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Determination of Color, Texture and Edge Features for Content-Based Image Retrieval

Sharvari M. Waikar *, Dr.K.B.Khanchandani **

*(Department of Electronics and Telecommunication, Amravati University, S.S.G.M.C.E, Shegaon
Email: waikarsharvari@gmail.com)
** (Department of Electronics and Telecommunication, Amravati University, S.S.G.M.C.E, Shegaon
Email: kbkhanchandani@rediffmail.com)

ABSTRACT
Expansion of content-based image retrieval (CBIR) system has become a vital research issue as the digital image libraries and multimedia databases are increasing day by day. The image retrieval is divided into two major types: Text-based image retrieval and Content-based image retrieval. Conventional text-based image search engines apply manual annotation of images whereas the content-based image retrieval retrieves images based on image content. This paper explains about the determination of color, texture and edge features required for content-based image retrieval. The image features like color is expressed by using mean and standard deviation, the texture feature is expressed by gray level co-occurrence matrix (GLCM) and the edge features are expressed by using edge histogram descriptor (EHD).

Keywords - Content-based image retrieval, color, edge, image features, texture

I. INTRODUCTION

The demand and need for the digitalized data has been increased in the world. The technology has created huge amount of data in fields like education, forensics, geographical areas, fashion design, entertainment , medical diagnosis, image search on internet, art galleries etc. It is essential to characterize the data and to retrieve the data correctly. The image retrieval deals with the collection of number of images of various types. The image can be retrieved by using text-based method and content-based method. Conventional text-based image search engines apply manual annotation of images means images are explained manually. The Problem of this manual method was it requires big size of databases. Also enormous amount of labour involves in manual image annotation and it needs lot of time. An additional problem is of human perception. To overcome all these problems the content-based image retrieval comes into existence. The contents of an image can be color, texture, edge etc. Research activities in CBIR have steps forward in the following four directions:

1. Global image properties based, 2.Region-level features based, 3.Relevance feedback, 4.Semantic based. Variety of CBIR algorithms has been proposed and most of them focus on the likeness calculation stage to find a correct image or a group of images proficiently that are comparable to the given query [1].

In this paper we are focusing on finding the color, texture and edge features of an image required for the similarity measurement stage in the content-based image retrieval. To get the color information of an image the Hue, Saturation, and Value (HSV) color space is used. Also the mean and standard deviation of image pixels are calculated. For the texture feature the gray level co-occurrence matrix (GLCM) is used whereas to determine the edge features the edge histogram descriptor (EHD) is used.

The remaining paper is organized as follows. Section 2 contains the definition of the content-based image retrieval with block diagram. Section 3 explains about the image features and its extraction methods. Section 4 gives the experimental results and the section 5 gives conclusion.

II. CONTENT-BASED IMAGE RETRIEVAL

Content-based image retrieval (CBIR) is a system for retrieving images from the image database. The content-based image retrieval will be depending upon the different image features such as color, texture, edge or shape. The input can be a query image or sketched figures to the system. The block diagram for the content-based image retrieval is shown in Fig.1. By finding the similarities/differences between the feature vectors of input query image and the images in the database the retrieval can be achieved. The features of input query image are compared with the image features in the feature database [2].

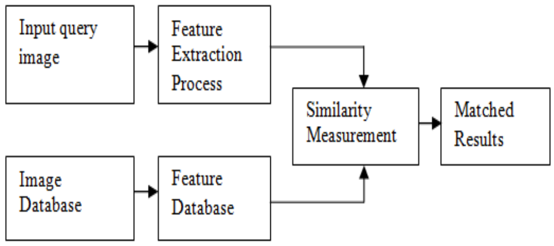

Figure1: Block diagram of content-based image retrieval system

III. IMAGE FEATURES

To retrieve images the system should be able to find the similarities between the input query image and the database image. There exist various methods to represent any of the visual features of an image. Depending upon the necessity and subjectivity one can use any of the visual features and its extraction method.

3.1 Color Feature Extraction Method

Color plays the vital role in determination of the visual feature of an image. It is one of the commonly used visual features in content-based image retrieval. By using three primaries of a color space a color image can be represented. The RGB color space does not communicate with the human way of perceiving the colors. It cannot perform the separation of the luminance component from the chrominance components. Hence we are using the Hue, Saturation, Value (HSV) color space in our approach. The advantages of HSV color space are given: HSV color space is having good compatibility with human intuition; it separates the chromatic and achromatic components [1]. In the HSV color space, Hue is used to represent the various colors present in the image, Saturation explains a measure of the percentage of white light added to a pure color in the image and value explains the perceived light intensity [3]. The color distribution of pixels has enough information in an image. The mean of pixel colors gives the main color of the image, and the standard deviation of pixel colors gives the difference of pixel colors. The mean (μ) and the standard deviation (σ) of a color image can be expressed as follows:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} P_i \qquad \text{- - - -(1)}$$

$$\sigma = \left[\frac{1}{N-1}\sum_{i=1}^{N}(P_i - \mu)^2\right]^{1/2} \qquad \text{- - - -(2)}$$

Where $\mu = [\mu H, \mu S, \mu V]^T$ and $\sigma = [\sigma H, \sigma S, \sigma V]^T$. Each component of μ and σ provides the HSV information, correspondingly. And Pi point to the i^{th} pixel of an image [4], [5]. In this way we can determine the color feature of an image.

