Similarity Measure Based Retrieval System Using Color and Texture Descriptors: an Experimental Analysis

Dr.P.Sumathi, C.Sudha
Assistant Professor, Research scholar, Department of Electronics,
Indian Institute of Technology,
Chennai, Tamilnadu, India

Abstract
Content Based Image Retrieval aims at searching image libraries for specific features such as Color, Texture and Shape. We compare image retrieval systems based on the combination of two complementary features: on one hand, we propose a method to find the dominant colors in images to better capture the color properties of the original images; on the other hand, to increase the retrieval rate, we make use of Edge Histogram descriptor to acquire the texture features. It was seen that the proposed methodology surpasses other methods in terms of not only the quantitative measure (similarity metric), but also retrieval capabilities. This methodology finds its use in image retrieval, online shopping and object recognition.

Keywords *- Color and Texture Features, Similarity metrics, Retrieval Rate*

I INTRODUCTION

In Content Based Image Retrieval, the descriptor values are extracted from the query image and matched to the corresponding descriptor values of the image in the database. The choice of the descriptor depends upon the evaluation criteria such as the Retrieval Rate for effective retrieval from the database. Good descriptors should generate descriptions with high variance, a well balanced cluster structure and high discriminance to be able to distinguish different media content.Retrieval

features can be based on Colour Statistics, Texture Features, Visual Content Descriptor and Shape. The Visual Content Descriptor tools consist of the basic structures and descriptors that cover the visual features such as Colour, Texture, Shape and Motion. The Colour Descriptors include the Scalable color descriptor, Color layout descriptor, Dominant color descriptor, Color structure descriptor in the HSV color space. The Texture Descriptors considers the Visual patterns (both homogeneous and non-homogeneous) and the structural information on the surface. The Homogenous texture descriptor works well for input with effective coarseness and regularity of surfaces. The Edge Histogram descriptor holds good for images with non uniform edge distributions by capturing the spatial distribution of edges in the query image. Retrieval techniques can be either feature based or template based. Former technique calculates the similarity between the shapes as a distance in the feature space, while the latter uses a measure of similarity between the two. Similarity metric plays a vital role in analyzing and classifying complex shapes in both human and computer vision. There are different ways of describing features viz. the external representation and the internal representation. In the former the object boundary and its features are used while in the later the region surrounded by the boundary is used to describe the feature properties.

II RELATED WORKS

A review of retrieval of image data from a data base is vital to understand the Content Based Image Retrieval mechanism [1].It seeks images in a data set with content similar to that of the target image. Then, similarity between images can be represented as a probability of pair matching [2] with the help of patch based descriptor (Local Binary Pattern).This methodology was widely used in image captured from the news articles on web. An overview of the color spaces used for processing images [8] is vital for the choice of the color descriptor. It is dealt for understanding the importance of the perceptual, historical and the application background that lead to the suitability of a color space. Experiments were conducted with color and texture features in application of full body person recognition [4].Combined color and texture features in both static and in varying illumination conditions [5] focused on the basics of Color space, Color histograms and Texture features.

A review of features based on the color, texture and the local geometry [7] is useful for the retrieval of salient points from a shape. This framework is applicable for image retrieval as well as in object recognition. Organisation of the paper is as follows: In section 3, we present Texture and the Color Descriptor, The implementation of the algorithms is dealt in section 4 and the experimental results are observed in section 5. Finally the concluding remarks and the future research issues are dealt in section 6.

III. TEXTURE AND COLOR DESCRIPTOR

Texture is a powerful low-level descriptor for image search and retrieval applications. Similarity based image-to-image matching can be provided by the Homogeneous descriptor. But the Edge Histogram Descriptor captures the spatial distribution of edges. The distribution of edges is a good texture signature useful for image to image matching

even when the underlying texture is not homogeneous. Color descriptors originating from histogram analysis have played a central role in the development of visual descriptors. A generic color histogram descriptor is defined to capture the color distribution with reasonable accuracy for image search and retrieval applications. The color descriptors consists of a number of histogram descriptors, a dominant color descriptor and a color layout descriptor, choice of the descriptor depends upon the retrieval rate, complexity and its applicability to a broad range of applications.

