Comparison Of Traditional Method of HSV Histogram Equalisation with Adaptive HSVsegmentation and Kekre Transform for Content Based Image Retrieval

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Abstract—C**ontent-based image retrieval system based on an efficient combination of both colors and features is explained in this paper. According to Kekre's Transform, feature vectors are formed using a combination of row mean and column mean of both query as well as database images, to measure the extent of similarity using Euclidian distance. Similarly, HSV color space quantifies the color space into different regions and thereby calculating its mean and Euclidian distance the color vector can be derived. Taking mean of the Euclidian distances of both the algorithms better accuracy of the image retrieval process can be attained.**

Keywords- CBIR, HSV Histogram equalization, Adaptive HSV segmentation, Kekre transform

I. INTRODUCTION

All The recent development of multimedia databases has led to extensive application of digital library and image search engines. This has resulted in an increased need for more efficient Content Based Image Retrieval [1], [2], [3]. The term 'content' in this context might refer to colors [4], [5], shapes [6], textures [7], features [8] or any other information that can be derived from the image itself. The term 'content' in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself. Here the three methods of content retrieval, viz., 3D color histogram equalization of HSV image, Adaptive HSV segmentation and Kekre transform, are compared.

Common CBIR systems perform two main operations in their approach [1], [9].The first one is feature extraction (FE) [8], where a set of features, called image signature or feature vector. Features of an image should have a strong relationship with semantic meaning of the image. In second step, CBIR system retrieves the relevant images from the image data base for the given query image, by comparing the feature of the query image and images in the database. Relevant images are retrieved according to minimum distance or maximum similarity [10] measure calculated between features of query image and every image in image database.

II. HSV HISTOGRAM EQUALIZATION

In image retrieval systems color histogram is the most commonly used feature. The main reason is that it is independent of image size and orientation. Also it is one of the most straight-forward features utilized by humans for visual recognition and discrimination. Statistically, it denotes the joint probability of the intensities of the three color channels. Once the image is segmented, from each region the color histogram is extracted. The major statistical data that are extracted are histogram mean, standard deviation, and median for each color channel i.e. Red, Green, and Blue. So totally $3\times 3 = 9$ features per segment are obtained. All the segments need not be considered, but only segments that are dominant may be considered, because this would speed up the calculation and may not significantly affect the end result.

Content-based image retrieval is the task of searching images in databases by analyzing the image contents. In this demo, a simple image retrieval method is presented, based on the color distribution of the images. The user simply provides an "example" image and the search is based upon that example (query by image example). For this first version of the demo no relevance feedback is used.

Almost 1000 images have been used for populating the database. For each image a 3-D histogram of it's HSV values is computed. At the end of the training stage, all 3D HSV histograms are stored in the same .mat file. In order to retrieve M (user-defined) query results, the following steps are executed:

The 3D (HSV) histogram of the query image is computed. Then, the number of bins in each direction (i.e., HSV space) is duplicated by means of interpolation.

III. Algorithm for HSV color Histogram Equalization

For each image i in the database:
1. Load its histogram Hist(i).
2. Use interpolation for duplicating the number of bins in each direction.
3. For each 3-D hist bin, compute the distance (D) between the hist of the query image and the i-th database image.
4. Keep only distances (D2) for which, the respective hist bins of the query image are larger than a predefined threshold T (let L2 the number of these distances).
5. Use a 2nd threshold: find the distance (D3) values which are smaller than T2, and let L3 be the number of such values.
6. Calculate the similarity measure is defined as: S(i) = L2 * average(D3) / (L3^2).
7. Sort the similarity vector and prompt the user with the images that have the M smaller S values.

IV. Kekre Transform

Kekre Transform matrix is a square matrix of any order MxM which need not have to be in powers of 2 unlike most of other transform. All upper diagonal and diagonal values of Kekre's Transform matrix are one, while the lower diagonal values except the values just below the diagonal is zero. Generalized Kekre Transform matrix can be shown as follows:

$$[K] = \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ -m+1 & 1 & 1 & \cdots & 1 & 1 \\ 0 & -m+2 & 1 & \cdots & 1 & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 1 & 1 \\ 0 & 0 & 0 & \cdots & -1 & 1 \end{bmatrix} \quad (1)$$

The above matrix can be generated using the following relation:

$$K(x,y) = \begin{cases} 1 & , x \leq y \\ -N + (x-1) & , x = y+1 \\ 0 & , x > y+1 \end{cases} \quad (2)$$

For taking Kekre Transform of an MxM image, the numbers of required multiplications are (M-1) and numbers of additions are 2M (M-1).

