histogram, Color Moment, Color autocorrelogram, Gabor wavelet and Wavelet Transform

I. INTRODUCTION

The recent incredible growth in computer technology [1], and with the availability of image taking devices such as digital camera, image scanners, and the size of digital image collection is increasing rapidly. An efficient [2] image searching, browsing and retrieval system are required by users from various domains like remote sensing, fashion, crime prevention, publishing, medicine, architecture etc. For this purpose, many general purpose image retrieval systems have been developed. There are two categories for image retrieval: text base and content based. In text based image retrieval, the images are manually annotated by text descriptors, which can be used by database management system (DBMS). Then, DBMS is used as image retrieval system. There are two disadvantages of this approach. The first is laborious for manual annotation. The second is not accuracy in annotation because of subjective of human perception. To overcome these disadvantages in text based image retrieval, content-based image retrieval (CBIR) was introduced in the early 1990s.

The "Content-based" means that the searching of images according to the content of image rather than the metadata like keywords, tags, description associated with the image. The term "content " here refer to colors, texture, shapes and other information of image that image itself derived from the image. CBIR system extracts of images from large database of images using the similarity between query image and database images. The similarity is measure based on feature like colors, textures and shapes [3]. In the CBIR system, firstly obtain the features of every image and then store in the database, and then database is called feature database. Similarly, feature is obtain for query image, and then similarity matching process is performed. In this process, query image is passed by the user similar images is retrieved from image database.

Technique like query by example (QBE) or query with a specific content features can be further merge with the Relevance Feedback. The relevance feedback is given by the user for improve the performance of relevant images, by decreasing the irrelevant images in the retrieval process.

In a CBIR system, features play an important role. Early researches on CBIR system employed single feature of image like color, texture and shape which was not sufficient to extract the relevant images from image database. So, various active researches in CBIR have led to the combination of various feature extraction method to solve this difficulty.

II. RELATED WORK

There is a number of previous works in the literature on CBIR. A few important works is reviewed in the following:

Rui et al. [4] proposed an interactive retrieval approach based on relevance feedback mechanism, which considers the two issues in CBIR: i) the difficulty of representing semantics using low level features, ii) human visual perception of color. The proposed approach,

implemented over more than 70000 images, shows that the overhead of composing the query is limited and the user information is precisely captured using this approach.

Hamid A. Jalab [5] presented an image retrieval technique where color layout descriptor is used as color feature, and Gabor wavelet coefficients are used as texture feature. They report significant enhancement in retrieval performance. The experiment using the "wang.ist.psu" database reports the average precision-recall values as 56.16% and 56.25% respectively.

Majid Fakheri et al. [6] has presented a method using texture and shape features of the image. The Texture semantics is retrieved using Gabor wavelets. Shape feature is extracted using Gradient Vector Flow fields. Similarity is matched using the principle of most similar highest priority (MSHP). The proposed approach implemented using the Corel dataset shows an accuracy of 60.7%.

Zhi-chun huang et al. [7] has proposed an image retrieval technique based on combination of color moments of the HSV color space and Gabor texture descriptors with Euclidean distance used for distance measure. The proposed method, implemented on the WANG database showed that the approach has accuracy of 63.6% with standard deviation of 0.286 which is comparatively higher than other methods based on color and texture feature extraction.

M. Rakhee et al. [8] proposed a CBIR technique based on combination of shape feature along with color-texture using Walsh Wavelet. The performance of the scheme is tested on a database containing 44 images and the results of the proposed scheme shows that shape extraction with Sobel and Prewitt operators gives better efficiency than Canny and Robert operators.

Rikin et al. [9] has proposed a CBIR system in order to get higher efficiency based on color moment, Ranklet transform and Hough Transform, and shown that the retrieval results are precise than using the feature individually. Wang database was used to evaluate the proposed approach.

Recently, Arun and Govindan [10] proposed an image retrieval techniques based on inferring visual dictionaries. This is an unsupervised visual dictionary learning scheme which provides low error in encoding image patches. Good precision performance is reported for retrieval.

