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Content Based Image Retrieval Using Color and Textural Features

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Abstract: In this paper, a novel approach for content based image retrieval using color and textural features is presented. The system is developed and tested on 400 images in 5 different categories such as forest, water contained area, animals, cartoon and construction buildings images. The features extraction developed consists of the combination of textural and color features. The texture features are extracted through wavelet transformation and the color features with color histogram. The extraction of color features from digital images depends on an understanding of the theory of color and the representation of color in digital images. Color spaces are an important component for relating color to its representation in digital form. The transformations between different color spaces and the quantization of color information are primary determinants of a given feature extraction method. The approach is found to be robust in terms of accuracy and is 92.4% amongst five categories.

Keywords: content based image retrieval, color histogram, wavelet transform, texture

I. INTRODUCTION

The term Content-based image retrieval was originated in 1992, when it was used by T. Kato to describe experiments into automatic retrieval of images from a database, based on the colors and shapes present. Since then, this term has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features. The techniques, tools and algorithms that are used originate from fields such as statistics, pattern recognition, signal processing, and computer vision. [9]. In content-based image retrieval (CBIR), the image databases are indexed with descriptors derived from the visual content of the images. Most of the CBIR systems are concerned with approximate queries where the aim is to find images visually similar to a specified target image. In most cases the aim of CBIR systems is to replicate human perception of image similarity as much as possible [5]. The CBIR gained good amount of popularity due to its large application base such as crime investigation and prevention, Medical diagnosis, Military, Photograph archives, Retail catalogues, face finding, Architectural and engineering design, Art collections etc. The general stages involved in development of CBIR are Data collection; Image pre-processing, Feature extraction, Classification and Resultant Retrieved images. The system searches the previously maintained information to find the matched images from database. The output will be the similar images having same or very closest features as that of the query image [10].

The literature reveals that the CBIR has become a topic of great interest in recent years mainly due to the large collection of images over the Internet, and there has been some substantial and progressive research in the area. The majorly approaches[1,8,9,13] in CBIR are based on object model creation called query image and retrieval of the same from the large data set. During the process of model creation large set of features which are based on texture and color are found to be addressed. In this direction Jaiswal and Kaul [1] presented that content based image retrieval is not a replacement of, but rather a complementary component to text based image retrieval. Only the integration of the two can result in satisfactory retrieval performance. In this paper they addressed components of a content based image retrieval system, including image feature representation, indexing, and system design, while highlighting the past and current technical achievement. Typical characterization of color composition is done by color histograms in [7]. Swain et. al [2] proposed the method, called color indexing, in which the method identifies the object using color histogram indexing. A distance between query image histogram and a data image histogram can be used to define similarity match between the two distributions. To overcome problem with histogram in 1995 Mehtre et al [4] proposed two new color- matching methods as Distance Method and Reference Color Table Method, for image retrieval. They used a coarse comparison of the color histograms of the query and model images in the Distance method they proposed. Most color histograms are very sparse and thus sensitive to noise. Stricker and Orengo [5] have proposed cumulated color histogram technique in which they showed that the results are better than color histogram approach. Observing the fact that the color histograms lack information about how color is spatially distributed. Rui and Huang [6], introduced a new color feature for image retrieval called color correlogram. This feature characterized how the spatial correlation of pairs of color changes with distance in an image. Usually, because the size of color correlogram is quite large, the color auto correlogram is often used instead. This feature only captures spatial correlation between identical colors. Dharani et. al [8] in their survey presented that CBIR system based on the color, texture and shape features have been developed by partitioning the image into tiles. The features computed on tiles serve as local descriptors of color and texture features. The color and texture analysis are analyzed by using two level grid frameworks and the shape feature is used by using Gradient Vector Flow. Some of the papers showed [13] comparison of result of their method with other system and claimed to give better performance. Verma and Mahajan[12] have used canny and sobel edge detection algorithm for extracting the shape features for the images. After extracting the shape feature, the classified images are indexed and labelled for making easy for applying retrieval algorithm in order to retrieve the relevant images from the database. In their work, retrieval of the images from the huge image database as required by the user can get perfectly by using canny edge detection technique according to results.

From the literature it is evident that there are methods which are robust in terms are accuracy but are consuming large amount of time in retrieval of the query image or there are methods fast enough but fail to give desired level of accuracy Hence there is a scope to develop new method which balance the both criteria and a new method is proposed. This paper is organized in following sections as follows. Proposed method basics are addressed in section II, algorithm is presented in III, experimental results are discussed and presented in IV and finally the paper is concluded.