The image retrieval process initiates by applying Kekre Transform matrix to row mean vectors and column mean vectors of the image to get Kekre transform row mean vectors and column mean vectors respectively as shown below.

Row Mean Vector = [Average (Row-1), Average (Row-2), …., Average(Row-n)] (3)

Column Mean Vector = [Average (Col-1), Average (Col-2), …., Average(Col-n)] (4)

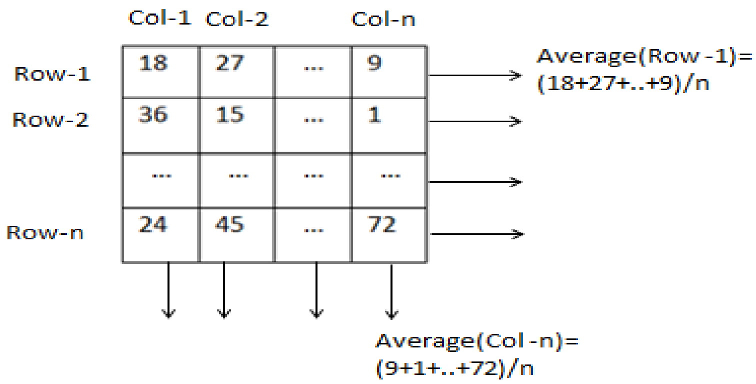

FIG. 1 SAMPLE IMAGE TEMPLATE (WITH SIZE nxn)

These coefficients are used to extract features from both the query image and the image from the database with the multiplication of the Kekre Transform matrix with the row mean and column mean vectors. For identifying the similarity measure between the query image and the database image, we calculate the Euclidian Distance for row coefficient and column coefficient respectively.

The Euclidian distance is given by

$$D = \sqrt{\sum_{i=1}^{n} (Vpi - Vqi)^2} \quad (5)$$

V. Adaptive Segmentation For HSV Color Space

The image retrieval process using adaptive segmentation of HSV is carried out by converting its RGB colour space to HSV colour space using the formulae given in figure as follows:

$$H = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} \quad (6)$$

$$S = 1 - \frac{3}{R-G+B}[\min(R,G,B)] \quad (7)$$

$$V - \frac{1}{3}(R+G+B) \quad (8)$$

Since the RGB values generally lie in the range of 0 to 255 we need to use the formulae given below, which will convert the Hue values between 0° and 360°, Saturation values between 0 and 1 and values between 0 and 1.

$$H = \left[\left(\frac{H}{255}\right) * 360\right] |360| \quad (9)$$

$$S = \frac{S}{255} \quad (10)$$

$$V = \frac{V}{255} \quad (11)$$

After the conversion from RGB colour space to HSV colour space of the entire image, the image is divided into m different regions depending on the values of hue and saturation.

The TABLE I illustrates the fact that the hue is divided into partitions of 20° is done in order to separate the 3 primary colours and yellow magenta and cyan into 3 sub-divisions each. And the saturation for each hue is further sub-divided by 0.2.

Thus, 18*5=90 different regions of colour distribution in the image.

TABLE I. DIFFERENT RANGES OF HUE AND SATURATION USED IN IMAGE RETRIEVAL PROCESS

S#	Hue	Saturation
1	0<H<20	S<0.2
2		0.2<=S<0.4
3		0.4<S<=0.6
4		0.6<S<=0.8
5		S>=0.8
...	...	...
7	340<H<360	S<0.2
8		0.2<=S<0.4
9		0.4<S<=0.6
10		0.6<S<=0.8
90		S>=0.8

After dividing the image into various regions using table given above the pixels present in each region of the image are selected. Then the corresponding hue values are extracted and grouped together to form a hue vector.

This vector for every region is divided into n segments depending on the number of pixels in the hue vector of the region. If the number of pixels in the region are more the hue vector will be divided into more number of segments and if the number of pixels in the region are less the hue vector will be divided into less number of segments.

