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Content Based Image Retrieval using Color Histogram, Correlogram & Wavelet Transform Features

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Abstract—*The Content Based Image Retrieval (CBIR) is new and upheld approach to find similar images from tremendous large image database. In this paper, we utilize Content Based Image Retrieval approach to deal with the problem of finding most comparative images from the database with a query image. The color is one of the components of the image, which can be utilized to find the similarity between the images but sometimes it provides unsuitable results because images with similar color do not have same content. Therefore, this issue is overcome by using the combination of color and texture features like Color histogram, Color Autocorrelogram and Wavelet transform. These features are represented in feature vectors and these vectors are matched to query feature vector with the help of similarity metric. The distance of this matrix is arranged in ascending order and then, finally retrieves the results. The performance can be assessed in terms of precision and recall.*

1. INTRODUCTION

Content Based Image Retrieval has become one of the critical factors in different applications like digital libraries, finger print identification, pattern recognition, signature matching, medicine, research etc [1]. Earlier image retrieval used text based retrieval, prior to image retrieval in which manual text or keywords or annotation were used for searching an images[2]. When text is utilized for retrieval of images, distinctive object images may be the outcome and sometimes due to incorrectly spelled text, it also delivers wrong result.

Content based Image Retrieval also called as Query by Image Content (QBIC) and content-based visual information retrieval (CBVIR) [3] is the procedure of retrieving images from a database that have similar content of color, texture and shape.

Content Based Image Retrieval utilizes the contents of image to retrieve the images. Color and Texture represents the contents of an image, that are easily visible to humans. The color features used in this paper are color Histogram, color autocorrelogram and texture feature utilized is wavelet transform[1]. In content based image retrieval, a query image is used to retrieve the similar images from image database. The features of query image are stored in query feature vector and the features of images from database are stored in feature vector of database. These two vectors are used for similarity measurement by using Histogram Euclidean distance and Histogram Manhattan distance[3] .

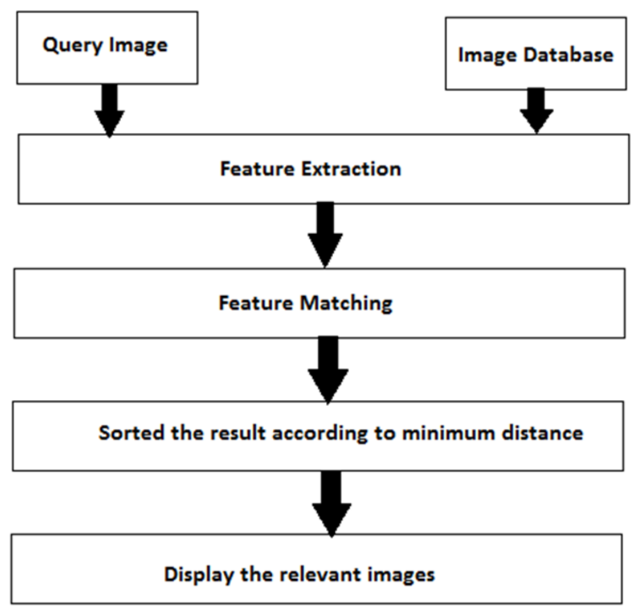


Fig. 1: Block Diagram of CBIR System

The rest of the paper is organized as follows. In Section 2 the feature extraction is described. Section 3 illustrates the feature matching process and Section 4 discusses the steps of image retrieval. Section5 shows experimental results and finally Section 6 concludes the paper.

2. FEATURE EXTRACTION

The initial step of retrieval of images is to represent color and texture component into feature vector. The features of color and texture consider in this paper are discussed below.

(a) Color Feature

Color is the visual element which can be generally used in image retrieval since, it is effortlessly visible to human being. The most important feature of color is color histogram. The extraction of color histogram from an image is to first convert the RGB image into HSV color space, quantize the HSV color space to reduce the number of colors from an image and then compute the histogram which should be normalized. These histograms are stored in feature vector.

