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Content Based Image Retrieval using HSV Color, Shape and GLCM Texture

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Abstract: In the most recent years, content based image retrieval has been studied with more attention due to huge amounts of image data accumulate in different fields, e.g., medical, satellite, art collections, commercial images and general photographs. Image databases are generally big, and in most of the cases, the images are indexed only by keywords given by a human. Even though keywords are most useful in retrieving images that a user wants, sometimes the keyword approach is not sufficient and not efficient. Instead, a Query-by-example (QBR) or pictorial-query approach gives similar images to the query image given by a user. The query images can be a photograph, user-painted example, or line- drawing sketch. In this method, images are retrieved by their contents such as color, texture, shape, or objects. Thus, the degree of similarity between query images and images in database can be measured by color feature extraction, texture feature extraction, shape feature extraction similarity, or object presence between the two images. Using a single feature extraction for the image retrieval cannot be a amicable solution for the accuracy and efficiency. High-dimensional feature will reduce the query efficiency; low-dimensional feature will reduce the query accuracy, so that, better way is using multi features for image retrieval. Color, texture and shape are the most important visual features.

Keywords: Content Based Image Retrieval(CBIR), Hue(H), Saturation(S), Value (V), Grey Level Co-Occurrence Matrix (GLCM).

I. INTRODUCTION

Image retrieval is retrieving images from a large database of digital images using computer system. Conventional methods of image retrieval use some more methods of adding metadata by captioning, keywords or the descriptions to the images by this the retrieval can be performed[1]. Manual image annotation is time consuming, expensive and laborious. For addressing this there has been a vast amount of research done on automatic image annotation. It is crucial to understand the scope and details of the image data in order to determine the complexity of the image search system design [12]. The design is also majorly dependent on the factors and some of the factors include archives, domain specific collection, enterprise collection, personal collection and web etc.

As far as technological advances are concerned, growth in [11] content-based image retrieval has been unquestionably rapid. Regardless of the nature of the collection, as the expected user-base grows, factors like concurrent query support, efficient caching, and parallel and distributed processing of requests become critical.

For next generations, real-world image retrieval systems use both software and hardware approaches to achieve these issues are essential. More realistic and also dedicated specialized servers, optimized memory and storage support, and highly parallelise image search algorithms to exploit cluster computing powers are required to achieve a large-scale image retrieval.

II. RELATED WORK

There are many approaches for Content Based Image Retrieval using different features such as color, shape, and texture. Some of the published work which covers the more important CBIR Systems is discussed below.

Chin-Chin Lai et.al. [2] have proposed an interactive genetic algorithm (IGA) to reduce the gap between the retrieval results and the users' expectation called semantic gap. They have used HSV color space that corresponds to human way of perceiving the colors and separate the luminance component from chrominance ones. They have also used texture features like the entropy based on the grey level co-occurrence matrix and the edge histogram. They compared this method with others approaches and achieved better results.

A. Kannan et.al.[3] have proposed Clustering and Image Mining Technique for fast retrieval of Images. The main objective of the image mining is to remove the data loss and extracting the meaningful information to the human expected needs. The images are clustered based on RGB components, Texture values and Fuzzy C mean algorithm.

Rishav Chakravarti et.al [4] have published a paper on Color Histogram Based Image Retrieval. They have used color histogram technique to retrieve the images. This method allows retrieval of images that have been transformed in terms of their size as well as translated through rotations and flips.

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A. Ramesh Kumar et.al [5] have published on Content Based Image Retrieval using Color Histogram. They have used Color Histogram technique to retrieve the similar images. To speed up the retrieval, they have used the proposed grid-based indexing to obtain the nearest neighbours of the query image and exact images are retrieved. Indexing can be performed in vector space to improve retrieval speed. Mainly, they have implemented CBIR using color histogram technique and is refined with help of grid technique to improve the image retrieval performance.

III. PROPOSED METHOD

This paper mainly accomplishes the results by the combination of three feature extractions. They are color feature extraction, texture feature extraction, and shape feature extraction [10].

