Content Based Image Retrieval Using Sketches

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Abstract. This paper aims to introduce the problems and challenges concerned with the design and creation of CBIR systems, which is based on a free hand sketch (Sketched based image retrieval-SBIR). This analysis led us to studying the usability of a method for computing dissimilarity between user-produced pictorial queries and database images according to features extracted from Gray-Level Co-occurrence Matrix (GLCM) automatically.

CBIR is generally characterized by the methods that consumes less time. Hence fast content – based image retrieval is a need of the day especially image mining for shapes, as image database is growing exponentially in size with time. In this paper, texture features extracted from GLCM, tested, and investigated on different standard databases is proposed, it exhibits invariant to rotation. The retrieval performance of the proposed method is showed for both the dinosaurs retrieval efficiency achieved about 95% and precision also 95% where color is not dominant. It is also observed that the proposed method achieved low retrieval performance over these four image features for sketch based and color dominant images. This process can be used as coarse level in hierarchical CBIR that reduces the database size from very large set to a small one. This tiny database can further be scrutinized rigorously using the Edge Histogram Descriptor (EHD) and Color and Color Co-occurrence Matrix (CCM) etc.

1 Introduction

The growing of data storages and revolution of internet had changed the world. The efficiency of searching in information set is a very important point of view. In case of texts we can search flexibly using keywords, but if we use images, we cannot apply dynamic methods. Two questions can come up. The first is who yields the keywords. And the second is an image can be well represented by keywords. In many cases if we want to search efficiently some data have to be recalled. The human is able to recall visual information more easily using for example the shape of an object [9, 12, 13], or arrangement of colors and objects. Our purpose is to develop a content based image retrieval system, which can retrieve using sketches in frequently used databases. The user has a drawing area where he can draw those sketches, which are the base of the retrieval method [4, 8, 11]. Using a sketch based system can be very important and efficient in many areas of the life. In the following paragraph some application possibilities are analyzed. The CBIR systems have a big significance in the criminal investigation. The identification of unsubstantial images, tattoos and graffities can be supported by these systems. Similar applications are implemented in [5, 6, 7].

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Another possible application area of sketch based information retrieval is the searching of analog circuit graphs from a big database [3].

The Sketch-based image retrieval (SBIR) was introduced in QBIC [2] and Visual SEEK [10] systems. In these systems the user draws color sketches and blobs on the drawing area. The images were divided into grids, and the color and texture features were determined in these grids. The applications of grids were also used in other algorithms, for example in the edge histogram descriptor (EHD) method [1]. The disadvantage of these methods is that they are not invariant opposite rotation, scaling and translation.

2 Proposed Architecture

The objective of the proposed work in this paper is to study the texture features from GLCM as effective features for CBIR. CBIR system retrieves the relevant shapes from the image database for the given query sketch image or original image by computing the features of the query image and comparing with similar feature set of corresponding images in the database. Relevant shapes having minimum distance (or maximum similarity) computed between features of query image and feature set in image database are retrieved.