A color histogram [9] represents the distribution of colors in an image through a set of bins, where each histogram bin corresponds to a color in the quantized color space [13]. A color histogram for a given image is represented by a vector:

$$H=H0,\ H1,\ H2,\ H3,\ldots,\ Hi,\ldots\ldots\ldots,Hn\text{---} \qquad (1)$$

where, i is the color bin in the color histogram, *Hi* represents the number of pixels of color in the image and n is the total number of bins used in color histogram. Typically each pixel in an image will be allocated to a bin of a color histogram and the value of each bin provides the number of pixels that has the similar corresponding color. In order to compare images of various sizes, color histograms should be standardized. The normalized color histogram *H'* is given as:

$$H'=H0',\ H1',\ H2',\ldots\ldots,\ Hi',\ldots.\ ,Hn'\text{-------} \qquad (2)$$

The color correlogram was proposed to describe the color distributions of pixels as well as spatial correlation of pairs of colors. The first and the second measurement of the three-dimensional histogram are the shades of any pixel pair and the third measurement is their spatial separation [13]. A color correlogram is a table listed by color sets, where the k^{th} section for (i, j) indicates the likelihood of finding a pixel of color j at a separation k from a pixel of color i in the image. Let I represents the whole arrangement of image pixels and Ic(i) represents the set of pixels whose colors are c(i). Then, the color correlogram is characterized as:

$$\Upsilon^{(k)}_{I,j}=P_r[p_2 \in I_{c(j)}\ ||p_1-p_2|=k]\text{-----------------------}(3)$$

where, i, j ∈ {1, 2,…,N}, k∈ {1, 2,…,d}, and

|p1–p2| is the distance between pixels p1 and p2.

If we consider all the possible combinations of color pairs, the size of the color correlogram will be very expansive ($O(N^2d)$), therefore a simplified version of the feature called the color autocorrelogram is frequently utilized. The color autocorrelogram just catches the spatial correlation between indistinguishable colors and in this way decreases the dimension to O(Nd). Contrasted to the color histogram, the color autocorrelogram gives the best retrieval results, but on the other hand it is computational expensive because of its high dimensionality.

These features are stored in feature vectors for feature matching process.

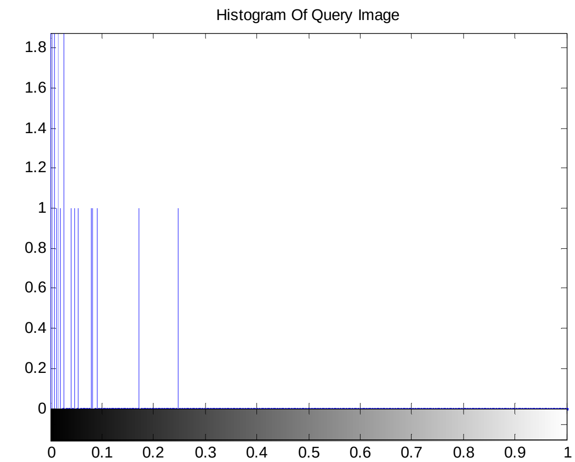


Fig. 2: Histogram of query image (rose)

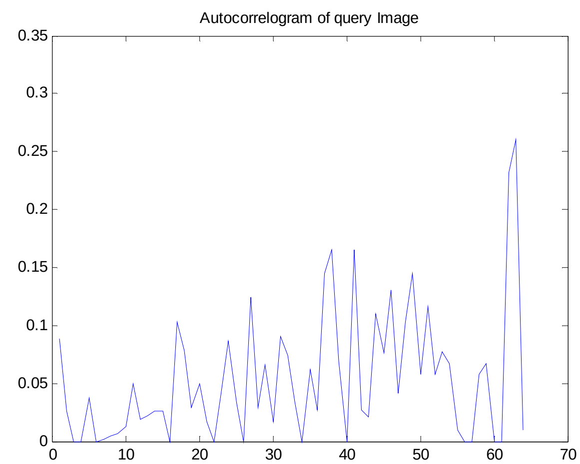


Fig. 3: Autocorrelogram of Query Image (rose)

(b)Texture Feature

Texture is another important element for image retrieval. "Texture is an attribute representing the spatial arrangement of the grey levels of the pixels in a region or image"[10]. The texture feature used in this paper is wavelet transform.