II. PROPOSED METHOD

The feature extraction plays a vital role for any recognition system as the classification accuracy does do depend on the distinctive features that have been extracted. In the proposed approach two sets of features are extracted, the first being the color features using the color histogram and the other with textural set of features based on the wavelet transform.

Color histogram:

The color histogram is most important component in image retrieval. It is a vector which is collection of element with each element representing number of pixels in a bin of image. A color histogram represents the distribution of colors in an image, through a set of bins, where each histogram bin corresponds to a color in the quantized color space. A color histogram for a given image is represented by a vector:

$H = \{H[0], H[1], H[2], \ldots H[i], \ldots H[n]\}$

Where 'i' is the color bin in the color histogram and H[i] represents the number of pixels of color 'i' in the image, and 'n' is the total number of bins used in color histogram. Typically, each pixel in an image will be assigned to a bin of a color histogram. Accordingly in the color histogram of an image, the value of each bin gives the number of pixels that has the same corresponding color. In order to compare images of different sizes, color histograms should be normalized. The normalized color histogram H_ is given as:

$H' = \{H'[0], H'[1], H'[2], \ldots H'[i], \ldots H'[n]\}$ where $H'[i] = H[i]/p$.

'p' is the total number of pixels of an image.

Wavelet based features:

The wavelet transform represents a function as a superposition of a family of basic functions called wavelets. Wavelet transforms extract information from signal at different scales by passing the signal through low pass and high pass filters. Wavelets provide multiresolution capability and good energy compaction. Wavelets are robust with respect to color intensity shifts and can capture both texture and shape information efficiently.

The wavelet transforms can be computed linearly with time and thus allowing for very fast algorithms [11]. Discrete wavelet transformation (DWT) is used to transform an image from spatial domain into frequency domain. The wavelet transform computation of a two-dimensional image is also a multi-resolution approach, which applies recursive filtering and sub-sampling.

In applied mathematics symlet wavelets are a family of wavelets and are a modified version of Daubechies wavelets but with increased symmetry.

The dwt2 command performs single-level two-dimensional wavelet decomposition shown in figure 2.1 with respect to either a particular wavelet or particular wavelet decomposition filters (Lo_D and Hi_D) which are specified.

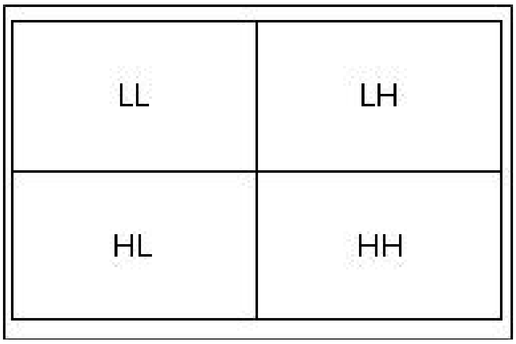

Fig. 1 level 1 of the 2D wavelet transforms rgb2hsv conversion:

The value represents intensity of a color, which is decoupled from the color information in the represented image. The hue and saturation components are intimately related to the way human eye perceives. HSV is often called HSB (B for brightness). Hue varies from 0 to 1 when color goes from red to green then to blue and back to red. H is then defined modulo 1 as color is seldom mono chromatic, saturation(S) represents the amount of white color mixed with the monochromatic color. Value (V) does not depend on the color, but represents the brightness. So H and S are chrominance and V is intensity. The transformation equations for RGB to HSV color model conversion are

$V = \max(R, G, B)$

$S = V - \min(R, G, B)/V$

$H = G - B/6S$, if $V = R$

$H = (1/3) + (B - R/6S)$, if $V = G$

$H = (2/3) + (R - G/S)$, if $V = B$.

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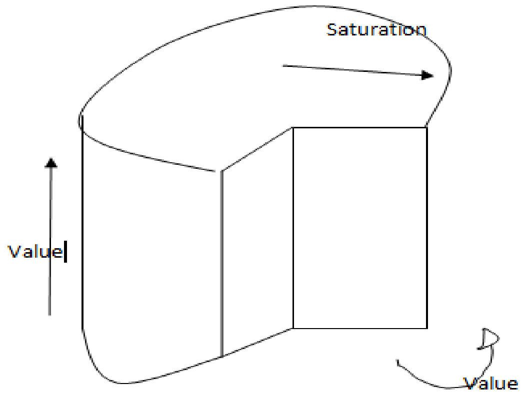

Fig. 2 HSV Color space

fspecial filters:

prewitt:

It is used for a horizontal edge-emphasizing filter.