3.2 Texture Feature Extraction Method

Texture is also helpful feature for expressing the image content. It contains essential information regarding the structural collection of surfaces and their relationship to their nearby environment. In our approach we are using the gray level co-occurrence matrix (GLCM) which belongs to the statistical technique to determine the texture feature [2]. There is relation between the co-occurrence matrix and the second-order statistical property of the sub band wavelet coefficients. The joint probability can be defined as the element (i, j) of the co-occurrence matrix, with parameters d and θ. There exists dependency among adjoining wavelet coefficients, hence d is normally small [6]. For representing the texture, gray level co-occurrence matrix, is a simple and efficient method. The GLCM provides the probability p (i, j; d, θ) of two pixels in an image, which are positioned at distance d and angle θ, which are having gray levels i and j. The GLCM mathematically expressed as follows:

$$p(i,j;d,\theta) = \#\{(x_1,y_1)(x_2,y_2) \mid g(x_1,y_1) = i,\ g(x_2,y_2) = j, |(x_1,y_1) - (x_2,y_2)| = d, \angle((x_1,y_1),(x_2,y_2)) = \theta\}$$

- - - - (3)

Here # represents the number of occurrences in the window. Intensity levels i and j are of a first pixel and second pixel at positions ($x1$, $y1$) and ($x2$, $y2$), correspondingly. We are finding the GLCM according to the one direction (i.e., θ = 0◦) and distance d (= 1), to make simpler computation and to decrease the computation effort [1].

3.3 Edge Feature Extraction Method

Edge is also an essential feature in extracting the image content. This feature can be expressed by using the histogram method. An edge histogram provides information concerning the frequency and brightness changes of an image within the image space [5]. We are determining the edge feature by implementing edge histogram descriptor (EHD) for description of edges in an image [1]. The stages involved in the EHD process are given below [7].

- An image is partitioned into 4 × 4 subimages.
- Further each subimage is partitioned into nonoverlapping image blocks having a small size.
- After that, those edges in each image block are classified as: vertical, horizontal, 45∘ diagonal, 135∘ diagonal and nondirectional edges.
- The histogram for each subimage corresponds to the relative frequency of occurrence of five types of edges in the respective subimage.
- All image blocks in a subimage are examined and after that, the five-bin values are normalized by the total number of blocks within a subimage. These normalized bin values are quantized for the binary representation. Finally the normalized and quantized bins constitute the EHD.

IV. Experimental Results

In this section the output for extraction of the color, texture and edge features of an image has been given. We can consider any image as query image from the database collected. There is not a standard image database for this system at current time. There is no agreement on the type of images and the number of images included in the database. The majority of image retrieval systems are proposed for the general databases [1]. The numerical value for the mean and the standard deviation of the pixels in the image will get as the output for color feature extraction. The graph will get for texture and edge feature extraction. Following Fig.2 gives how the GLCM has been determined. Fig.3 shows an example query image from the collected image database.Fig.4 shows the graph for the texture feature. The graph explains the relation between the number of occurrence of same change in gray levels of two adjacent pixels and maximum gray levels.Fig.5 gives the graph for the edge feature. It gives the relation between frequency and directionality in brightness changes in an image. The contents of an image can be extracted by using the above mentioned stages in the software Matlab. Feature extraction is significant step in efficient and accurate content-based image retrieval. In this way the extraction process of image features can be done which is required for the similarity computation of query images and data base images for content-based image retrieval.

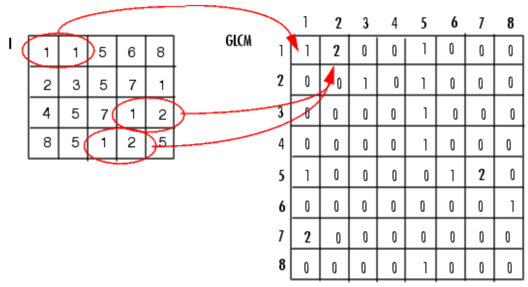

Figure 2: How to determine GLCM

Figure 3: Example Query Image

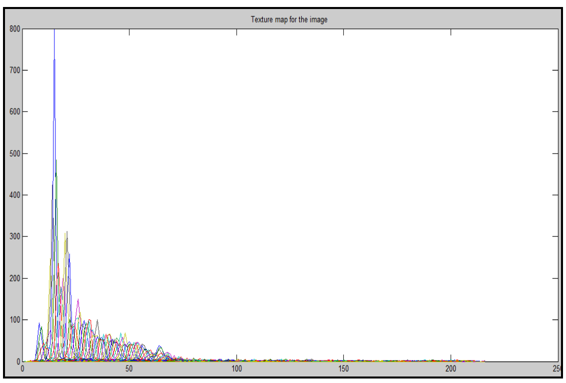

Figure 4: Texture Map for an Example Query Image

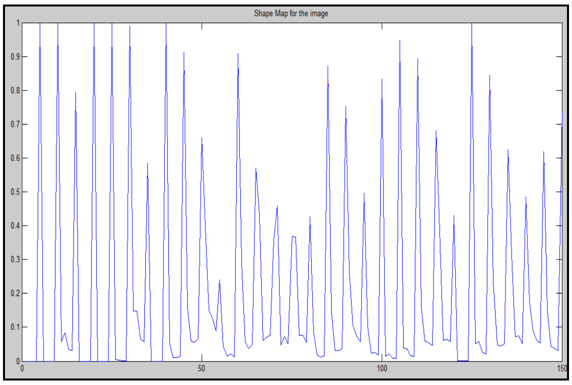

Figure 5: Edge Map for an Example Query Image

V. CONCLUSION

The content-based image retrieval is the field which is having applications in ample range. The CBIR system helps to handle the images in the different fields. The database for this system can be as per the user's requirement. This paper helps to find the contents of the image or extracts the visual features of the images from the collected image database. The similarity measurement of image features can be performed after the visual features extraction process. This paper mainly focused on the study of determination of the visual features of an image required for the content-based image retrieval. The future work can be advanced considering additional low-level or high level image descriptors to get to more closely to the user's anticipation of image retrieval and also to enlarge the retrieval accuracy of the content-based image retrieval system.

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