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Comparison of Image Retrieval System Based on Textural, Color and Shape Feature Extraction

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Abstract--- Content based image retrieval system primarily uses texture, color and shape features as image descriptors. Color and texture are used to retrieve the local information whereas shape features are extracted as global descriptors after identifying boundary pixels in the image [7]. In this paper, textural features are extracted from Gray Level Co-occurrence Matrix (GLCM) which contains the frequency of occurrence of a pair of pixels in different directions. For color feature, the image is converted from RGB to HSV plane. Color moments of each band are combined with histogram, to form color feature vector. Shape features are extracted after edge detection of the image. Most Similar Highest Priority (MSHP) principal is used to finally retrieve the similar images from the database. The results are compared and it is concluded that shape feature when combined with texture and color features give better results.

Keywords--- GLCM, Histograms, HSV, Edge detection, Most Similar Highest Priority Principle (MSHP)

I. Introduction

Content based image retrieval (CBIR) is a technique of retrieving similar images where decision is based on the features extracted from the image [1]. CBIR is widely used by doctors, journalists, art historians and design engineers.

The system proposed here, divides the image into equal sized non-overlapping tiles. From each tile, textural, color and shape features are extracted. All feature vectors are combined by multiplying with suitable weight into one. Images and the corresponding feature vector of each tile are stored in the database. In matching process each tile of query image is compared with all the tiles of target image instead of tiles at corresponding position [4]. In this paper the experiments using a) Texture and Color b) Texture, Color and Shape feature extraction are conducted and conclusion is made after comparing the results. The paper is divided into different sections. Section 2 describes Feature Extraction which is further sub divided into Section A to explain creation of Grid, Section B computes Textural features, Section C describes Color and Section D describes Shape feature extraction. Section 3 explains the Image Matching Principal and Section 4 shows Experimental Results. Section 5 gives Conclusions of the paper.

II. Feature Extraction

Image database is created with images from different categories. All the images are resized to 256x384 to create uniformity among all the images.

A. Grid

All the images are divided into non-overlapping equal sized sub-blocks or tiles [2]. Each image contains 24 tiles of size 64x64. Thus image contains a grid of 4x6 tiles as shown in the following figure:

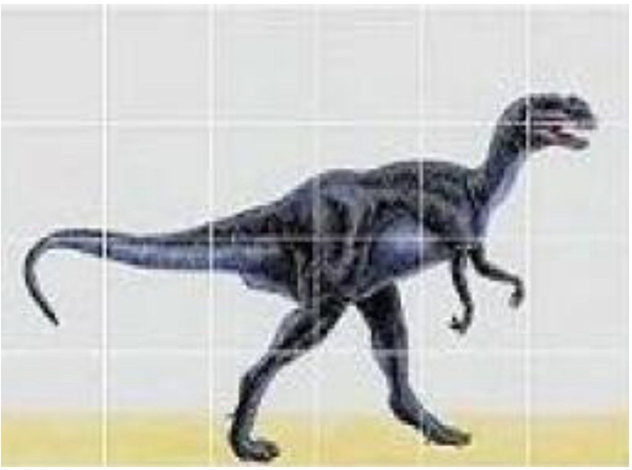

Figure 1: Image Sub-blocks

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Features are extracted from each sub-block and a feature vector is stored in database with the image.

B. Textural Features

Textural features are extracted from each image by creating GLCM as explained in [10]. It is a matrix of relative frequencies, P_{ij} with which two neighboring pixels occur in the image. Features like Energy, Entropy, Contrast and Inverse Difference are calculated for each sub-block.

Following notations are used to evaluate different features:

- p(i,j) : $(i,j)^{th}$ entry in a normalized gray-tone spatial dependence matrix, = P(i,j)/R.
- $p_x(i)$:i^{th} entry in the marginal-probability matrix obtained by summing the rows of p(i,j), $\sum_{j=1}^{N_g} P(i,j)$.
- N_g, Number of distinct gray levels in the quantized image.

Features extracted are:

- Energy
  $f1 = \sum_i \sum_j P(i,j)^2$
- Entropy
  $f2 = -\sum_i \sum_j p(i,j)\log(p(i,j))$
- Contrast
  $f3 = \sum_{n=0}^{N_g-1} n^2 \left\{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j)\right\}$
- Inverse Difference
  $f4 = \sum_i \sum_j \frac{1}{1+(i+j)^2} P(i,j)$

Each feature is computed for four different angles 0°, 45°, 90°, 135° making a 1x16 dimensional textural feature descriptor.

C. Color Feature

For color features Hue (H), Saturation (S) and Value (V) domain of the image is used. In this space, hue is used to distinguish colors, Saturation is the percentage of white light added to a pure color and Value refers to the perceived light intensity [8][9]. The image is converted from RGB to HSV domain with 8 quantization levels in H, 3 each in S and V. This creates histogram for each sub block with 14 (8+3+3) bins. Number of pixels in each bin are calculated and written against that bin to create 1X14 dimension color vector like in the following table.

