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RESEARCH ARTICLE

Integrated Feature Extraction for Image Retrieval

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Abstract— To retrieve the images from large database that are highly related to the query image where query image is given by user. Three features are used for retrieving the images, which are color, shape and texture. These features are extracted by different techniques. Color feature is extracted by Color Histogram and Color Descriptor. Shape feature is extracted by Hu Moment and Edge detection Method. Texture feature is extracted by Gray Level co-occurrence matrix and texture descriptor. We Compare these three features analyse which is the most suitable features for image retrieval. The robust feature vector set is a combination of three features lead to best results.

Indexed Terms: - CBIR, Color Descriptor, Color Histogram, Sobel, Canny, Hu Moment Invariant, Texture descriptor, GLCM.

I. INTRODUCTION

Digital Image Processing is one of the rapid progress technologies which lead to massive development of images in database. Text Based Image Retrieval (TBIR) is one of the techniques to search images in the database by using keyword annotation. Need of Content Based Image Retrieval (CBIR) is to overcome the demerits in TBIR that are many things hard to express that are feelings, situation, what is scary, what is it invoke. Annotation is never complete because of depending on the goal of the annotation, many ways to say the same thing (synonyms, hyponyms). CBIR is the process of searching images in the database by scrutinizing the image contents. The user simply provides a “query” image and the search is based upon that query (e.g. Fig. 1). CBIR system is used in many applications such as Fingerprint Identification, Biodiversity Information Systems, Digital Libraries, Crime Prevention, Medicine, Historical Research, etc.

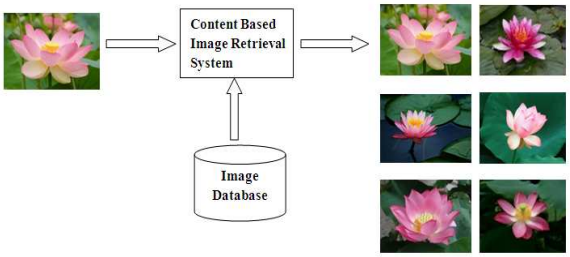


Fig. 1 An example of CBIR system.

II. PREVIOUS METHODS

A combination of shape descriptors used to retrieve the images is edge descriptor and region descriptor. Region based shape descriptor represented by global transform use Angular Radial Transform (ART). Edge based shape descriptor represented by local transform use Polar Hough Transform (PHT). The hybrid transform provide edge detected image, which are used it to plot the histogram which helps in retrieval of images. The main disadvantage of the system is that, it opposes the color content in the image [1]. Color feature and texture feature was extracted by the color histogram and Wavelet transform. To find the mean of the wavelet coefficient that are used to plot the histogram and counts the bin, these values are used to retrieve images. The main disadvantage is computation of texture retrieval is complex [4]. Color histogram used to retrieve the color features and texture feature is extracted by the Global descriptor. This feature does not consider the rotation, scaling, and translation of an image [5]. CBIR system uses the hybrid features such as texture and shape. Texture Feature extracted by using the pyramidal wavelet transforms and shape feature is extracted by Fourier descriptor. In this system, the color features are not considering [2]. Shape feature extracted by gradient operator (Robert, Sobel and Canny) and also extracted by slope magnitude method with Block Truncating Code [6].

III. PROPOSED METHODS

In many CBIR systems, the images are retrieved by low level features and high level features. Low level features are color, texture, shape, spatial information and etc. In proposed system, three features such as color, texture and shape are considered.

A. Color Feature

Advances in imaging and computer hardware have led to an explosion in the use of color images in a variety of applications including Medical imaging; Content based image retrieval, Digital in painting, Digital multimedia, and Visual quality inspection.

Color is a phenomenon that relates to the physics of light, chemistry of matter, geometric properties of object and human visual perception. Color is important clue for image understanding. Color is a purely psychological phenomenon.

Color model is also called as Color Space or Color System. A color model is an abstract mathematical model describing the way colors can be represented as tuples of numbers, typically as three or four values of color components. There are different types of color spaces that are RGB, CMYK, HSV, HSI, etc from which we consider RGB color space and HSV color space.