Single level discrete 2D wavelets transform:

[cA, cH, cV,cD] = dwt2(X1,wname,'mode',MODE) computes the approximation coefficients matrix cA and details coefficients matrices cH, cV, and cD (horizontal, vertical, and diagonal, respectively), obtained by wavelet decomposition of the input matrix X1. The 'wname' string contains the wavelet name. Wavelet used in this work is 'sym4'. MODE is a string containing the desired extension mode.

Classifier

The nearest neighbor technique simply classifies an unknown sample as belonging to the same class as the most similar or "nearest" sample point in the training set of data, which is often called a reference set. Nearest can be taken to mean the smallest Euclidean distance in n-dimensional feature space, which is the usual distance between two coordinate points a = (a_1, …a_n) and b = (b_1, …b_n), defined by

$$d_e(a,b)=\sqrt{\sum_{i=1}^{n}(b_i-a_i)^2}$$

where n is the number of features. This is an extension of Pythagorean Theorem to n dimensions, and would be the distance measured by a rular in one-, two-, or three-dimensional space. Euclidean distance is probably the most commonly used distance function or measure of dissimilarity between feature vectors.

III. ALGORITHM

Steps:

- Extract the Color components Red, Green, and Blue from an image.
- Decompose each Red, Green, Blue Component using 2D-discrete Wavelet transformation at 1st level to get approximation coefficient and vertical, horizontal and diagonal detail coefficients.
- Apply fspecial filter prewitt to detect the edges.
- Combine approximate coefficients of Red, Green, and Blue Components.
- Similarly combine the horizontal and vertical coefficients of Red, Green, and Blue Component.
- Assign the weights 0.003 to approximate coefficients, 0.001 to horizontal and vertical coefficients (experimentally setup values).
- Convert the approximate, horizontal and vertical coefficients into HSV plane.
- Color quantization is carried out using color histogram by assigning 8 level each to hue, saturation and value to give a quantized HSV space with 8x8x8=512 histogram bins.
- The normalized histogram is obtained by dividing with the total number of pixels.
- Calculate the similarity matrix of query image and the image present in the database using minimum distance classification technique.

IV. EXPERIMENTAL RESULTS

Since there are no standard datasets available we have created our own data set. This database contains around 400 images which are taken from various sources. Such as web, photographs being scanned and some of them have been clicked through cameras and mobiles. The image dataset is divided into 5 distinct categories like forest; water logged areas, animals, cartoons and constructed areas such as buildings.

For testing image from one of these categories has been given as an input. The outcome expected is procurement of all images which fall into same category. The result snapshots for query images of all categories are shown in the figures 3-to figure 7.

