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Content Based Image Retrieval Using Color Moments and Texture

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Abstract—This paper proposes an algorithm to retrieve the color images from the database using color moments and the texture of color image. The color moments integrates the mean, standard deviation and the skewness to estimate the brightness and the intensity of the image. The texture descriptors are calculated using the energy and entropy values from the curvelet coefficients. Finally, similarity measure is computed and compared with all the images present in the database to classify the feature vectors. Experimental results show that the proposed algorithm is more accurate and efficient in retrieving the images with the user interested objects. Evaluation metrics used are Precision and Time taken to retrieval.

Keywords—Color moments, Texture, Curvelet Transform, Similarity measure, Energy and Entropy values and Precision.

I. INTRODUCTION

Digital images require a large amount of data to be stored and the users are able to find images quickly and accurately from the large number of images .In early years, image retrieval was done by the textual annotators using the keywords. Here, increasing the number of digital images stored is not feasible. So there are some limitations in using the textual annotators. To overcome this problem, the image retrieval process (1) can be taken by the Content Based Image Retrieval System (CBIR)(2).

The objective of the content based image retrieval system is to extract the features and can classify the images for retrieving the similar images related to the input query image. CBIR system is widely used in many modern technologies where the large amount of images is to be used.

This system utilizes the features like color, texture(3), shape and spatial relationships to extract the relevant images from the database(4). Color feature is not only closely related to objects in an image, but also dependent on size of an image, orientations and the angle (5). Color feature has the robustness and the common representations of color features are color histograms, color moments and dominant color etc.,(6) these features are compared to similarity measure using the Euclidean distance measurement (7).This categorization of images can be processed by many techniques such as SVM (Support Vector Machine) kernel(8), Decision tree. There are some limitations in feature extraction (9), so the curvelet transform technique integrates the texture classification (10) effectively by evaluating the energy and entropy values as described later (11).Discrete curvelet transform (12) produces accurate results than the existing one.

II. DIFFERENT CBIR METHODS

In a typical retrieval system, the query image and the images stored in the database are pre-processed automatically to extract the features using the curvelet. The query image is also processed same as the database images. The feature vectors are used to classify the images. And relevant images are retrieved based on the similarity measures from the database. In the image retrieval system, there are many approaches used to retrieve the feature based images.

There are different CBIR methods used for determining the features like color and texture. Color feature is evaluated using the primitives of the color moments using the known RGB color model.

Many methods have been proposed to extract the texture features either directly or from the image statistics, for example co-occurrence matrix or spatial frequency domain. The different methods used for feature extraction are: Markov Random Fields parameters, Gabor multichannel features, fractal-based features and co-occurrence features.

III. PROPOSED METHOD

The proposed algorithm is modification of existing method Sasikumar *et al* method [1], which uses Discrete Sine Transform (DST). The developed algorithm is more efficient in comparison with [1]. Fig.1 shows the block diagram of an image retrieval system using the Curvelet

Transform. The color moments and Texture of an image are estimated as follows.

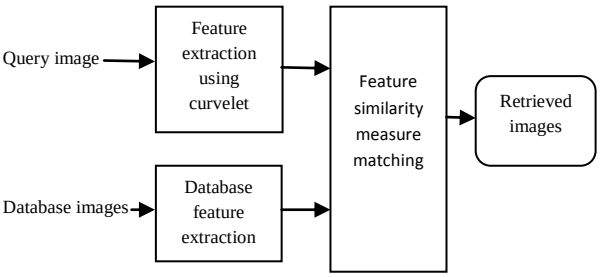

Figure. 1.Image retrieval mechanism using Curvelet Transform Technique.

A. Color moments

Color moments are calculated to estimate the brightness and the intensity of the images. The color moments used in this algorithm to extract the images on the color basis are mean, standard deviation and Skewness.

Mean can be understood as the average color value in the image. Square root of the variance can be defined as the standard deviation. Skewness can be understood as a measure of the degree of asymmetry in the distribution.

An image is characterized by 9moments- 3moments for each 3 color channels.