1) RGB Color Space: In the RGB model, each color appears in its primary spectral components of red, green, and blue. RGB model is based on a Cartesian coordinate system. The color subspace of interest is the cube shown in Fig. 2, in which RGB primary values are at three corners; the secondary colors cyan, magenta, and yellow are three other corners; black is at origin; and white is at the corner farthest from the origin[14].

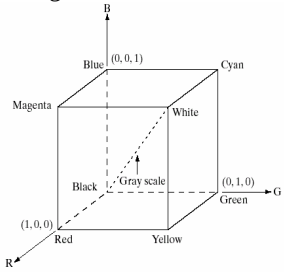


Fig. 2 Schematic of the RGB color cube. Points along the mail diagonal have gray values, from black at the origin to white at point (1, 1, 1)

In RGB model, the gray scale (points of equal RGB values) extends from black to white along the line joining these two points. The different colors in the RGB model are points on or inside the cube, are defined by vectors extending from the origin. For convenience, the assumption is that all color values have been normalized so that the cube shown in Fig. 2 is the unit cube. That is, all values of Red, Green, and Blue are assumed to be in the range [0, 1].RGB image in which each of the red, green, and blue images are an 8-bit image. The term full-color image is used often to denote a 24-bit RGB color image.

2) HSV Color Space: The HSV color space (Hue, Saturation, Value) is often used by people who are selecting colors (e.g., of paints or inks) from a color wheel or palette, because it corresponds better to how people experience color than the RGB color space does. As hue varies from 0 to 1.0, the corresponding colors vary from red through yellow, green, cyan, blue, magenta, and back to red, so that there are actually red values both at 0 and 1.0. As saturation varies from 0 to 1.0, the corresponding colors (hues) vary from unsaturated (shades of gray) to fully saturated (no white component). As value, or brightness, varies from 0 to 1.0, the corresponding colors become increasingly brighter. The following Fig. 3illustrates the HSV color space [14].

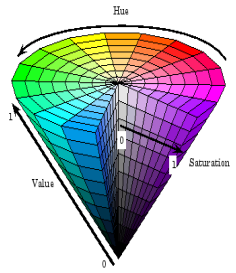


Fig. 3 Illustration of the HSV Color Space

B. Color Feature Extraction

Color feature is extracted by Color Histogram and Color Descriptor. The Color histogram specifies the color pixel distribution in an image. Color histogram uses two types of color space that are RGB, HSV. Color Histogram (CH), contains occurrences of each color obtained by counting all image pixels having that color. Each pixel is associated to a specific histogram bin only on the basis of its own color, and color similarity across different bins or color dissimilarity in the same bin is not taken into account. Since any pixel in the image can be described by three components in a certain color space (for instance, red, green and blue components in RGB space or hue, saturation and value in HSV space), a histogram, i.e., the distribution of the number of pixels for each quantized bin, can be defined for each component. Color descriptor consists the color expectancy, color variance and color skewness. Color expectancy is the average or mean of intensity in image. Color variance is the square root of the standard deviation. Color skewness is a measure of the asymmetry of the probability distribution of a real valued random variable. Two types of skewness are Positive skewness and Negative skewness.

C. Texture Feature Extraction

An image texture is a set of metrics calculated in image processing designed to quantify the perceived texture of an image. Image Texture gives us information about the spatial arrangement of color or intensities in an image or selected region of an image. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky, or bumpy as a function of the spatial variation in pixel intensities. In this sense, the roughness or bumpiness refers to variations in the intensity values, or gray levels.

1) Gray Level Co-Occurrence Matrix: A statistical method for examining the texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix.

Many Statistics such as Contrast, Homogeneity, Correlation and Energy are derived from the GLCM. These characteristics provide the details about the Texture of an image. Contrast measures the local variations in the gray-level co-occurrence matrix. Correlation measures the joint probability occurrence of the specified pixel pairs. Energy provides the sum of squared elements in the GLCM also known as uniformity or the angular second moment. Homogeneity measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Comparing to Texture analysis statistics and Texture filter characteristics, texture analysis method provides the shape feature characteristics. Texture filter method provides the Range filter which calculates the local range of an image, Standard deviation filter which calculates the local deviation of an image, Entropy filter calculates the local entropy of a gray scale image. Entropy is a statistical measure of randomness.