Aditi Giri et al. [11] this paper focuses on color and texture based techniques for achieving efficient and effective retrieval of images Color feature extraction is done by color histogram and color moment. Texture feature extraction is acquired by wavelet and gabor transform. For classification of extracted features we have used support vector machine. Euclidian distances are calculated of every features for similarity measures.

The above literature survey shows that the CBIR as on today is still an active topic of research. Despite the fact that the numerous attempts are made to develop a highly efficient system, most of the CBIR systems lag behind in terms of the efficiency due to lack of semantic information available from the image features. It is concluded that using only one type of feature extraction is insufficient to retrieve images efficiently. There is substantial improvement in retrieval accuracy when combinations of these techniques are used. Hence, there is a need for further work in CBIR for achieving better efficiency in terms of precision, recall and time complexity.

III. PROPOSED METHOD

In this paper suggested a new approach to image retrieval, in which color feature extraction and texture feature extraction methods are used. In this approach collection of images is stored in the database. The proposed approach is basically divided into two major phases. In the first phase applies the feature extraction techniques above all database images and then extract the feature vectors, stores into feature database (feature dataset). In this paper feature extraction method is combination of color and texture feature technique that are HSV histogram, Color moment, Color autocorrelogram, Gabor wavelet, and Wavelet transform techniques. In the second phase, the same process is done for query image and obtains feature vector of query image. At last, the similarities of the query image feature vector with the database feature vectors is computed to retrieve images based on some distance metric, the whole process is shown in the figure 1.

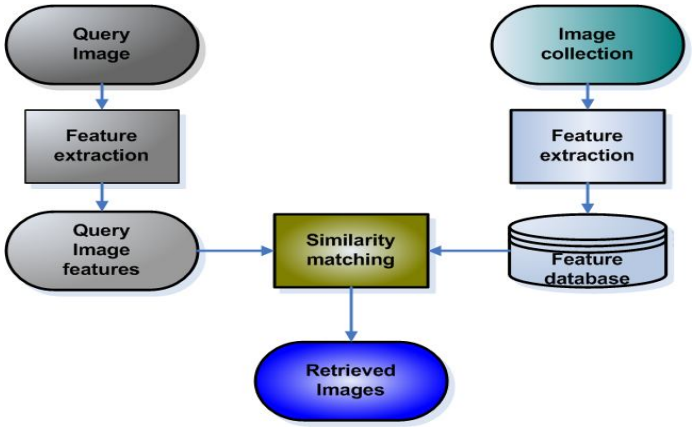

Figure 1: Block diagram of CBIR system

IV. FEATURE EXTRACTION

Feature extraction is necessary step in retrieving the images from the database. It is the process of extracting the most relevant information from the image which is used to define relevant images. These features are further converted into vectors called feature vectors. There are various methods for extracting features from images. Color feature and texture feature are used in this paper. An important attribute of the image is Color which is invariant to any change in size and direction of the image. Hence, this feature has been used in many CBIR systems. In this approach, HSV histogram, Color moment, Color autocorrelogram are employed for the extraction of color features.

HSV HISTOGRAM:

The histogram of colors [3] is an important feature to represent components of color that are present in the image. In this approach, the image is quantized in HSV color space into 8x2x2 equal bins. The HSV corresponds to Hue, Saturation and Value which provides human visual perception of color. After the quantization phase, a histogram is created which is further converted into feature vector. The rotation, translation and scale invariance of color histogram enable it as an efficient feature for representing images in CBIR systems.

COLOR AUTOCORRRELOGRAM:

A color correlogram [14] expresses how the spatial correlation of pairs of colors changes with distance. The important points of autocorrelogram feature are: (i) it includes the spatial correlation of colors, (ii) it can be used to describe the global distribution of local spatial correlation of colors [15], [16]; (iii) it is easy to compute, (iv) it is the size of the feature is fairly small. This feature can outperform both the traditional histogram method and the recently proposed histogram refinement methods for image retrieval.
Therefore, the correlogram is one kind of spatial extension of the histogram and is extensively used over color histogram. As the histogram is the color distribution in an image I, the correlogram is the color correlation distribution in image I.