It defines the i[th] color channel at the j[th] Image pixel as p_{ij}. The three color moments can then be defined as:

MOMENT 1 - Mean:

$$E_i = \sum_{N}^{j=1} \frac{1}{N} P_{ij} \qquad (1)$$

MOMENT 2 -Standard Deviation:

$$\sigma_i = \sqrt{(\frac{1}{N}\sum_{N}^{j=1}(P_{ij} - E_i)^2)} \qquad (2)$$

The standard deviation is the square root of the variance of the distribution.

MOMENT 3 – Skewness The degree of asymmetry in the distribution can be defined as the Skewness.

$$S_i = \sqrt[3]{(\frac{1}{N}\sum_{N}^{j=1}(P_{ij} - E_i)^3)} \qquad (3)$$

A function of the similarity between two image distributions is defined as the sum of the weighted differences between the moments of the two distributions. Formally this is:

$$d_m(H,I) = \sum_{i=1}^{r} w_{i1}|E_i^1 - E_i^2| + w_{i2}|\sigma_i^1 - \sigma_i^2| + w_{i3}|s_i^1 - s_i^2| \qquad (4)$$

Where,

(H,I) are the two image distributions being compared.

'i' is the current channel index

'r' is the number of channels

E_i^1, E_i^2 are the first moments (mean) of the two image distributions.

σ_i^1, σ_i^2 are the second moments(standard deviation) of the two image distributions

s_i^1, s_i^2 are the second moments (skewness) of the two image distributions

w_i are the weights for each moment.

Pairs of images can be ranked based on their d_m values. Those with greater values are ranked lower and considered less similar than those with a higher rank and lower d_m values.

B. Texture feature extraction

Texture features are determined using the curvelet coefficients. The features are the key points for comparing the query image with the images loaded in the database.

From the co-occurrence matrix is obtained from curvelet coefficients, which is used to determine the texture features such as energy and entropy are determined.

Entropy measures the randomness of a gray-level distribution. The entropy is considered to be high if the gray levels are distributed randomly throughout the image. Energy measures the number of repeated pairs. The energy is considered to be high if the occurrence of repeated pixel pairs is high.

Texture features are calculated from each Curvelet Sub-band. In order to improve the classification gain, co-occurrence matrix is formed for each sub-band of discrete curvelet transform. From the co-occurrence matrix, the texture features such as energy and entropy are calculated.

(a)Entropy

$$Entropy = -\sum_{i=1}^{M}\sum_{j=1}^{N} P[i,j]\, log\, P[i,j] \qquad (5)$$

Here *p[i,j]* are the pixel values at the *(i,j)* coordinates of the image. The size of the image is *MXN*.

(b)Energy

$$Energy = \sum_{i=1}^{M}\sum_{j=1}^{N} P^2\,[i,j] \qquad (6)$$

Here *P[i,j]*are the pixel values at the *(i,j)*Coordinates of the image. The size of the image is *MXN*.

C. *Similarity Measure*

Similarity measure can be computed using Euclidean distance which is estimated using color moments and Texture features of an image. The measured Euclidean distance of a query image is compared with the database images results in bringing out the similar images.

The retrieval efficiency can be rated by using the precision and the elapsed time. Precision is defined as the ratio of number of relevant images retrieved to the total number of images retrieved. By using these color moments, texture features and the distance measure the retrieval performance can be improved.

Similarity metrics can be computed from the relevant curvelet coefficients described as

$$d(Q,T) = (\sum_{i=0}^{2n-1} (Q_i - T_i)^2)^{\frac{1}{2}} \qquad (7)$$

Where Q={Q_0,Q_2,…….Q_{2n-1}}is the feature vector of the query image and T={T_0,T_2,…….T_{2n-1}} is the feature vector of target image in the database. The images with the distance 'd' which is the closest similarity are arranged in ascending order for retrieving the image. The efficiency of the retrieval system can be measured by precision and elapsed time as follows.

$$\text{Precision} = \frac{\text{No.of relevant images retrieved}}{\text{Total no.of images retrieved}} \qquad (8)$$

Elapsed time is the time taken to process the image retrieval of the images.

D. Algorithm of proposed method

The proposed algorithm is explained in 4 steps as follows.