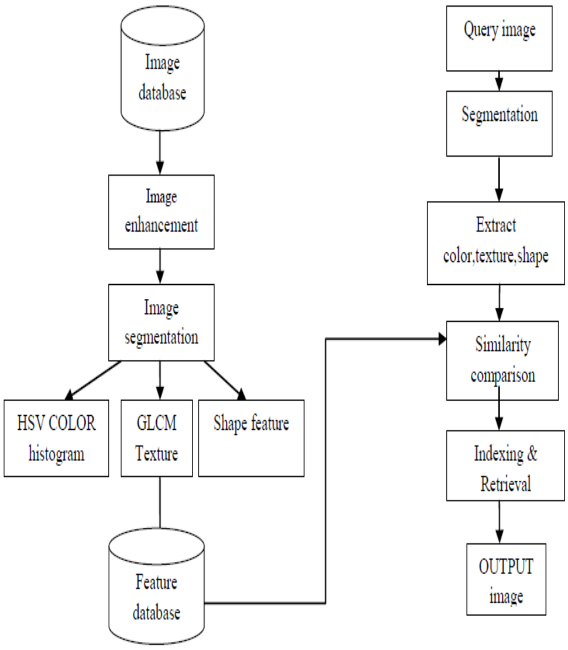

Fig.1 Block diagram of CBIR using combination of color, texture, shape.

Color feature extraction:

HSV Color space: Basically the three properties or three dimensions of color that ar hue, saturation and value HSV means hue, saturation and value. It is very important to look at because it describes the color based on three properties. It creates the full spectrum of colors by editing the HSV values. The first dimension is the hue. The other name to the hue is color or the complicated variation in the color. The quality of color is determined by its dominant wavelength. This hue is basically classified into three categories. They are primary hue, secondary hue and tertiary hue. The primary hue itself consists of three colors they are red, yellow and blue. The secondary hue is the formations with the equal amounts of colors of the primary hue and the colors of the secondary hue which were formed by the primary hue are orange, green and violet. The remaining one is the tertiary hue is formed by the combination of the primary hue and the secondary hue. The limitless number of colors is produced by mixing the colors of the primary hue in different amounts. Saturation is the degree of color [8]. Then the second dimension is the saturation. Saturation just gives the intensity to the colors. The saturation and intensity drops with just by mixing the color or by adding black to the color. While by adding the white to the color in spite of more intense the color becomes lighter. Then finally the third dimension is the value. Here the value means the brightness of the color. When the value is zero the color space is totally black with the increase in the color there is also increase in the brightness and shows the various colors. The value describes the contrast of the color. That means it describes the lightness and darkness of the color. As similar to the saturation this value consists of the tints and shades. Tints are the colors with the added white and shades are the colors with the added black.

PROPERTIES OF THE HSV COLOR SPACE:

The HSV color space looks like as a hexacone, with the central vertical axis denotes luminance component, I (often denoted by V for intensity value). Hue is the chrominance component defined as an angle in the range $[0, 2\pi]$ relative to the red axis with red at angle 0, green at $2\pi/3$, blue at $4\pi/3$ and red again at 2π. Saturation, S, is the other chrominance component, measured as a radial distance from the central axis of the hexacone with value between 0 at the centre to 1 at the outer surface [16]. For zero saturation, as the intensity is increased, we move from black to white through various shades of gray. On the other hand, for a given intensity and hue, if the saturation is changed from 0 to 1, the perceived color changes from a shade of gray to the most pure form of the color represented by its hue. If saturation is near 0, all the pixels in an image look alike even though their hue values are different.

As we increase saturation value towards 1, the colors get separated out and are visually perceived as the true colors represented by their hues. Low saturation implies that the presence of a large number of spectral components in the incident light causes loss of color information even though the illumination level is sufficiently high. Thus, for low value of saturation or intensity, we can approximate a pixel color by a gray level while for higher saturation and intensity, the pixel color can be approximated by its hue value. For low intensities, even for a high saturation, a pixel color is close to its gray value. In a similar way, for low saturation even for a high value of intensity, a pixel is perceived as gray. We use these properties to estimate the degree of image by which a pixel contributes to color perception and gray level perception.

One attainable way of capturing color perception of a pixel is to choose suitable thresholds on the intensity and saturation. If the intensity and the saturation are above their respective thresholds, we may consider the pixel to have color dominance; else, it has gray level dominance. However, there is a hard thresholding does not properly capture color perception near the threshold values.

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This is due to the fact that there is no fixed level of illumination above which the cone cell gets excited. Instead, there is a gradual transition from scotopic to photopic vision. Similarly there is no fixed threshold for the saturation of cone cell that leads to loss of chromatic information at higher levels of illumination caused by color dilution. Therefore, use suitable weights that vary smoothly with saturation and intensity to represent both color and gray scale perception for each pixel.