A. EDGE HISTOGRAM DESCRIPTOR

A given image is sub-divided into 4x4 sub images, and the local edge histogram for each of these sub-images is computed. Edges are broadly grouped into five categories: vertical, horizontal, 45° diagonal, 135° diagonal and isotropic. Thus, each local histogram have five bins corresponding to the above five categories. The image partitioned into 16 sub-images results into 80 bins. These bins are non uniformly quantized using 3 bits/bin.

To compute the edge histogram, each of the 16 sub-images is further subdivided into image blocks. The size of these image blocks scale with image size. The number of image blocks per sub- image is kept constant, independent of the original image dimensions. A simple edge detector is applied to each of the macro-block as a 2x2 pixel image. The pixel intensities for the 2x2 partition of the image block are computed by averaging the intensity values of the corresponding pixels. The edge detector operators include four directional selective detectors and one operator. Those image blocks whose edge strengths exceed a certain minimum threshold are used in computing the histograms.

Thus, for an image block, we can compute five edge strengths, one for each of the five filters. If the maximum of these edge strengths exceed a certain preset threshold, the corresponding image block is considered to be an edge block. An edge block contrite the edge histogram bins. The edge computation is simple and can be applied directly to even compressed bit streams.

B. COLOR DESCRIPTOR

A set of dominant colors in an image provide a compact description that is easy to index. The target application is similarity retrieval in large database using colors. Colors in a given region are clustered into a small number of representative colors. The feature descriptor consists of the representative colors, and the color variance for each representative colors. Color histogram represents the distribution of colors in an image, derived by counting the number of pixels of each of the given set of color ranges in a two dimensional or a three dimensional color space.

Histogram of an image can be produced by the discretisation of the colors in the image into a number of bins and counting the number of image pixels in each bin.

IV. IMPLEMENTATION

All the algorithms implemented in our framework are enumerated in this section.

A. EDGE HISTOGRAM DESCRIPTOR

The following are the enumerated steps for computing the edge histogram:

Partition the input image space into 4 sub images. Partition further, the sub images individually into 16 blocks. Find the five types of edges namely vertical, horizontal, 45°, 135°, and non-directional. Set a Threshold. Find the Gray level value of each block and multiply it with the operators. The value exceeding the threshold will be declared as the corresponding edge type. Extract Local Edge Histogram (5 bin) for each block using the extraction operators. Normalize and quantize the histogram bin values. Repeat the above step for all the blocks and the sub images.

The Histogram Intersection parameter has been determined to find the Dissimilarity measure between the images for effective retrieval. The Dissimilarity factor can also be determined through the statistical parameters such as mean and standard deviation of the images. The corresponding feature vector of the descriptor consists of these statistical parameters.

$$f = (\mu_1\, \Phi_1\, \mu_2\, \Phi_2 \ldots\ldots\ldots\ldots \mu_n\, \Phi_n) \quad (1)$$

Where f is the feature vector, μ and Φ are the mean and standard deviation of the images. If N is the length of the feature vector, then the dissimilarity measure is determined as

$$d(s, m) = [(s - \mu_i) / \Phi_i] \quad (2)$$

Where s is the scaling factor.
d(s, m) value is calculated for the entire length of the feature vector.

B. COLOR DISSOCIATION DESCRIPTOR

The methodology for computing the dissociated colors and the similarity between them are explained below:

Initialize the color matrix for the input image and set a scaling factor. Find whether the corresponding color component of the input image has a value greater than the scale and also check whether it is greater than the other color components .If it is greater then initialize the color matrix with the corresponding color component's color matrix. Repeat the above steps all over the image.

Compute the histogram distribution of the images and find the similarity coefficients between them. Histograms are compared using the similarity measure (Histogram Intersection) that sums up the difference between the minimum and the maximum value of the histograms of the query and the database images for each histogram bin.