For pixel p_1 and p_2 of color and separated by distance k. The correlogram of I for i, j as shown in given below Equation (1).

$$\gamma_{c_i c_j}^{(k)}(I) = p\left[p_2 \epsilon I_{c_j} | p_1 - p_2| = k,\ p_1 \epsilon I_{c_i}\right] \quad (1)$$

So the correlogram of the image I is a table which is indexed by color pairs and distance, where the k^{th} entry for <i, j> will denote the probability of finding a pixel of color j at a distance of k from a pixel of color i.

Whereas an autocorrelogram can be stored as a table indexed by color i where d-th entry shows the probability of finding a pixel i from the same pixel at distance k. Hence autocorrelogram shows the spatial correlation between identical colors only.

COLOR MOMENT:

"Color moment" is proposed [12] as a measurement for color. In fact, the base concept of the Color moment is the distribution of the color in an image, which also can be indicated as a probability distribution. To overcome the quantization effects of the color histogram, the color moment as a feature vector for image retrieval is used [13].

By two low order moments [11] most of the color distribution information is captured.

The mean color captures by first-order moment (μ_c) in equation (2)

$$\mu_c = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} P_{ij}^{c} \quad (2)$$

The standard deviation captures by the second-order moment or variance (σ_c) in equation (3)

$$\sigma_c = \left[\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(P_{ij}^{c} - \mu_c\right)^2\right]^{\frac{1}{2}} \quad (3)$$

Where, P_{ij}^{c} is the value of the c^{th} color component of the color pixel in the i^{th} row and j^{th} column of the image.

GABOR WAVELET:

Gabor wavelet [3] is one of the leading approaches in texture feature extraction. Basically, these are the group of wavelets; which capture energy information at particular frequency on a particular direction. This wavelet is implemented in different manner and is well suited for texture extraction.

The equation for the Gabor wavelet transform of a image I(a,b) with size $P \times Q$ is given by convolution:

$$G_{m,n} = \sum u \sum v\, I(a-u, b-v)\varphi_{m,n}^{*}(u,v) \quad (4)$$

Where, m is the scale value and n is the direction value respectively; u and v represent the size of filter mask; $\varphi_{m,n}^{*}$

denote the complex conjugate of $\varphi_{m,n}$. This self-similar function $\varphi_{m,n}$ is get from the mother wavelet ψ. In this purposed approach, the numbers of scale (m) and orientation (n) are 6 and 8 respectively.

After, put on the Gabor wavelet transform, we obtain the energy information (at different orientation and scale) which can be denoted in Equation (5) as follows:

$$E(m,n) = \sum a \sum b \left| G_{m,n}(a,b) \right| \quad (5)$$

From this energy information, the feature vector is obtained by computing mean using Equation (6) and standard deviation using Equation (7).
Where:

$$\mu_{m,n} = \frac{E(m,n)}{P \times Q} \quad (6)$$

$$\sigma_{m,n} = \frac{\sqrt{\sum a \sum b \left(|G(a,b)| - \mu_{m,n} \right)^2}}{P \times Q} \quad (7)$$

WAVELET TRANSFORM:

Wavelet transform [11] is a multi-resolution approach. In many aspects of image processing wavelet transform have been used. A wide range of wavelet-based tools and ideas have been proposed and studied for image compression, noise removal from images, image retrieval and image reconstruction. To retrieve images for texture features the multi resolution wavelet transform has been employed. The wavelet features do not achieve high level of retrieval accuracy. Therefore, to achieve higher level of retrieval accuracy using wavelet transform various methods have been developed. To increase effectiveness in CBIR wavelet features computed from discrete wavelet coefficients are assigned weights. In our approach, firstly image is changed into gray color space, and then resized to 256x256 [3]. Then, two-dimensional DCT is put on the image, and the mean and standard deviations are calculated to construct the feature vector.

