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MPEG-7 Edge Histogram Descriptor (EHD) for Advancement in CBIR System

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ABSTRACT

In design and development of any Content Based Image Retrieval (CBIR) system, feature extraction from image plays a vital role. Color, texture and shape are three important features that can used to represent an image. Efficiency of CBIR system is depends on feature extraction which effectively represents image contents. Instead of focusing on single feature, most of the recent CBIR system uses combinations of these features to represent an image. This paper introduces the concept and area of content based image retrieval system. It also includes the overview of basic MPEG-7 visual feature descriptor; edge histogram descriptor (EDH) to extract the contents from images. To enhance the result of CBIR system, the methodology combines color moments, color-correlogram and Gabor texture features along with edge orientation histogram.

Key words: CBIR, Feature Extraction, MPEG-7, Edge Histogram Descriptor (EDH)

INTRODUCTION

Due to rapid enhancement in digital technology, huge amount of digital information in the form of images and videos is available in recent years. Also gigabytes of new digital information are generated and transmitted every day [1-2]. Today's technology demands the use of this digital information in form of images in various domains including bioinformatics, medicine, entertainment, designing, advertisement and engineering sciences. All this visual information is useless, if there is no proper mechanism to effectively store and retrieve these images. In early days, images were represented by text and then text-based concept of traditional database management system was used to search and retrieve images. As the approach is based on text-based search, it is commonly known as Text-based Image Retrieval (TBIR) [3]. The problems in front of Text-Based image retrieval (TBIR) system became more severe, as volume of digital images produced increased dramatically in various fields of science and engineering. The other and main difficulty faced by this approach is to describe rich content in image manually. It is very expensive and obviously subjective task. This is driving force behind the emergence of Content Based Image Retrieval (CBIR) system [1&3]. In CBIR system manual representation of images by text- based key words is replaced by, their own visual content, such as color, texture and shape. Since 1990s, it is an active area of research and development. Exhaustive efforts have been undertaken by many researchers to build efficient and effective CBIR system. Most of the work in this area is focused on feature extraction, similarity matching, indexing (to sort output images based on certain attributes), relevance feedback (take users view to display the result) [1-2].

The aim of this paper is to focus on feature extraction using Edge Histogram Descriptor (EHD) [4]. EHD belongs to family of MPEG-7 descriptor standard which includes standardized tools to enable detail description of visual information. To develop more effective CBIR system, these techniques are combined with color moment, color auto-correlogram and Gabor texture features.

CONTENT BASED IMAGE RETRIEVAL SYSTEM

Application involving automatic indexing, searching, retrieving and browsing of image databases uses concept of Content based image retrieval (CBIR) systems. It is technique which uses visual content (color, shape and texture) of image to search large image database as per users' interest [1-2]. A typical CBIR system is as follows -

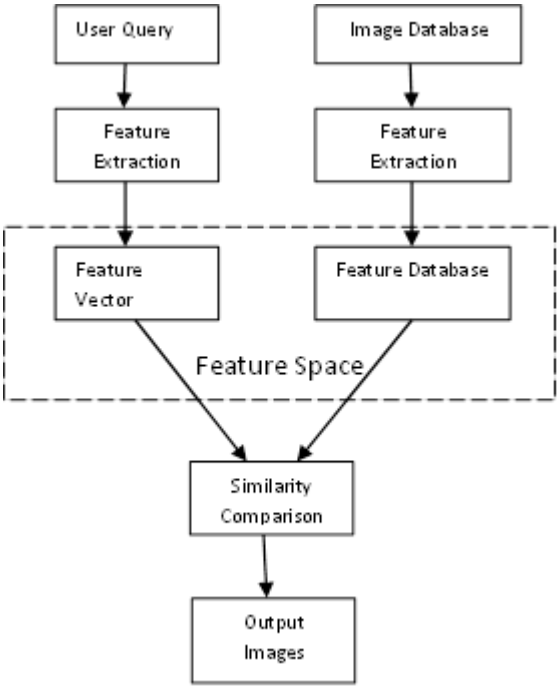

Fig. 1 A typical view of CBIR System

In CBIR system, the input query given by user is in the form of image. It has to search the relevant images similar to input image from image database. For this feature extraction of query image and images present in database is done based on certain visual features. It forms feature space (digital representation of image using visual feature). Then feature vector of query image is matched with feature vectors of images present in feature database. After similarity matching, most similar images result as an output. Thus in the CBIR system, the input given and output produced are both in form images [5].

EDGE ORIENTATION HISTOGRAM

In order to describe and interpret visual contents from images, MPEG-7 standard provides different Multimedia Descriptors. These MPEG-7 visual standard descriptors offer interoperability across different multimedia database systems [6]. MPEG-7 provides standardized descriptors for visual, audio and video retrieval. Main visual features descriptors are color descriptors, shape descriptors and texture descriptors. In the methodology widely used texture descriptor: Edge Histogram Descriptor (EHD) is applied to develop CBIR system.