D. Shape Feature Extraction

Shape is a very powerful feature. Two dimensional Shapes can be described by two different ways such as external representation and internal representation. Boundary based representation is called the External representation which classified into two categories, spatial and transform. Gabor filter and Gaussian Derivatives comes under this category. Region based representation is also called as Internal representation. Hu moment invariant comes under this category [3].

In the proposed system, Shape features are extracted by Edge detection method and Hu moment Invariant. In Edge detection method, we considered two methods that are Sobel and canny. Hu derived expressions from algebraic invariants applied to the moment generating function under a rotation transformation. They consist of groups of nonlinear centralised moment expressions.

$$\mu_{pq} = \int_{-\infty}^{\infty}\int_{\infty}^{\infty} (x-\bar{x})^p (y-\bar{y})^q f(x,y)\, dx\, dy \qquad (1)$$

The result is a set of absolute orthogonal (i.e. rotation) moment invariants, which can be used for scale, position, and rotation invariant. The Normalized central moment expressions are

$$I_1 = \eta_{20} + \eta_{20} \qquad (2)$$

$$I_2 = (\eta_{20} - \eta_{02})^2 + (2\eta_{11})^2 \qquad (3)$$

$$I_3 = (\eta_{30} - \eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \qquad (4)$$

$$I_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \qquad (5)$$

$$I_5 = (\eta_{30} - 3\eta_{12})(\eta_{30}+\eta_{12})[(\eta_{30}+\eta_{12})^2 - 3(\eta_{21}-\eta_{03})^2] + (3\eta_{21}-\eta_{03})(\eta_{03}+\eta_{21})[3(\eta_{30}+\eta_{12})^2 - (\eta_{21}+\eta_{03})^2 \qquad (6)$$

$$I_6 = (\eta_{20} - \eta_{02})^2 | (\eta_{30} | \eta_{12})^2 - (\eta_{21} | \eta_{03})^2] | 4\eta_{11}((\eta_{30} | \eta_{12})(\eta_{21} | \eta_{03}) \qquad (7)$$

$$I_7 = (3\eta_{21} - \eta_{03})(\eta_{30}+\eta_{12})[(\eta_{30}+\eta_{12})^2 - 3(\eta_{21}+\eta_{03})^2] - (\eta_{30} - 3\eta_{12})(\eta_{03}+\eta_{21})[3(\eta_{30}+\eta_{12})^2 - (\eta_{21}+\eta_{03})^2 \qquad (8)$$

E. Similarity Measurement

Similarity measure is done by Euclidean distance. Euclidean Distance is the measure of distance between the two points which is calculated by following equation (9)

$$d(p,q) = \sqrt{\sum_{i=1}^{n} (p_i - p_i)^2} \qquad (9)$$

The normalized Euclidean distance is calculated by

$$\|D\| = \sqrt{(\sum_{i=1}^{n} (p_i - q_i)(q_i - p_i))} \qquad (10)$$

IV. EXPERIMENTAL RESULTS

The proposed image retrieval system is implemented using MATLAB R2009b with image processing toolbox on Intel Core 3 processor with 2 GB of RAM and 40 GB of Hard disk and also using Wang database.