NON-INTERVAL QUANTIZATION:
Due to the large range of images for each component by directly calculating the characteristics for the retrieval then the computation will be very difficult to ensure rapid retrieval. It is necessary to quantify HSV space component to reduce computation and improve efficiency. At the same time, because the human eye to distinguish colors is limited, do not need to calculate all segments [18]. Unequal interval quantization according the human color perception has been applied on H, S, and V components.

Based on the color model of substantial analysis, it is divided color into eight parts. Saturation and intensity is divided into three parts separately in accordance with the human eyes to distinguish. In accordance with the different colors and subjective color perception quantification, quantified hue (H), saturation(S) and value (V) [14]. In accordance with the quantization level above, the H, S, V three-dimensional feature vector for different values of with different weights to form one dimensional feature vector and is given by the following equation:

$$G = Qs * Qv * H + Qv * S + V$$

Where Qs is the quantized series of S and Qv is the quantized series of V. And now by setting Qs = Qv = 3, Then G = 9H+3S+V.

$$H=\begin{cases} 0 \text{ if } h \in [316,20] \\ 1 \text{ if } h \in [21,40] \\ 2 \text{ if } h \in [41,75] \\ 3 \text{ if } h \in [76,155] \\ 4 \text{ if } h \in [156,190] \\ 5 \text{ if } h \in [191,270] \\ 6 \text{ if } h \in [271,295] \\ 7 \text{ if } h \in [296,315] \end{cases}$$

$$S = \begin{cases} 0 \text{ if } s \in [0,0.2) \\ 1 \text{ if } s \in [0.2,0.7) \\ 2 \text{ if } s \in [0.7,1) \end{cases}$$

$$V = \begin{cases} 0 \text{ if } v \in [0,0.2) \\ 1 \text{ if } v \in [0.2,0.7) \\ 2 \text{ if } v \in [0.7,1) \end{cases}$$

In this way, three-component vector of HSV form one-dimensional vector, which quantize the whole color space for the 72 kinds of main colors. So, we can handle 72 bins of one-dimensional histogram. This quantification can be effective in reducing the images by the effects of light intensity, but also reducing the computational time and complexity.

CHARACTERISTICS OF THE COLOR CUMULATIVE HISTOGRAM:
Color histogram is first derived by first quantize colors in the image into a number of bins in a particular color space and counting the number of the image pixels in each bin. One of the weaknesses of the color histogram is that when the characteristics of the images should not take over all the values. The statistical histogram will appear in the number of zero values. The emergence of these values would make the similarity measure does not accurately reflect the color difference between the images and the statistical histogram method to qualify the more sensitive parameters. Therefore this represents the one dimensional vector by constructing a cumulative histogram of the color characteristics of the image after using the non interval HSV quantization for G.

With the rapid development of computer technology and network communication technology, predominantly the emergence and popularization of Internet, rapid expansion of the size of the multimedia database such as digital image, every day hundreds of millions of military or civilian image data is stored in the database. The main method of image files is to establish keywords or text description of the title as well as some additional information, and then establish a link between storage path and the keywords of the image, which is text-based image retrieval. However, with the storage capacity of images to start using GB or TB, the own shortcomings of text-based image retrieval technology led to two difficulties in the retrieval: First, it has been impossible to note each image; Second, the subjectivity and non precision of image annotation may lead to the adaptation in the retrieval process. In order to overcome these problems, Content-Based Image Retrieval (CBIR) was proposed in the 90's.

Color retrieval is one of the most significant features of the image retrieval. There are many color models to express color such as the RGB color model, YUV color model and the HSV color model. HSV color model is there of most consistent with the induction of the human visual model. H represents color hue, and it is the wavelength of the light reflected from an object or throughout the object; S represents color saturation, means how much white is added to the color; V represents brightness (vale), is the degree of color shading. But, the computer can only identify the RGB color component of an image, in which R represents the red component, G represents the green component, *B* represents the blue component.

TEXTURE FEATURE EXTRACTION:

GRAY LEVEL CO-OCCURRENCE MATRIX (GLCM):
Gray-co-matrix function can be used to produce the GLCM (Gray level co-occurrence matrix). Gray-co-matrix function computes the relationship among the pixel value *i* happens with respect to the pixel value *j*[19]. The pixel to

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its straightaway right and by default the spatial relationship is set as the pixel of interest even although the spatial relation between the two pixels is affirmed. Each value in the GLCM is nothing but the sum of the number of times that the pixel value i happens with relation to the pixel value j in the input image [7].