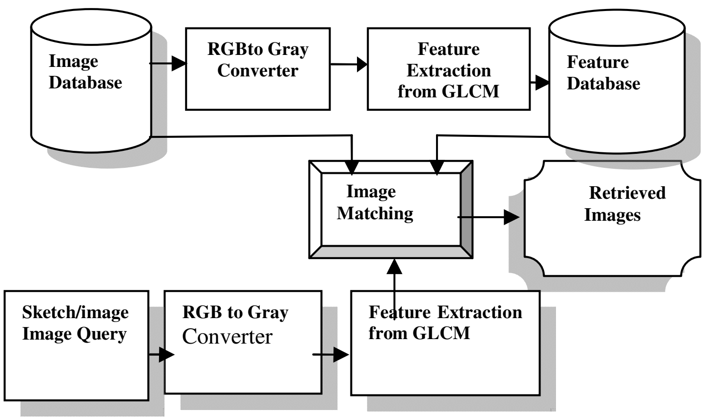

Fig. 1. Architecture of the system

2.1 The Purpose of the System

Even though the measure of research in sketch-based image retrieval increases, there is no widely used SBIR system. Our goal is to develop a content-based associative search engine, which databases are available for anyone looking back to freehand drawing. CBIR is generally characterized by the methods that consumes less time. Hence fast content – based image retrieval is a need of the day especially image mining for shapes, as image database is growing exponentially in size with time. In this paper, texture features extracted from GLCM is proposed and tested on standard databases, it exhibits invariant to rotation. This process can be used as coarse level in hierarchical CBIR that reduces the database size from very large set to a small one. This tiny database can further be scrutinized rigorously using the Edge Histogram Descriptor (EHD), the histogram of oriented gradients (HOD), and Color and Color Co-occurrence Matrix (CCM) etc. In our system the iteration of the utilization process is possible, by the current results looking again, thus increasing the precision.

Examine the data flow model of the system from the user's point of view. It is shown in Figure 1. First the user draws a sketch or loads an image. When the drawing has been finished or the appropriate representative has been loaded, the retrieval process is started. The content-based retrieval as a process can be divided into two main phases. The first is the database construction phase, in which the texture features are extracted from GLCM and stored in the form of feature vectors – this is the off-line part of the program. This part carries out the computation intensive tasks, which has to be done before the program actual use. The other phase is the retrieval process, which is the on-line unit of the program.

The performance of the proposed CBIR system is tested by retrieving the specified number of shapes from the database. The average retrieval rate and retrieval time are the main performance measures in the proposed CBIR system. The average retrieval rate is known as the percentage average number of shapes belonging to the same image as the test (query) shape in the top 'N' matches. 'N' indicates the number of retrieved shapes.

3 Texture Feature Extraction Based on GLCM

GLCM creates a matrix with the directions and distances between pixels, and then extracts meaningful statistics from the matrix as texture features. GLCM texture features commonly used are shown in the following:

GLCM is composed of the probability value, it is defined by $p(i, j \mid d, \theta)$ which expresses the probability of the couple pixels at θ direction and *d* interval. When θ and *d* is determined, $p(i, j \mid d, \theta)$ is showed by $P_{i,j}$. Distinctly GLCM is a symmetry matrix; its level is determined by the image gray-level. Elements in the matrix are computed by the equation showed as follow:

$$P(i, j \mid d, \theta) = \frac{P(i, j \mid d, \theta)}{\sum_i \sum_j P(i, j \mid d, \theta)} \tag{1}$$

GLCM expresses the texture feature according the correlation of the couple pixels gray-level at different positions. It quantificationally describes the texture feature. In this paper, four features is selected, include energy, contrast, entropy, inverse difference.

$$\text{Energy } E = \sum_x \sum_y P(x, y)^2 \tag{2}$$

It is a gray-scale image texture measure of homogeneity changing, reflecting the distribution of image gray-scale uniformity of weight and texture.

$$\text{Contrast} \quad I = \sum \sum (x-y)^2 P(x,y) \tag{3}$$

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

$$\text{Entropy} \quad S = -\sum_x \sum_y P(x,y) \log P(x,y) \tag{4}$$

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

$$\text{Inverse difference} \quad H = \sum_x \sum_y \frac{1}{1+(x-y)^2} P(x,y) \tag{5}$$

It measures local changes in image texture number. Its value in large is illustrated that image texture between the different regions of the lack of change and partial very evenly. Here $p(x, y)$ is the gray-level value at the coordinate (x, y).