The Retrieval rate has been determined to find the efficiency of each descriptor. This parameter is defined by:

$$RR(q) = NF(a, q) / NG(q) \quad (3)$$

Where NG (q) corresponds to the ground truth set for a query q, NF (a, q) is the number of ground truth images found within the first [a.NG (q)] retrievals and RR (q) is the retrieval rate.

V. EXPERIMENTAL RESULTS

The implementation was done in MATLAB 7.0 and the observed results are discussed.

A. COMPARATIVE RESULTS

The comparative results obtained by using Color and, Texture Descriptors on the Content Based Image Retrieval system are enlisted below. The experiment was conducted on different databases (Fig.3) such as Bag, Shoe, Instrument, Plane, watch, Coral, Fish, Flowers, Minerals and Microbes and the following observations were made.

I) TEXTURE-EDGE HISTOGRAM

The Edge Histogram Descriptor (EHD) was used to compute the texture features and the corresponding dissimilarity measure. The Dissimilarity between the images has been calculated with two parameters namely the Histogram Intersection and the Dissimilarity Factor measured through the determination of the statistical parameters.

TABLE I

Histogram Intersection (HI) and Dissimilarity Factor (DF) determined for retrieval within the class.

Sl. no	Database	Histogram Intersection	Dissimilarity Factor
1.	Flowers	0.1650	0.2500
2.	Microbes	0.2427	0.2010
3.	Minerals	0.3812	0.0050
4.	Fishes	0.1319	0.1214
5.	Corals	0.0612	0.0312
6.	Bags	0.0600	0.0630
7.	Shoes	0.8000	0.6800
8.	Watches	0.7300	0.6000

TABLE II

Histogram Intersection (HI) and Dissimilarity Factor (DF) determined for retrieval between the classes are shown below

Sl. no	Database	HI	DM
1.	Corals – Fishes	0.7221	0.1322
2.	Corals – Flowers	0.2152	0.1242
3.	Fishes – Flowers	0.1076	0.1980
4.	Corals – Microbes	0.3129	0.0161
5.	Fishes – Microbes	0.4162	0.0467
6.	Flowers – Microbes	0..3260	0.0540
7.	Corals – Minerals	0.4217	0.1621
8.	Fishes – Minerals	0.2870	0.8520
9.	Flowers – Minerals	1.3600	0.3980
10.	Microbes – Minerals	0.9530	0.5850

TABLE III
Observation made for different databases using the Histogram Intersection in the Edge Histogram Descriptor.

Data Base	HI	Total Images	Retrieved Images	RR (%)
Fish	0.60	64	46	71.02
Corals	0.55	17	13	76.40
Minerals	0.95	24	22	91.80
Flowers	0.65	10	09	90.00
Bags	0.06	14	13	92.80
Shoes	0.80	43	35	81.39
Watches	0.73	19	16	84.29
Microbes	0.70	12	10	83.30

TABLE IV
Dissimilarity Factor measured for databases in the Edge Histogram descriptor is shown:

Data Base	DF	Total Images	Retrieved Images	RR (%)
Fish	0.15	77	59	76.60
Corals	0.20	22	19	86.60
Minerals	0.60	42	38	90.40
Flowers	0.10	15	12	86.60
Bags	0.06	14	13	92.80
Shoes	0.80	43	35	81.39
Watches	0.73	19	16	84.29
Microbes	0.50	38	34	89.4

II) COLOR-DISSOCIATION DESCRIPTOR

The Color Dissociation descriptor was used to compute the color features and their corresponding similarity metric.