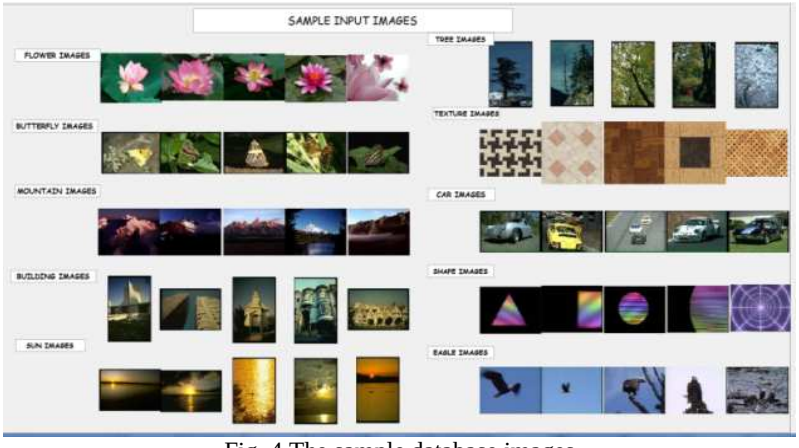
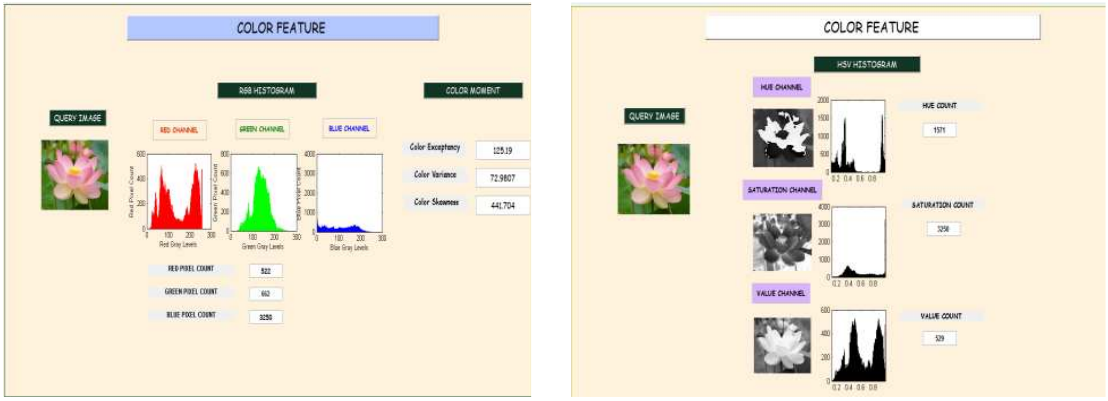


Fig. 4 The sample database images

The color feature is extracted by RGB histogram. In Fig. 5 shows, the user gives query image; the RGB histogram and Color descriptor are calculated.

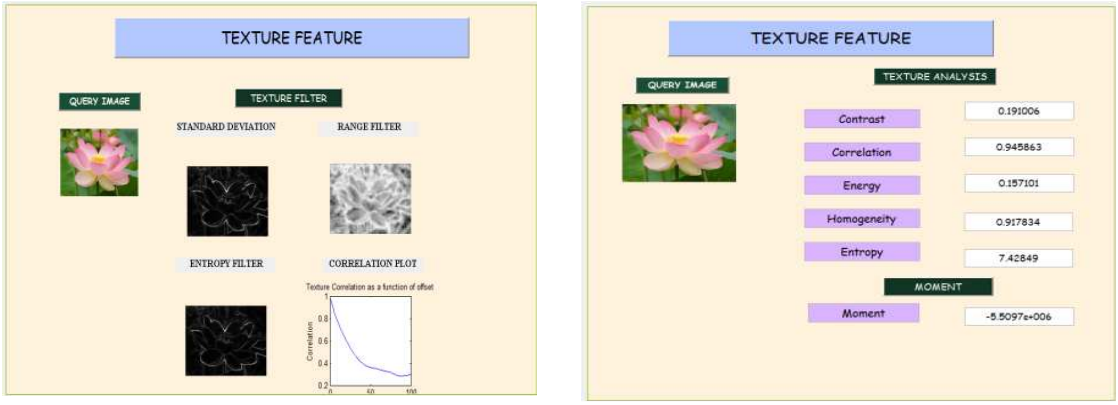


(a) (b)

Fig. 5(a) Color feature extraction by color histogram and descriptor, Fig. 5(b) Color feature extraction by HSV histogram

Comparison to the RGB histogram and HSV histogram, HSV histogram provide more efficiency. The reason is Red channel use 256 bins similarly other two channels uses 256 bins. In HSV histogram, hue use 16 bins, Saturation use 8 bins and value use 1 bin.