The wavelet transform is utilized to transform the image from spatial domain into frequency domain. Wavelet transform decompose a signal into a family of basis functions $\psi_{mn}(x)$ obtained through translation and dilation of a mother wavelet $\psi(x)$, i.e.

$$\Psi_{mn}(x)=2^{-m/2}\ \psi(2^{-m}\ x-n)\text{-----------------}\ \ \text{---------------}(4)$$

where, m and n are dilation and translation parameters, respectively. A signal $f(x)$ can be represented as:

$$f(x)=\sum_{mn} c_{mn}\ \Psi_{mn}(x)\text{---------------}\ \ \text{---------------------}(5)$$

The calculation of the wavelet transforms of a 2D signal includes recursive filtering and sub-sampling. In every level, the signal is segmented into four frequency sub-bands, *LL*, *LH*, *HL*, and *HH*, where *L* denotes low frequency and H denotes high frequency.

Wavelet transform [11] is a signal processing technique that decomposes a signal or image into various frequency sub groups at number of levels and different resolutions. At each level of disintegration, the high-frequency sub-band catches the details of the signal or images. The low frequency sub band is a subsampled adaptation of the original image, with comparative statistical and spatial properties of the original signal. Thus, the low-frequency sub band can be further segmented into larger amounts of resolution, and it helps in representing spatial objects at various coarser levels of exactness in multi resolution sub groups [6]. So, the wavelet transform splits a signal $f(x)$ into a family of functions obtained through dilations and translations of a kernel function $\psi(x)$, called the mother wavelet which is limited in both spatial and frequency domains. The 2-D wavelet and scaling functions can be expressed as the tensor products of their 1-D complements.

After the disintegration, feature vectors can be developed utilizing the mean and standard deviation of the energy distribution of every sub-band at each level.

3. FEATURE MATCHING

The image features extracted from an image like color histogram, color correlogram and wavelet transform are produced in vector form called feature vectors. The query feature vector and database feature vector are calculated and are used for similarity measurement in image retrieval. A similarity measurement is defined in terms of distance metric [3,5,8]. The distance metric are used in paper as:

(a)Euclidean distance: It is the most regularly utilized distance metric as a part of image retrieval because of its efficiency and effectiveness. It can quantify the distance between query feature vector and database feature vector as:

$$^{\delta}d=\sqrt{(\sum_{i=1}^{n}(|Q_i-D_i|^2)} \text{--------------} \quad \text{--(6)}$$

where, *Q* and *D* are query and database feature vectors respectively.

(b)Manhattan distance: It is also known as Taxicab distance which can be defined as:

$$D=|x_1-x_2|+|y_1-y_2| \text{-------------------} \quad (7)$$

4. STEPS FOR IMAGE RETRIEVAL

1. Read the Query Image.

2. To find color histogram, convert the RGB image into HSV color space, quantize the HSV color space into 32 bins, compute the HSV color histogram and construct the feature vector.

3. To evaluate color autocorrelogram, quantized the RGB image into 64 bins, compute the color autocorrelogram and create the feature vector.

4. To assess wavelet moments, convert the RGB image into gray scale image of size 256, compute the 2D discrete wavelet transform using coif1 wavelet and construct the feature vector using mean and standard deviation.