For the entire dynamic range of an image the processing asked to calculate a GLCM is prohibitive. The input image was scaled by the gray matrix. By default to dilute the intensity values from 256 to 8 in Greyscale image gray-co-matrix use scaling. Applying the num levels and the gray limits arguments of the gray-co-matrix function the number of gray levels and the scaling of the intensity values in the GLCM can be operated.

The properties about the spatial distribution of the Gray level in the texture image can be exposed by the Gray level co-occurrence matrix.

TEXTURE FEATURE EXTRACTION BASED ON GLCM:

GLCM creates a matrix with the instructions and lengths between pixels, and then extracts meaningful statistics from the matrix as texture characteristics[15]. GLCM texture features commonly used are shown in the following:

GLCM is compiled with the probability value, it is defined by $P(i, j/ d, \theta)$ which expresses the probability of the couple pixels at θ direction and d interval. When θ and d is found, $P(i, j/ d, \theta)$ is showed by Pi, j . Distinctly GLCM is a symmetry matrix; its level is checked by the image gray-level [17].

Elements in the matrix are computed by the equation showed as follow:

$$P(i, j/d, \theta) = \frac{P(i,j/d,\theta)}{\sum_i \sum_j P(i,j/d,\theta)}$$

GLCM carries the texture feature allowing to the correlation of the couple pixels gray-level at different values. It identifies the texture feature quantificationally. In this paper, four features is elected, include energy, contrast, entropy, inverse difference.

1. Energy:

$$E = \Sigma\Sigma\, p(x, y)^2$$

It is a gray-scale image texture evaluate of homogeneity changing, reflecting the dispersion of image gray-scale uniformness of weight and texture.

2. Contrast:

$$I = \Sigma\Sigma(x - y)^2 p(x, y)$$

Contrast is the main diagonal near the moment of inertia, which finds the value of the matrix is allotted and images of local changes in number, reflecting the image clarity and texture of shadow depth. Contrast is large means texture is deeper.

3. Entropy:

$$\text{Entropy} = -\Sigma\Sigma\, p(x, y) \log p(x, y)$$

Entropy finding the image texture randomness, when the space co-occurrence matrix for all values are equal, it reached the minimum value; on the other hand, if the value of co-occurrence matrix is very uneven, its value is higher. Therefore, the maximum entropy implied by the image gray distribution is random.

4. Inverse difference:

It finds the local changes in image texture number. Its value in greater is instanced that image texture among the different regions of the lack of exchange and partial very evenly. Here $p(x, y)$ is the gray-level value at the coordinate (x, y).

FEATURE EXTRACTION, INDEXING AND RETRIEVAL:

The process of image retrieval comprises of two main tasks training / indexing and retrieval. Common to both the tasks is the feature extraction. Features are the illustrations of the images. An indexing means characterization of images based on one or more image properties. In indexing implicit properties of an image can be included in the query to reduce search time for retrieval from a vast database. Features like color, texture, shape, spatial relationship among entities of an image and also their combination are usually being used for the computation of multidimensional feature vector [6].

The feature of the color, texture, shape is known as primitive feature. The percentages of retrieval efficiency totally rely on selection of proper image feature. Hence it is very significant to select better features as well as efficient feature extraction techniques. In this proposed work is based on one of the primitive feature called shape. An indexed shape feature vectors of the database images from the feature database. In the retrieval phase, given a query image, its feature vector is worked out, compared to the feature vectors in the feature database, and images most alike to the query images are returned to the user.

SHAPE FEATURE EXTRACTION:

The shape of object plays an essential role among the different aspects of visual information [9]. Therefore, it is a very powerful feature when used in similarity of images and retrieval. Contour-based shape description technique is implemented in this work [13]. The contour detection is one of the most useful method used operators in image processing. Generally, in digital images the contour can be connected to a rapid change in gray level in the observed image. In this work the basic idea behind that is to use the centroid-radii model to represent shapes. In this method, lengths of the shape's radii from boundary to centroid are used to represent the shape.

If the shape is used as feature, edge detection might be the first step to extract that feature. In this work, the canny

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edge detector is used to determine the edge of the object in the image [6]. After the edge has been detected the first step is tracing the contour of the object in the image. For this the edge image is scanned from four directions (left to right, right to left, top to bottom, bottom to top) and the first layer of the edge is detected as image contour. To avoid discontinuities in object boundary the contour image is then re-sampled.