3.1 Distance Metric for Similarity Measure

In conventional image retrieval technique, Euclidean distance is used to find the similarity between the query image and image database. Similarity score is used to find the best match of query image from the database image. The distance metric gives minimum distance between the query shape and its nearest shape in the database is the best metric. For better classification, the maximum intra-class distance should be less than the minimum of the inter-class distances. We assume P and Q represent the feature vectors for database image and query image respectively in each distance metric. The present work evaluates and compares the CBIR performance for computing distance d (P, Q) using the following distance metrics:

3.1.1 Euclidean L_2 Distance

Euclid stated that the shortest distance between two points on a plane is a straight line and is known as Euclidean distance. Euclidean distance metric as in equation (6) was often called Pythagorean metric since it is derived from Pythagorean Theorem. Euclidean distance metric is defined for p=2. In Euclidean distance metric difference of each feature of query and database image is squared which increases the divergence between the query and database image.

$$d_{Euc}(P,Q) = \sqrt{\sum_{j=1}^{N} | P_j - Q_j |^2} \tag{6}$$

4 Experimental Results and Analysis

In this paper, the system was tested with more than one sample database to obtain a more extensive description of its positive and negative properties. The first test was conducted by selecting sketch image as query images from the Database, the system was tested for top 20-retrieved images; the database consists of 20 images with 5 versions of rotation of each image, and the results have been shown for two different dinosaur sketch mages in Figure (2) and (3). For both the dinosaurs Retrieval efficiency achieved about 95% and Precision also 95%.

The second test was conducted on dataset contains 1000 images from Wang Database of images, divided into 10 categories, each category has 100 images. By selecting query images from the Database, the system was tested for top 20-retrieved images; and the results have been shown for bus and flower images in Figure (4) and (5). Low retrieval efficiency has been achieved; hence, this process can be used as coarse level in hierarchical CBIR that reduces the database size from very large set to a small one. The third test was conducted on dataset contains 15 images from Scene categories Database and 10 images from Wang Database with 5 versions of rotation of each image, and the results have been shown for two different sketch images in Figure (6) and (7). This process also can be used as coarse level in hierarchical CBIR that reduces the database size from very large set to a small one.

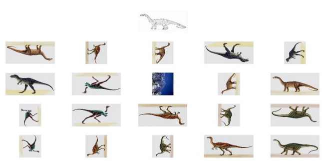

Fig. 2. Shows Top 20 retrieved images based on Dinosaur Sketch image as query image

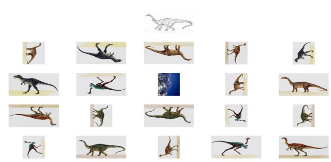

Fig. 3. Shows Top 20 retrieved images based on another Dinosaur Sketch image as query image

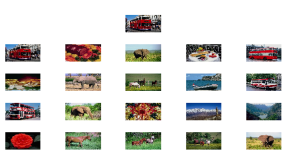

Fig. 4. Shows Top 20 retrieved images based on bus image as query image

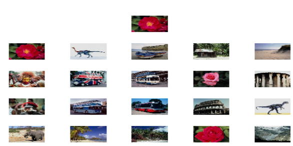

Fig. 5. Shows Top 20 retrieved images based on flower image as query image

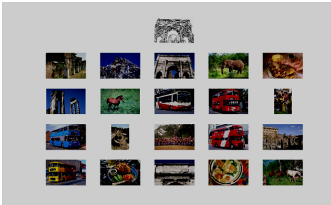

Fig. 6. ShowsTop20 retrieved images based on sketch image as query image

Fig. 7. Shows Top 20 retrieved images based on another sketch image as query image

5 Conclusion

We have proposed system architecture for the Content Based Image Retrieval by Gray level Co-occurrence Matrix (GLCM) derived four image features. The retrieval performance of the proposed method is showed in Figures (2) and (3). For both the dinosaurs Retrieval efficiency achieved about 95% and Precision also 95%. In this work, it is observed that the proposed method achieved low retrieval performance over these four image features for sketch based and color dominant images showed in Figure (4-7). The future work will focus on improved retrieval performance of sketch and color dominant images by exploring additional image features. Further, a research is in progress to improve the method aiming to increase the retrieval rate.

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