TABLE V
With the Histogram Intersection, the Similarity measure (SM) has been determined between different classes. And the corresponding retrieval rate (RR) are shown

Data Base	SM	Total Images	Retrieved Images	RR (%)
Fish	0.50	73	65	89.00
Corals	0.35	14	12	85.70
Minerals	0.60	40	36	91.60
Flowers	0.40	15	12	80.00
Bags	0.80	34	32	94.00
Shoes	0.93	66	55	83.30
Watches	0.90	31	29	83.30
Microbes	0.55	36	33	90.00

From the above observations, the performance of the descriptor parameters namely the Histogram Intersection, Dissimilarity factor and the Similarity Measure can be evaluated. Retrieval Rate is found to be 90.60% (Fig.1) and 91.60% for mineral database (Fig.2) in the texture and the color descriptor respectively. This explains the suitability of the descriptors depending upon the application.

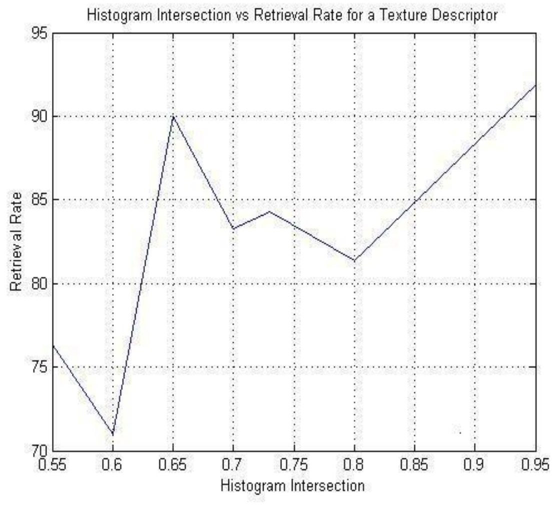

Fig 1.Plot between the Retrieval Rate and the Histogram Intersection values obtained from a Texture descriptor.

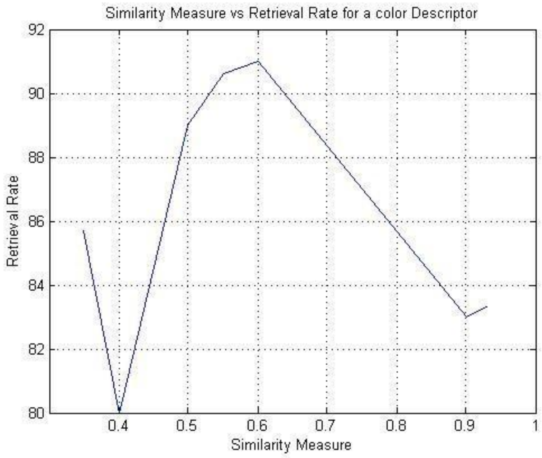

Fig 2.Plot between the Retrieval Rate and the Similarity Measure values obtained from the Color descriptor

VI. DISCUSSION

With regard to both the Texture Descriptor, both within the class (TABLE I) and between the classes (TABLE II) dissimilarity measure have been shown. Retrieval rate has been individually calculated for the Histogram Intersection (TABLE III) and Dissimilarity Factor (TABLE IV). For the Color Descriptor, the Similarity measure (TABLE V) had been determined from the Histogram Intersection of the images. It can be seen that the Retrieval Rate of the Bag images is the highest. It accounts to 92.8% in the Texture Descriptor and 94% in the Color descriptor respectively. Next best retrieval rate has been observed in the Minerals database, it accounts to about 90.7% and 91.6% in the texture and color descriptor respectively.

VII. CONCLUSION

The retrieval system was comparatively analyzed using Color and Texture descriptor. Color and Texture features have been extracted through the Color Dissociation Descriptor and the Edge Histogram Descriptor. The retrieval rate for each of the database has been determined using both color and the texture descriptors. This analysis explains the suitability of choice of descriptors according to the images to be retrieved.

The system can be used for effective image retrieval, online shopping as well as in object recognition. This framework was implemented in MATLAB and the simulation results have been discussed. The similarity ratio as seen in TABLE V for a color descriptor has a very narrow range while retrieving images between different databases, to still improve the retrieval rate, a combinational approach that uses both the Color and the Texture descriptors will be continued as the future work.

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