The EHD [4][6] is used to characterizes edges in form of spatial distribution in an image. The process of feature extraction using EHD consists of following steps:

1. First digital image array is subdivided into equal 4X4 subparts/ sub image.
2. In next step, every subpart is further divided into square blocks which are not overlap on each other. The size of blocks is depending on the resolution of input image.
3. From every block the edge is calculated and its type is identified. There are six types of edges. The type of edge may be vertical, horizontal, 45◦ diagonal, 135◦ diagonal, no-direction edge and no-edge.

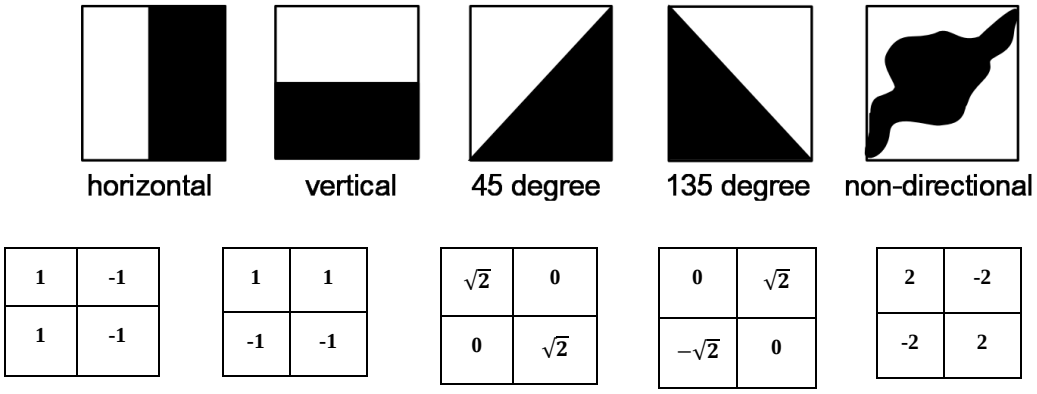

Fig. 2 Five types of edges and corresponding filters [7]

The first five edge types are detected using the filter coefficients illustrated in figure. 2. Information about no-edge blocks can be automatically obtained after the process of normalization.

4. By applying above steps, from every sub image 5-bin (vertical, horizontal, 45◦ diagonal, 135◦ diagonal, and no-direction) edge histogram is obtained.
5. Then normalization is used to calculate the value of each bin in the sub image. It is computed by normalizing total number of image blocks in the sub image.
6. Then nonlinear quantization of these normalized bin values is done. It helps to limit the number of bits sufficient for the descriptor.

By applying above steps, the texture features are extracted from the input image.

METHODOLOGY

In this paper, Edge Histogram Descriptor (EHD) of MPEG-7 is used to develop the Content Based Image Retrieval system. By using EHD the texture features of image are extracted [7][8]. Further to provide more effective system the approach combines color auto- correlogram, color moments and Gabor wavelet transforms along with EHD. The methodology to develop complete CBIR system contains following steps:

Step 1: All the images initially are stored in a directory, called image database. Directory of image database is selected first.
Step 2: With the process of normalization, all images in database are resized (set size of all images to 384 x 256).
Step 3: Compute the Edge Histogram Descriptor (EDH) by steps involved in extraction process mentioned above
Step 4: In this step Color Auto Correlogram is computed.
The color correlogram [2] is defined as: consider an image (I), with size n x m. let distance (d) is ϵ {1, 2,.....,n}, image I correlogram for i, j ϵ {1,2,.....,m} and k ϵ {1,2,.....d} is defined as

$$\gamma_{ci,cj}^{(k)}(I)=\Pr_{p1\in I_{ci},p2\in I}[P_2 \in I_{cj}|[P_1 - P_2] = K]$$

The color correlogram is represented by a tabled index with pair of colors; where probability of finding a pixel with color j at a distance k from a pixel with color i in the image, is determined by the kth entry for (i, j). It is important step in building image retrieval systems as this feature makes it more robust against large alteration in appearance of the same picture.

Step 5: In this step Color Moments [2] (here up to 3rd order) is calculated. Three orders are; first order (mean μ_i), the second order (variance σ_i) and the third order (skewnessS_i). Generally, image is recognized by distribution using color moments, when there is a certain probability distribution in color of image. Color distributions of images is efficiently and effectively represented by using color moments.

$$\mu_i = \frac{1}{N}\sum_{j=1}^{n} P_{ij} \ , \qquad \sigma_i = \left(\frac{1}{N}\sum_{j=1}^{n}\left(\left(P_{ij}-\mu_i\right)^2\right)^{\frac{1}{2}}\right) \ , \qquad S_i = \left(\frac{1}{N}\sum_{j=1}^{n}\left(\left(P_{ij}-\mu_i\right)^3\right)^{\frac{1}{3}}\right)$$