1. The query image of size *MXN is chosen*.
2. Color moments are calculated using mean, standard deviation and the skewness of an image.
3. Texture feature is estimated using Entropy and Energy values from the curvelet coefficients.
4. Euclidean distance is measured for similarity measurement of query image with database images.

IV.ANALYSIS OF RESULTS

A.Retrieval of Images

The developed algorithm is tested for various test images.The experimental results are tabulated as shown in the Table 1.Database consists of different colour and texture based images.From the Table 1 it is observed that the developed algorithm is more efficient and accurate over [1] .Computational complexity is reduced which can be observed from Table1.

TABLE 1: PERFORMANCE RESULTS OF PROPOSED ALGORITHM

Test images	**Evaluation metrics**	**Method**	
		Proposed algarithm	***Sasikumar et.al***
Image1	Precision	98.4%	96.7%
	Elapsed time	0.080s	0.283s
Image2	Precision	98.4%	96.7%
	Elapsed time	0.074s	0.253s
Image3	precision	98.4%	96.7%
	Elapsed time	0.068s	0.284s
Image4	precision	98.4%	96.7%
	Elapsed time	0.074s	0.297s
Image5	precision	98.4%	96.7%
	Elapsed time	0.078s	0.258s

Retrieval of images by the given test images are as shown below in fig 2&3.

Test Images:

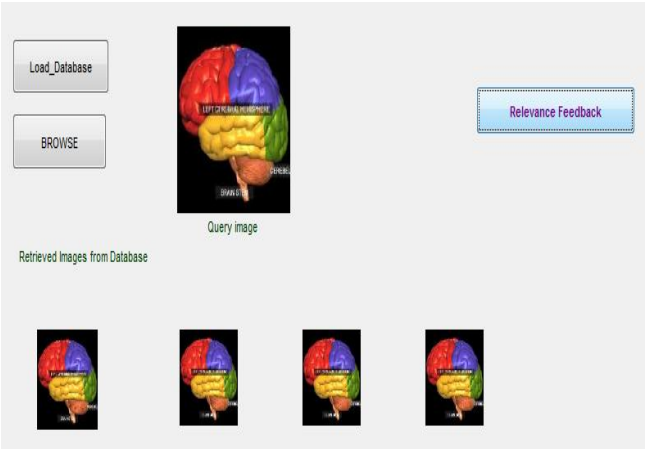

Figure2:Output images after retrieval of similar images.

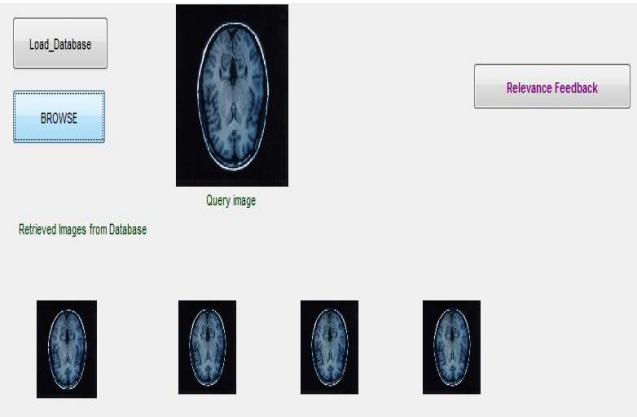

Figure.3.Output images after retrieval of similar images.

Here, this represents the retrieval of images using the discrete curvelet transform with the similarity measurement. The images are retrieved by evaluating the color moments and texture results. The similarity metrics of the proposed algorithm is compared with the Sasi kumar *et al* method. Hence the result shows that the image retrieval system using curvelet transform is efficient than the existing one.

V. CONCLUSIONS

The proposed curvelet algorithm is used for feature extraction in the image retrieval system. The objective of this approach is to improve the precision values for the feature representation.The performance is measured interms of precision which is defined as the ratio of number of relevant images retrieved to the total number of images retrieved.

By observing the characteristics of the image retrieval methods, the efficiency of the image retrieval system by using the curvelet is better than Discrete Sine Transform and the elapsed time taken to retrieve the images is less when compared with the existing algorithm.

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