Table I: Color histogram

Bin1	**Bin 2**	**Bin3**	**….**	**….**	**….**	**Bin 16**
24	45	12				07

Color moments are calculated as Mean, Variance and Skewness for each H, S, V band from every sub-block of the image.

$$X_{mean} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

where N is the number of pixels within each block, x_i is the pixel intensity in H/S/V channel.

$$X_{var} = \frac{1}{N}\sum_{i=1}^{N}(x_i - X_{mean})^2$$

$$X_{skewness} = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - X_{mean})^3}{(\frac{1}{N}\sum_{i=1}^{N}(x_i - X_{mean})^2)^{3/2}}$$

These three features are extracted from each band and will result in additional 1X 9 color feature vector.

D. Shape Feature

Shape information is captured in terms of the edge image of the gray scale equivalent of every image in the database. The gray level edge images of the R, G and B individual planes are taken and the shape descriptors are computed as follows [4] [6]:

$$F1 = \frac{{\mu_2}^{1/2}}{m1}$$

$$F2 = \frac{\mu_3}{(\mu_2)^{\frac{3}{2}}}$$

$$F3 = \frac{\mu_4}{(\mu_2)^2}$$

$$F4 = \frac{\mu_5}{{\mu_2}^{5/2}}$$

where $m_r = \frac{1}{N}\sum_{i=1}^{N}(Z(i))^r$

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r is r^{th} moment and N is number of boundary points. Z(i) is Euclidean distance between centroid and each N. Using this m_r, compute

$$\mu_r = \frac{1}{N}\sum_{i=1}^{N}[Z(i) - m_1]^r$$

We will get a 1x12 dimension shape feature vector for R, G, B plane.

III. Image Matching

In the proposed system, integrated image matching is carried out using Most Similar Highest Priority (MSHP) principal [4]. All three feature vectors are combined using the equation

$$D=w(F_{text}) + w(F_{color}) + w(F_{shape})$$

where F_{text}, F_{color} and F_{shape} are computed by taking sum of the vector. The value of *w* that gives best results is 0.5. With this a 4x6 matrix is formed by calculating distance *D* for each sub-block.

In matching process, each tile of query image is compared against every tile of image in database. But each tile can participate in matching process only once. The minimum distance d_{ij} is found between each tile of Query image i and database image j. The distance is recorded, and row and column corresponding to the tile is blocked by some very large number so that it cannot participate again in the matching process. This process is repeated till all tiles are blocked. Following figure explains the matching process

4.87	3.56	1.67	8.9
2.34	1.89	18.9	6.9
23.7	6.8	13.9	40.3
34.6	14.56	35.8	30.7

(i)

999	**999**	**999**	**999**
2.34	1.89	**999**	6.9
23.7	6.8	**999**	40.3
34.6	14.56	**999**	30.7

(ii)

999	**999**	**999**	**999**
999	**999**	**999**	**999**
23.7	**999**	**999**	40.3
34.6	**999**	**999**	30.7

(iii)

999	**999**	**999**	**999**
999	**999**	**999**	**999**
999	**999**	**999**	**999**
999	**999**	**999**	30.7

(iv)

D=1.67 +1.89 +23.7 +30.7=57.96

Figure 2: Image similarity computation based on MSHP

The minimum cost match distance between images is now defined as:

$$D_{qt} = \sum_{i=1}^{n}\sum_{j=1}^{n} d_{ij}$$

where d_{ij} is the best-match distance between tile i of query image q and tile j of target image t and D_{qt} is the distance between images q and t. Similarly, D_{qt} of a query image is computed with each image in database. They are sorted in increasing order and images with least distance values are displayed to user.

IV. Experimental Results

Query Image is given by the user as input to the system and Color and texture features are selected in drop-down box.

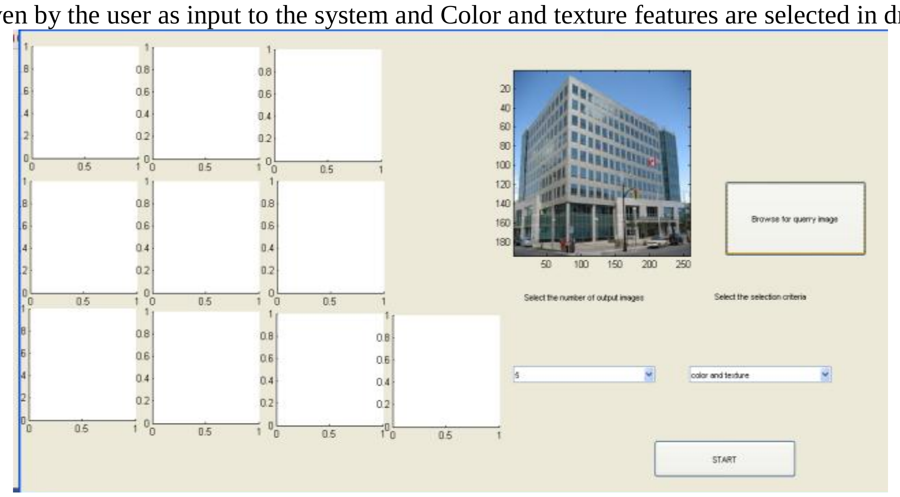

Figure 3: Query Image is selected

When Color and Texture features are extracted, system shows following results. 7/10 images are similar but not in correct priority.