Step 6: In this step, widely implemented tool to extract image texture feature, Gabor wavelet [2] is used to compute mean amplitude and Mean squared energy. Based on this wavelet moment are calculated. There are many approaches suggested to interpret texture of images by using Gabor filters. Mostly CBIR systems develop using Gabor wavelet, feature vector is constructed by calculating mean and standard deviation of distribution of wavelet transform coefficients. A two dimensional Gabor function g(x, y) to represent texture features of image is defined as:

$$g(x,y) = \frac{1}{2\pi\sigma_x\sigma_y}\exp\left[-\left(\frac{1}{2}\right)\left(\left(\frac{x^2}{{\sigma_x}^2}\right)+\left(\frac{y^2}{{\sigma_y}^2}\right)+2\pi j w_x\right)\right]$$

Where σ_x and σ_y are the standard deviations along the x and y direction.
Step 7: All feature vectors constructed using EHD, Color Auto Correlogram, Color Moments, Mean amplitude, Mean Squared Energy, and wavelet moments of an image are combined. It generates the feature vector of that image.
Step 8: Steps 2 to 7 are applied to each image in database to calculate feature vector. Thus feature vectors of all images in database form the feature database.
Step 9: Through interface, user select Query image as an input.
Step 10: Using steps from 2 to 6 now generate feature vector for input query image (again using EHD, Color Auto Correlogram, Color Moments, Mean amplitude, Mean Squared Energy, and wavelet moments).
Step 10: Next step is to match feature vector of query image to feature vectors computed and stored in feature database (step 8). There are various measures are used to compute the similarity between the images. Here Euclidean distance [2] is used as similarity measure. After matching similar images are retrieved. Consider two feature vectors a and b. suppose a = (a1, a2, ..., an)T and b = (b1, b2,....., bn)T, the distance using Euclidean method is calculated as follows: $d_E = \sqrt{\sum_{i=1}^{n}(a_i - b_i)^2}$
Step 11: Similar images retrieved in step 10 are sorted based on similarity distance. Finally, most similar images are displayed as a result.

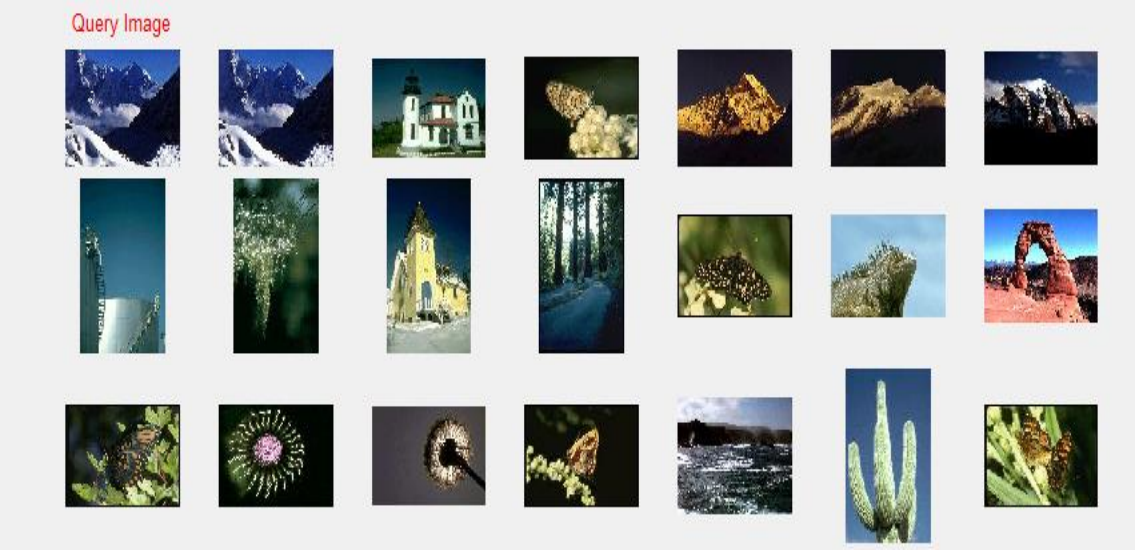

Fig. 3 Query Image and Output generated

RESULT AND DISCUSSION

The approach discussed here is implemented in MATLAB. The interface is developed which select image database and generate (load) feature database. Further user selects query image whose feature vector is compared with vectors in feature database and output is displayed. The system developed is tested on standard IMAGEVARY dataset containing 600 images.After giving query image as an input, the system gives output after indexing (sorting). The first 20 images are displayed here. It is observed that the system after combining many features like EHD, Color Auto-correlogram, color moment and Gabor wavelet transform generate the effective output.

CONCLUSION

Image feature extraction is main issue in developing any CBIR system. Feature extracted must effectively represent and interpret the image contents in a database. If number of features are combined together to generate the feature space, the image content can more effectively represented. Hence it will result in effective CBIR system.The methodology presented here uses MPEG-7 Edge Histogram Descriptor (EHD), as main feature extraction technique. For further improvement, these features extracted are combined with Color Auto-correlogram, color moment and Gabor wavelet transform. The system developed using the approach is effective to represent any image contents and eventually generates good output.

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