V. PROPOSED ALGORITHM

The proposed algorithm for feature extraction and storage is:
Step 1: Load the image for analysis.
Step 2: Resize to size 384x256.
Step 3: Quantize the image into Hue, Saturation and Value (HSV) into 8x2x2 value, and obtain HSV color histogram.
Step 4: Apply Color Autocorrelogram on the image.
Step 5: Extract first 2 color moments from each Red, Green and Blue Planes of image.
Step 6: Convert RGB image to Gray Scale for Gabor Wavelet.
Step 7: Apply Gabor Wavelet to calculate mean squared energy and mean amplitude.
Step 8: Again convert RGB image to Gray Scale image for Wavelet Transform and resize to size 256x256.
Step 9: Now, Apply Wavelet Transform to calculate first two moment of wavelet.
Step 10: Combine the feature vector results of steps 3 to 9 and store in the dataset.

The proposed algorithm for image retrieval from storage is:
Step 1: Load stored values from dataset.
Step 2: Load query image.
Step 3: Extract features for query image (As given in feature extraction algorithm above).
Step 4: Match the feature values stored in dataset.
Step 5: Retrieve the images which show maximum relevant.

VI. SIMILARITY MEASURE

The query image features are obtained to get the desired feature vectors. The image is retrieved based on the match between query feature vector and the database feature vectors to get the least distance by calculating the Manhattan (City Block) [3] distance is given below in equation (8).

$$d = \sum_{i=1}^{n} |X_i - Y_i| \quad (8)$$

Where X_i and Y_i are the feature vectors of query images and database image respectively

VII. EXPERIMENT RESULT

The implementation is done by using MATLAB. The experimental database used is the WANG [17] database of 500 images. This consists of Corel Photo database grouped in to 10 classes but in this paper contain only 5 classes. For Similarity measure generally Manhattan distance is used and it gives always better results. So, in this paper City Block or Manhattan or $L1$ distance metric is used. The comparison of conventional CBIR methods and the suggested method is also performed. The accuracy of the CBIR system proposed is measured using the precision performance measure. Precision [3] represents the ratio of the relevant images out of the total images retrieved to the total images retrieved; it is defined as follows:

$$Precision = \frac{Total\ relevant\ images\ retrieved\ from\ database}{Total\ \ images\ retrieved\ from\ database}$$

Method→ Image Classes↓	Color layout descriptor +Gabor Filters [5]	Gabor wavelets +GVF Function[6]	Color Moment +Gabor Texture[7]	RGB average +HSV histogram +Gabor wavelet+ discrete cosine transform[3]	Proposed method
African People	0.32	0.55	0.54	0.60	0.90
Beach	0.61	0.40	0.42	0.72	0.95
Building	0.39	0.40	0.16	0.64	0.70
Buses	0.39	0.68	0.67	0.88	0.90
Dinosaurs	0.99	0.96	0.99	1.00	1.00
Average precision	0.54	0.60	0.56	0.76	0.89

The results are shows in above table reported in [3], [5], [6], and [7]. These results are used for comparison by the proposed method. The results clearly show that for majority of image classes in the database, the suggested approach gives enhanced precision values, over all of the 5 classes is much better than that reported in[3], [5], [6], and [7]. Also, line graph show the best result for proposed method amongst in the all reported method [3], [5], [6] and [7] that is shown in figure 2. In figure2, 0 to 1 represent the precision value and African people, beach, building, buses and dinosaur are represent the different classes of images store in the database.