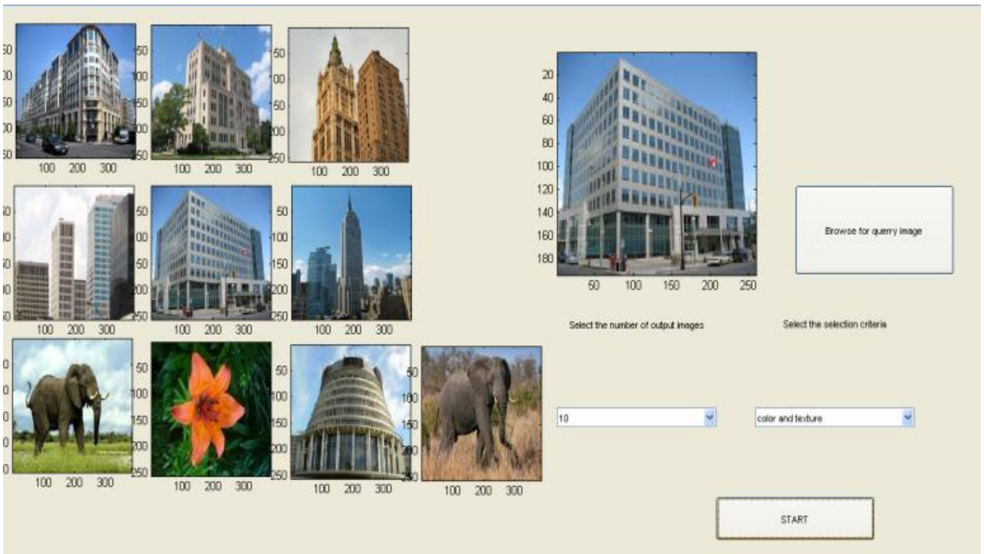

Figure 4: Results with Texture and Color Features

If Texture, Color, and Shape features are extracted, the results are better as 8/10 images are similar and in right order.

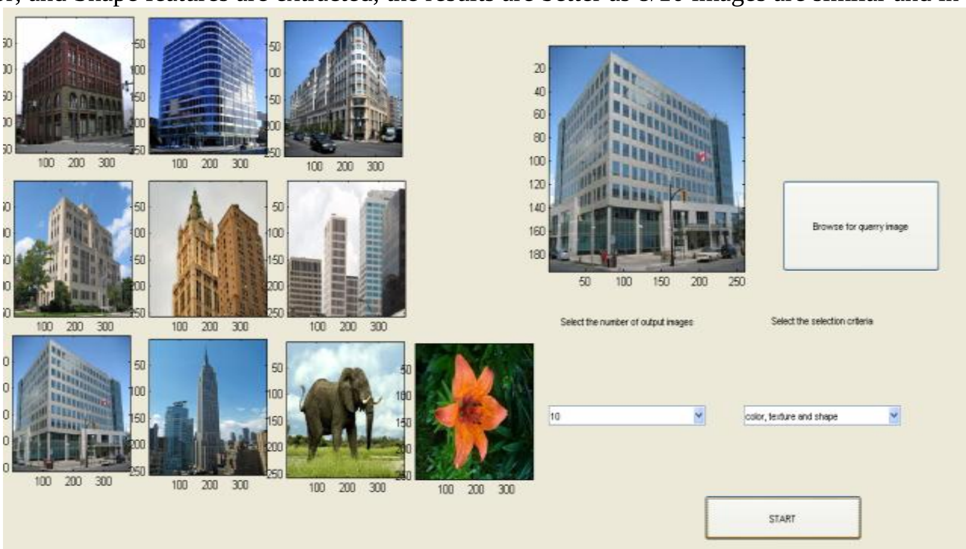

Figure 5: Results with Texture, Color and Shape Features

Following table shows precision of each category of images which is calculated as

$$P(t) = \frac{p(i)}{N}$$

Where p(i) is the number of images belonging to the category of query image, N is total number of images displayed.

Table 2: Precision values of the proposed system

Category	**Texture and Color**	**Texture, Color and Shape**
Beaches	0.60	0.70
Buildings	0.70	0.80
Bus	0.60	0.80
Dinosaur	0.70	0.90
Elephant	0.50	0.70
Flowers	0.60	0.70
Horses	0.60	0.80

V. Conclusions

Based on the experimental results, it is concluded that Content based Image Retrieval System gives better results when Textural, Color and Shape features are extracted from the image rather than extracting only Textural and Color features.

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