After the object contour has been detected, the first step in shape representation for an object is to locate the central point of the object. The centroid of an object is computed using the

$$x_c = \sum_{i=1}^{n} x_i/n$$
$$y_c = \sum_{i=1}^{n} y_i/n$$

where, *n* is the number of points of an object. The contour is characterized using a sequence of contour points described in polar from. Here the pole at centroid (*x* , *y*) is taken, then the contour graph can be represented by a polar equation $d = f(\theta)$ and each and every contour point (x, y) has the polar description, where *x*, *y*, *d*, and θ are related using Equations:

$$d = \sqrt{(x - x_c)^2 + (y - y_c)^2}$$
$$\theta = \tan^{-1}(y - y_c/x - x_c)$$

IV.EXPERIMENTAL RESULTS

After running the matlab code the figure window displays as:

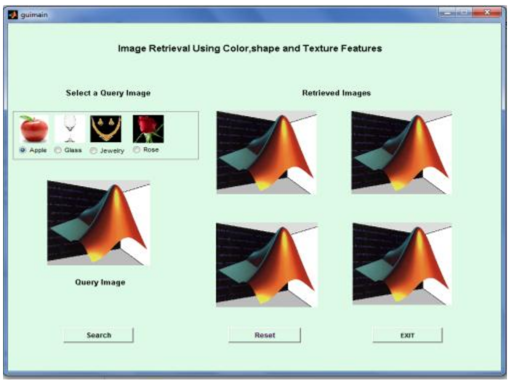

Fig1: Simulation result before giving input image

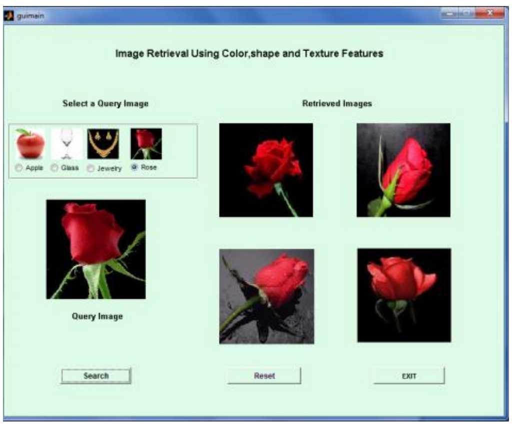

Fig2: Simulation result after giving input image as rose

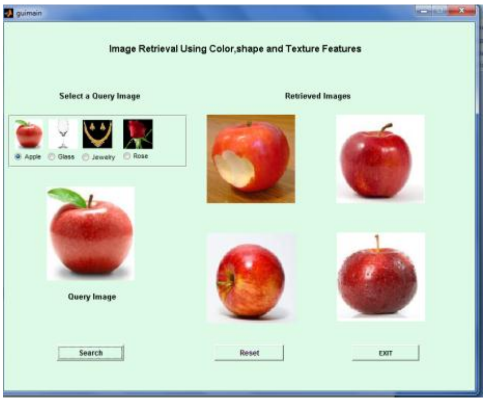

Fig3: Simulation result after giving input image as apple

Performance measure:

The performance rate of this system can be evaluated by the two parameters precision rate and recall rate. The precision rate or value is defined as the ratio of the number of relevant images retrieved to the total number of retrieved images. Mathematically expressed as below

$$\text{Precision Rate} = \frac{\text{The number of relevant images retrieved}}{\text{The total number of retrieved images}}$$

And recall rate parameter is the ratio of the number of relevant images retrieved to the total number of relevant images. Mathematically expressed as below

$$\text{Recall Rate} = \frac{\text{The number of relevant images retrieved}}{\text{The total number of relevant images}}$$

These are the two parameters that improve the performance of our system.

Table 1: Performance Evaluation of our system using precision and recall rate parameter

S. No.	*Classes*	*Precision Rate*	*Recall Rate*
1.	Apple	1	1
2.	Glass	1	1
3.	Rose	1	1
4.	Jewellery	1	1

V.CONCLUSION

This paper presents the practical approach of Content based Image Retrieval using color, shape and texture features. The basic concept of this without having any laborious work of typing keywords, we can use input as an image and can retrieve required images based on shape, color and texture features.

It has been found that variation in feature extraction methodologies can ensure the better and more accurate retrieval of relevant images from the large database. Lots of research is being currently done for the improvement in the feature extraction methods. The ultimate goal is to achieve higher retrieval efficiency from large database of images by improving the speed, efficiency and accuracy.

There are still lot of research is going on in the field of content-based image retrieval for its more faster and accurate behaviour.

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As further studies, the proposed retrieval method is to be evaluated for various databases and to be applied to video retrieval.

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