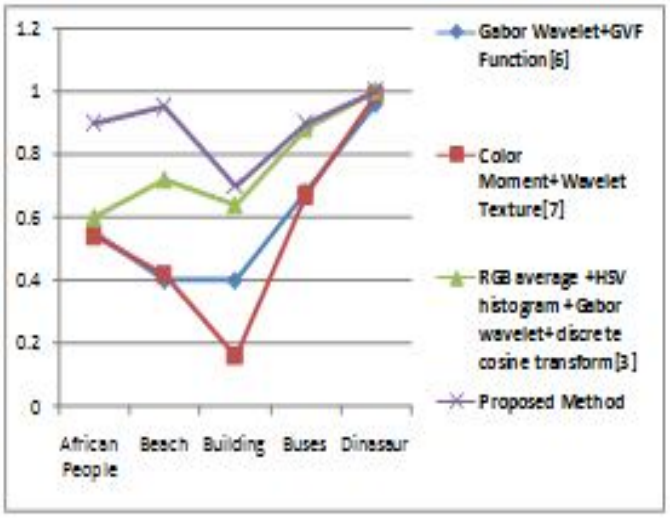

Figure 2: Relationship between precision value and image classes for Gabor wavelets +GVF Function[6], Color Moment + Gabor Texture [7], RGB average +HSV histogram +Gabor wavelet+ discrete cosine transform[3] and Proposed method.

According to the proposed method, figure 3 and 4 shows the retrieval results for African people query image and beach query image respectively.

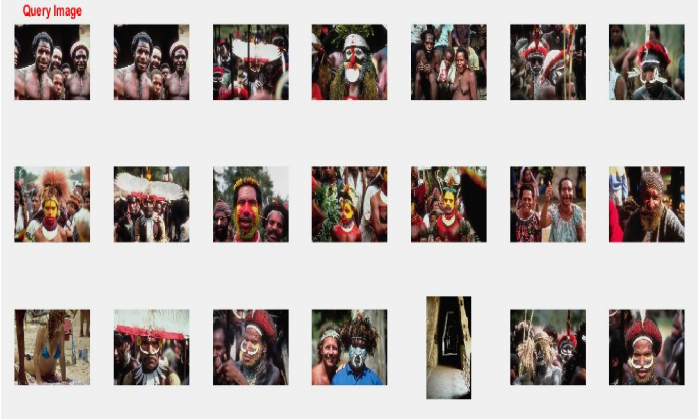

Figure 3: Query image of African people with its retrieval images

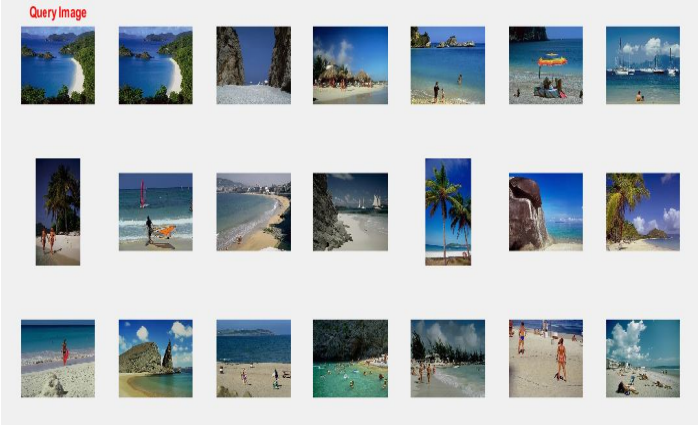

Figure 4: Query image of Beach with its retrieval images

VIII. CONCLUSION AND FUTURE WORK

This paper proposes an enhanced approach for image retrieval. In this Approach makes use of HSV color histogram, Color Moment, Color Autocorrelogram, Gabor Wavelet and Wavelet Transform. Experimental results show that the proposed method provides better accuracy than existing CBIR systems in retrieving images. The approach provides better precision for all of the image classes in the database when compared with four of the works in the literature. Moreover, the average precision over all of the image classes is obtained as 0.89 which is about 0.13 higher than highest value that reported in the works compared.

There are a number of areas for the improvement of the CBIR systems. An efficient CBIR system should supply maximal support to introduce the meaning (semantic) of the content in the images. In the literature, various techniques are available for improvement of CBIR systems. Combinations of

these techniques can be used for achieving better efficiency. The proposed method works on color- texture information for image retrieval. However, the growth of proposed scheme with the shape features can further increase the retrieval efficiency and time performance of the CBIR systems, which can be the scope for future work.

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