In order to partition the regions into various segments we need to use the following equation.

$$n_i = (X_i/T) * T_s \quad ,0 < i \leq m \tag{12}$$

Where, n_i represents the number of segments in region I, X_i represents the number of pixels in region i (where i ranges from 1 to m), T represents total number of pixels of the image, and TS represents total number of required segments of the entire HSV image.

After this process of breaking the various regions into segments the necessary colour distribution information is calculated by finding the maximum occurrence in each segment by using the hue histogram. Using this information we can generate the feature vector of the image.

In order to perform an image retrieval operation we need to generate a feature vector for the database image from individual regions. This feature vector is used in comparing both the images by using the Euclidean distance equation. Segments in each region of the query image are compared with the corresponding region of the database image using the Euclidean distance equation as given in eqn (5). Once the Euclidean distance of the individual regions is computed the mean of all the regions is computed to get the final distance that can be used to compare various images. Database images having a lower distance will be similar to the original image.

VI. ALGORITHMS KEKRE'S TRANSFORM AND HSV SEGMENTATION

Steps for proposed algorithm-1 for Feature Extraction (Kekre Transform):

1. Take a query input image.

2. Calculate row mean and column mean for the image.
3. Apply Kekre transform on the row mean and the column mean to obtain Kekre Transform row mean and Kekre Transform column mean respectively.
4. Compare these query image coefficients with the database coefficients using Euclidian Distances (D1 and D2) as a measure of similarity for row mean and column mean coefficients respectively.
5. Calculate mean (M1) of D1 and D2.
6. Now follow the steps given in proceeding algorithm.

Steps for proposed algorithm-2 for Colour Extraction (Adaptive HSV segmentation):

1. Take a query input image.
2. Convert the image from RGB colour space to HSV colour space.
3. Divide the image into different areas based on the ranges mentioned in TABLE I.
4. Further divide the areas obtained into segments depending on the number of pixels in each area.
5. Find the maximum colour occurrence from each segment by calculating the mode of Hue values in it.
6. Find Euclidian distances of corresponding areas in query image and the database image considering the included segments individually.
7. Find the mean (M2) of all the Euclidian distances obtained in the previous step.

Note: Alone Kekre's transform gives output based on features of the image. Adaptive HSV segmentation and 3D color Histogram both gives result based on color property of the image.

VII. RESULTS

The outcome of the experiment can be achieved by arranging the obtained mean of both the algorithms in ascending order. The resultfss obtained are as under:

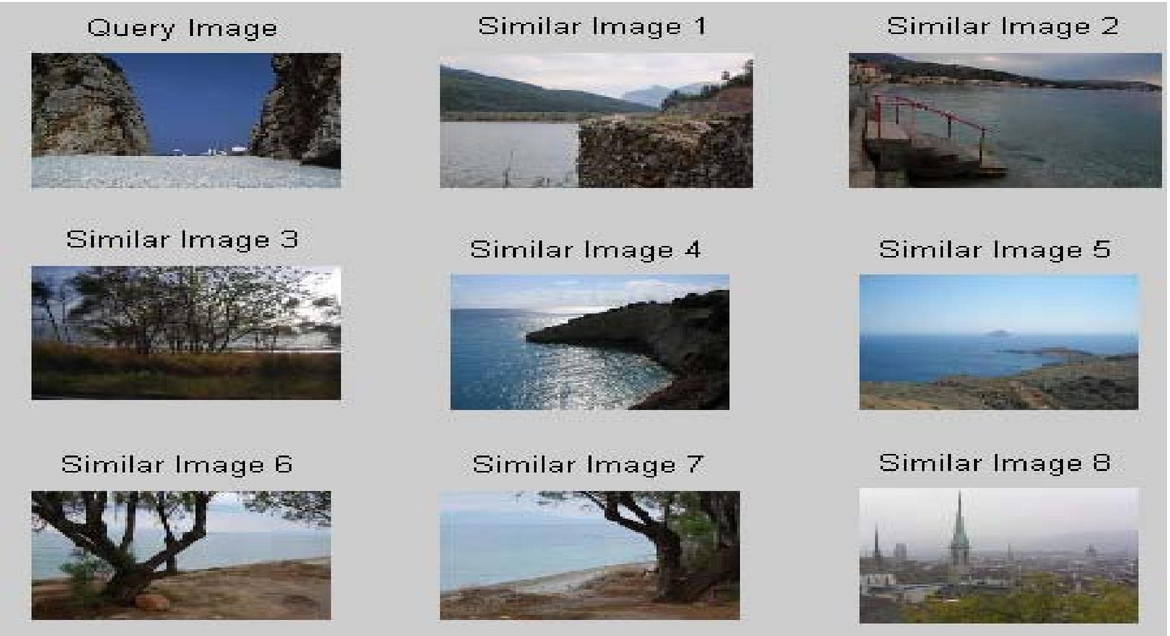

Fig.3 Results of Content retrieval using 3D color histogram of HSV image

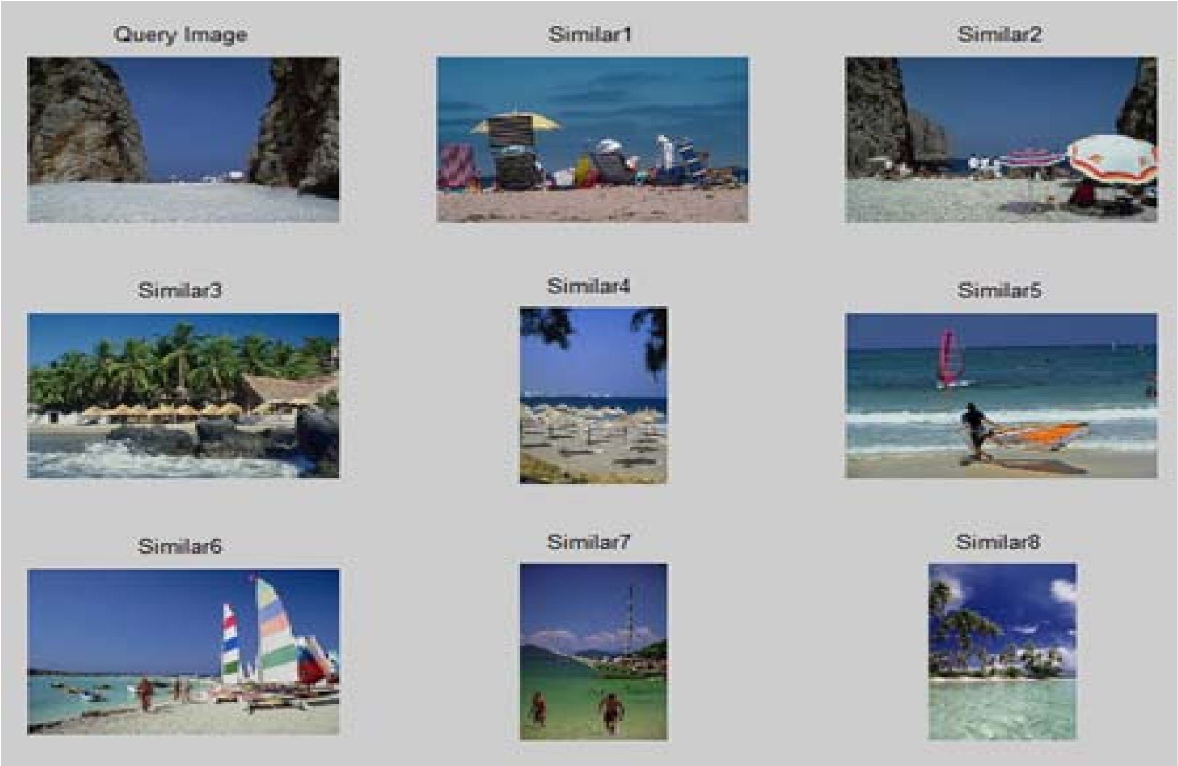

Fig.4 Results of Content retrieval using Kekre Transform of the image

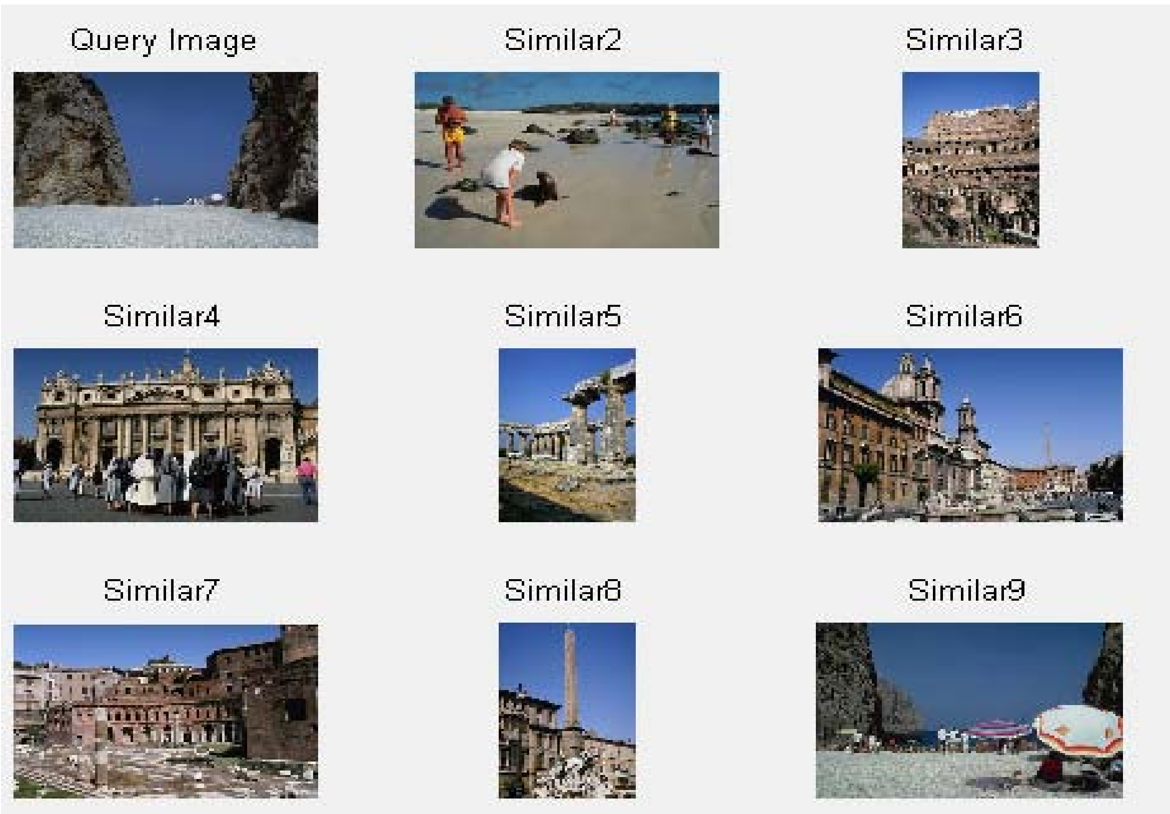

Fig.5 Results of Content retrieval using Adaptive HSV segmentation of the image

III. CONCLUSION

In 3D HSV color histogram, using histogram equalization values of the HSV image, the images are compared and results are obtained.

In Kekre's transform, the image vector is converted to a row mean and column mean vector and then multiplied with the Kekre's transform matrix to get the Kekre row and column mean vectors. After this the Euclidean distance is computed using the query image and the database image. Thus we get 2 Euclidean distances for Kekre's row and column mean vector which are combined together by taking the mean respectively for query and database images.

In adaptive segmentation of HSV the regions are initially computed and further divided into number of segments depending upon the number of pixels in the region. After this the Euclidean distances for the individual regions is calculated using the query image and the mean of all the regions is taken. Adaptive Segmentation of HSV color space takes place by calculating the mean of the resulting Euclidean distances obtained and arranging the values in ascending order and thereby the best image being arranged at the top.

While in 3D-color histogram, closet histogram values are used to obtain closer resembling images in terms of color. But Kekre's transform gives best result as it gives images which are having similar features like beaches.

ACKNOWLEDGMENT

We are very thankful to the Electronics and telecommunications department of Vivekanand Education Society's College of Information and Technology and AET's Atharva College of engineering for providing us with the necessary facilities to complete our research in the field CBIR. We also thank our family, friends for supporting us throughout our research.

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