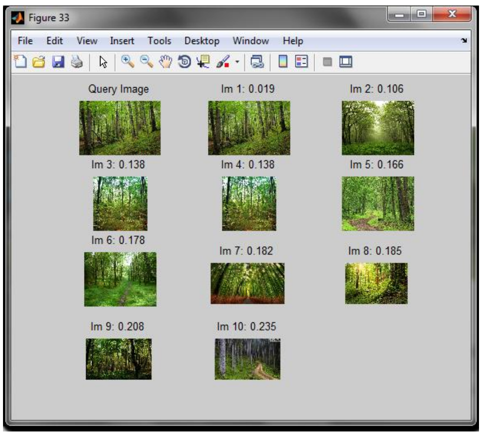

Fig. 3 Retrieve results for forest

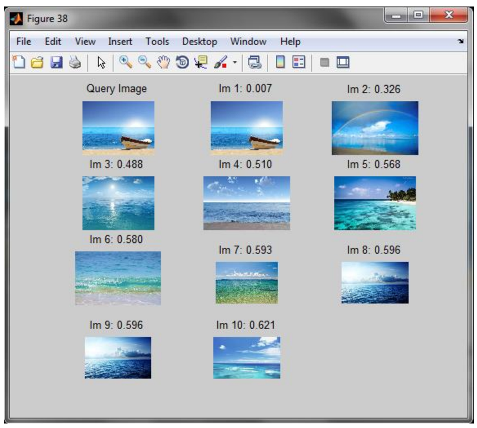

Fig.4 Retrieve results for water logged area

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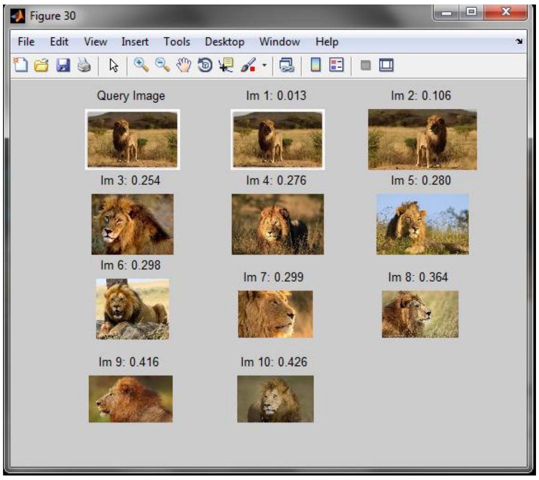

Fig.5 Retrieve results for animals

Table 1 gives details about the images used in performance evaluation of the system. In forest category images there are total 80 images and 74 images are being classified correctly. Hence the performance forest category is calculated as 92.5%. Likewise for other categories are also calculated. And the overall accuracy is estimated and is represented in Table 1.

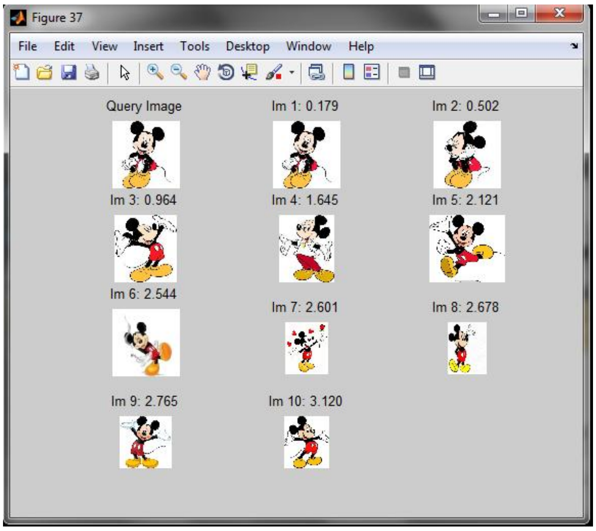

Fig.6 Retrieve results for cartoons

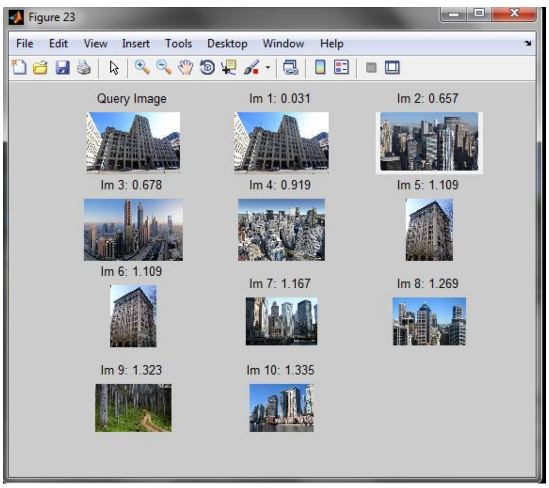

Fig.7 Retrieve results for buildings

Table1: Classification accuracy

Category	Total no. of images	Correctly classified images	% Accuracy
Forest	80	74	92.50%
Water logged area	90	88	97.77%
Animals	70	66	94.28%
Cartoons	70	62	88.57%
Buildings	90	80	88.88%

Therefore, aggregate performance of the system is 92.4%.

V. CONCLUSION

In this paper, novel feature extraction a technique is designed which consists of textural features, and are combined with color features. The features are extracted based on color histogram and wavelet based techniques. Further the classification of the images is carried out based on minimum distance classification technique known as nearest neighbor classification. The method is found to be effective and robust, in terms of accuracy and variety of images considered. The aggregate accuracy of method is found to be 92.4% which is effective and is comparable with other methods in this area. The developed system which uses textural features and color histogram features has more favourable results for images with similar color appearances but has limitation in selecting images with finer changes.

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