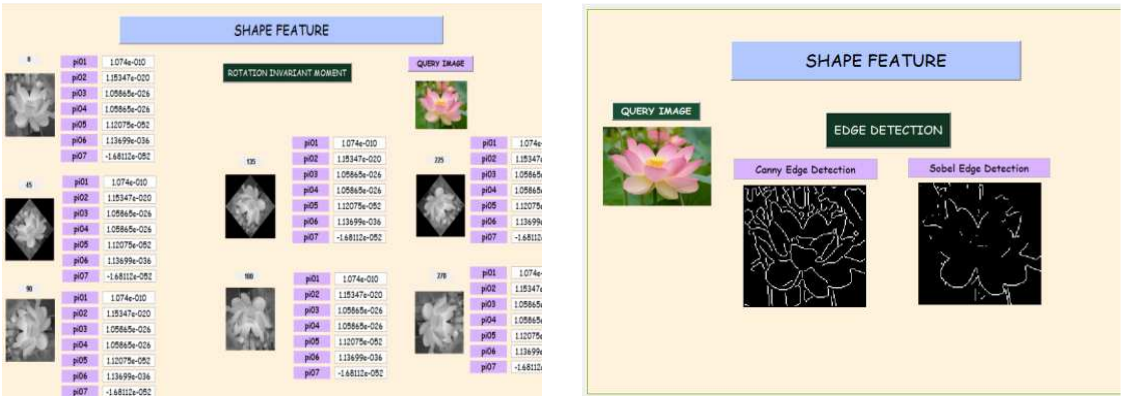
Texture feature extracted by texture filter techniques are Standard deviation filter, Range filter, Entropy filter. The correlation plot provides the detail about the offset and its correlation. Comparison to the texture filter and the texture analysis method, Texture analysis method (Fig. 6) is effective. Texture filter method does not bring the shape detail of the given object.Texture analysis method is performed using the Gray Level Co-occurrence matrix (GLCM), to find the Contrast, Correlation, Energy, and Homogeneity.



(a) (b)

Fig. 6(a) Texture feature extracted by Texture filter method. Fig. 6(b) Texture feature extracted by Texture Analysis method

Hu moment analysis method is used for extracting the shape features. If images rotated, translated or scaled in the database, Using Hu moment invariant to find the images in database.Comparison to the Sobel and Canny edge detection method, Canny provides more details than the Sobel method. But Sobel method provides noise suppression.



(a) (b)

Fig. 7(a) Shape feature extracted by Hu Moment analysis, Fig. 7(b) Shape feature extracted by Edge detection method

Fig. 8 Retrieved images for Proposed CBIR System

Fig. 8 shows the retrieved images that are highly related to the query image which is given by user. The retrieved images are fetched from database and also indexed based on similarity between the query image and database image.

TABLE I
FEATURE VECTOR SET

IMAGES	FEATURES			
	COLOR		***TEXTURE***	***SHAPE***
	RGB	HSV		
FLOWER – L1.jpeg 	R- 2570 G- 772 B - 934	H-7307 S-772 V-934	Contrast-0.209215 Correlation-0.964449 Energy-0.232401 Homogeneity-0.938027 Entropy-7.1754	Pi01- 2.14559e-010 Pi02- 4.60356e-020 Pi03- 5.97189e-026 Pi04- 5.97189e-026 Pi05- 3.56635e-051 Pi06- 1.2813e-035 Pi07- 5.3495e-051
BUILDING – b3.jpg 	R- 528 G- 340 B - 946	H-496 S-1118 V-342	Contrast-0.213583 Correlation-0.938567 Energy-0.183995 Homogeneity-0.92247 Entropy-6.96784	Pi01- 3.4353e-023 Pi02- 7.5443e-098 Pi03- 5.5018e-045 Pi04- 5.5018e-045 Pi05- 1.3456e-054 Pi06- 1.2835e-063 Pi07- 2.14559e-010
TEXTURE – T1.jpg 	R- 489 G- 536 B - 462	H-1272 S-711 V-489	Contrast-1.26433 Correlation-0.864065 Energy-0.13467 Homogeneity-0.792907 Entropy-6.48893	Pi01- 5.5331e-037 Pi02- 2.5931e-072 Pi03- 6.387e-048 Pi04- 6.387e-048 Pi05- 4.002e-017 Pi06- 4.3736e-073 Pi07 - -3.765e-021

Table I shows feature vector set for color image, shape image and texture image with their corresponding RGB, HSV, texture and shape values.

V. CONCLUSION

Content based image retrieval is a technique which uses the visual contents to search images from large scale image databases. The proposed retrieval system uses integrated features, such as color, texture and shape. Color features are extracted using color histogram by calculating the RGB pixel count, HSV pixel count, Color Moment values. Shape features are extracted using Hu Moments and also by Edge detection by calculating Normalized rotation invariant moment values, similarly texture feature which is extracted by texture analysis method and the parameters are contrast, correlation, homogeneity, entropy and energy. The similarity measure using these integrated features can be carried out using Euclidean distance which provides high accuracy of retrieved images.

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