5. Repeat the above steps on all images in the database.

6. Calculate the similarity matrix of query image and database image by using distance metric.

7. Repeat the steps for different query images and the images present in the database.

8. Retrieve the results and display the images.

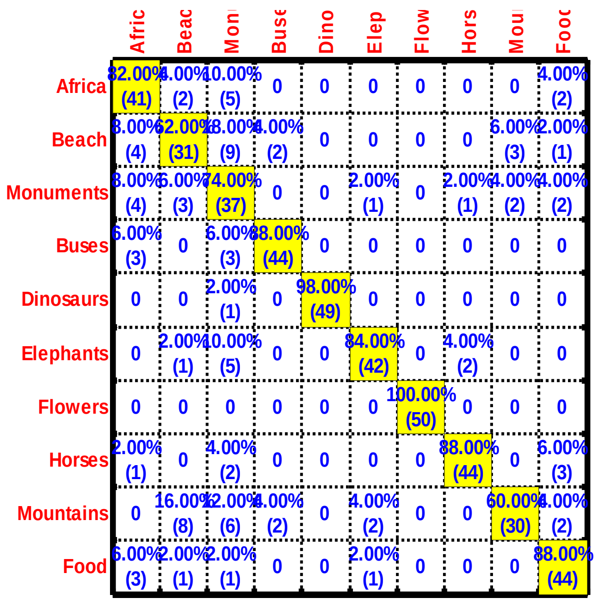
5. RESULTS

Both Color and Texture retrieval algorithms are implemented in MATLAB with the WANG database [15]. All the images are stored in JPEG format with size 384*256 or 256*384. This database contains total 1000 images of ten different categories; which include 100 African people, 100 beaches, 100 monuments, 100 buses, 100 Dinosaurs, 100 Elephants, 100 Flowers, 100 Horses, 100 Mountains and 100 food. A query image is provided by the user which is selected from the database of different categories and after that all similar images are retrieved and displayed. To evaluate the performance of the image retrieval algorithm, the two most well-known parameters (precision and recall) are used.

$$\text{Precision(P)} = \frac{\text{Number of relevant images retrieved}}{\text{Number of images retrieved}}$$

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

For testing purpose, distinctive query image is chosen from different categories. The system is executed with 20 number of returned images from the database and determine the average precision and average recall for every one of them. Fig. 4 illustrates both the parameters of the images and retrieved result images with query image are shown in figure 5 and 6 respectively. The average accuracy achieved of the proposed method is about 72.40%.



Confusion Matrix

Fig. 4: Average precision and recall values for color and texture retrieval approach

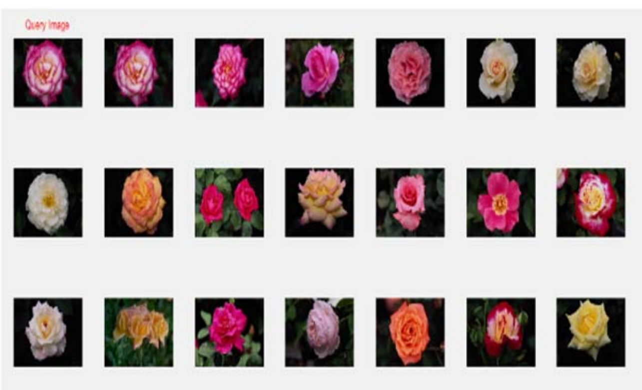


Fig. 5: Retrieval results from query image (rose)

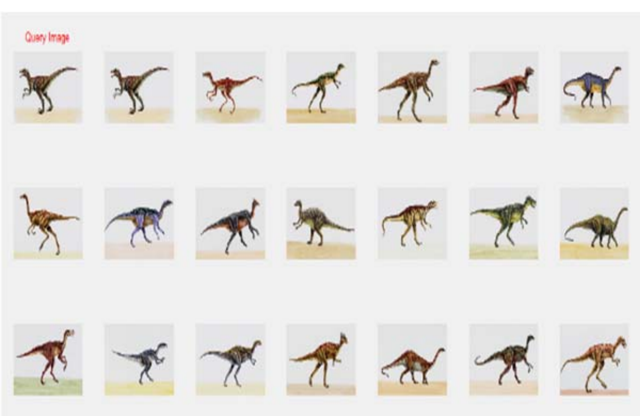


Fig. 6: Retrieval results from query image (dinosaur)

6. CONCLUSION

In this paper, a methodology is used for Content Based Image Retrieval which consolidates the color and texture features. The introduced algorithm uses color Histogram, color Autocorrelogram, Wavelet transform based feature extraction. Similarity between the query images and images from the database are ascertained by means of distance function. The computational steps are effectively reduced with the use of Wavelet transformation and it also improves the retrieving speed. The performance can be measured in terms of precision and recall. It provides retrieving accuracy near about 75%. The future of this field depends on the progress of image retrieval effectiveness.

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