EVALUATION OF CBIR APPROACHES FOR DIFFERENTLY SIZED IMAGES

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Abstract

CBIR is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. An experimental comparison of a number of different color descriptors for evaluation of CBIR approaches for differently sized images is presented in this paper. Color descriptors are considered for retrieval. The primary goal is to determine which approach is most efficient in representing the similarity of color images which are not same in size, though their aspect ratio is same. In this paper, we present the comparison of different color descriptors. For the purpose we have used Global Color Histogram (GCH), Local Color Histogram (LCH) and Color average. Publicly available image database is used and the retrieval performance of the features is analyzed in detail. The work is concluded by stating which method performs well.

Keywords

Image Retrieval, Image Size, Color Histogram, Correlation

1. Introduction

With advances in the computer technologies and the advent of the World-Wide Web, there has been an explosion in the amount and complexity of digital data being generated, stored, transmitted, analyzed, and accessed [Nandagopalan *et al* (2008)]. Much of this information is multimedia in nature, including digital images, video, audio, graphics, and text data. In order to make use of this vast amount of data, efficient and effective techniques to retrieve multimedia information based on its content need to be developed [Muda *et al* (2009)].

Understanding the nature and scope of image data plays a key role in the complexity of image search system design. Images need to be organized by summarizing their visual descriptors. A descriptor is an attribute that can capture a certain visual property of an image either globally for the entire image or locally for regions or objects [Smulders *et al* (2000)]. Color, texture and shape are commonly used features in CBIR systems. A key task in any CBIR system is the feature extraction. Mapping the image pixels into the feature space is known as feature extraction [Datta *et al* (2008)]. This information, also known as feature vector, represents images in data base and used for searching.

In retrieval stage, query image is also represented in the form of a feature vector and the similarity between the query vector and stored feature vectors is computed [Rui and Huang (1997)]. The similarly measure is used to determine the distance between the query image and stored images. After that images are ranked according to the distance and retrieved [Chitkara *et al* (2000)].

In this paper, we represent images by color descriptors. We compare the effectiveness and efficiency of these color descriptors in representing visual features when the sizes of test image and database images are different.

2 Methods and Materials

RGB color model is used for this work. In order to evaluate the effectiveness and efficiency of color features the following color descriptors are considered.

2.1 Color Features

Color is a widely used important feature for image representation. This is very important as it is invariant with respect to scaling, translation and rotation of an image. Color space, color quantification and similarity measurement are the key components of color feature extraction.

Color moments

Color moments are measures that can be used differentiate images based on their features of color. Once calculated, these moments provide a measurement for color similarity between images. The mean, variance and standard deviation of an image are known as color moments[10]. Following equations define the mean, variance and standard deviation of an image. An image therefore is characterized by 9 moments 3 moments for each 3 color channels. We will define the ith color channel at the jth image pixel as p_{ij}

$$E_i = \sum_{j=1}^{n} \frac{1}{n} p_{ij} \tag{1}$$

Mean can be understood as the average color value in the image.

$$\sigma_i = \sqrt{\left(\frac{1}{n} \sum_{i=1}^{n} \left(p_{ij} - E_i \right)^2 \right)} \tag{2}$$

The standard deviation is the square root of the variance of the distribution.

$$s_i = \sqrt[3]{\left(\frac{1}{n} \sum_{j=1}^{n} \left(p_{ij} - E_i \right)^3 \right)} \tag{3}$$

Skewness can be understood as a measure of the degree of asymmetry in the distribution.

Color Histogram

A histogram is the distribution of the number of pixels for an image[1]. The number of elements in a histogram depends on the number of bits in each pixel of an image. For example, if we consider a pixel depth of n bit, the pixel values will be in between 0 and 2^n-1, and the histogram will have 2n elements.

Similarity measurements

Similarity measurement is a means of evaluating CBIR algorithms efficiency. These algorithms search image database to find images similar to a given query image. The amount of similarities between images must be evaluated according to certain metrics. Hence, the feature vectors, extracted from the database image and from the query, are passed through a distance function d. The objective of any distance function (or similarity measure) is to find how feature vectors are close to each other. There exist several common techniques for measuring the distance (dissimilarity) between two N-dimensional feature vectors p and q. Each technique has some important characteristics related to an application. We have used the following [Chengjun Liu (2003), Adjeroh *et al* (2001)] -

The Euclidean metric is obtained as:

$$d(p,q) = \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2} \tag{4}$$

Coefficient of Correlation:

$$d_k(p,q) = \frac{\sum_{i=1}^{n} (q_i - q)(p_i - p)}{\sqrt{\sum_{i=1}^{n} (q_i - q)^2 \sum_{i=1}^{n} (p_i - p)^2}} \tag{5}$$

A general purpose image database of 5500 images chosen from different categories is used. The images are stored in JPEG format with size 440X320 and the RGB color model in used. Color feature vectors for each image have separately been computed and stored in a database.

In this work, the ratio of relevant retrieved images to the total number of retrieved images (precision) and the ratio of retrieved relevant images to the total number of relevant images in the database (Recall) are used to evaluate the color features.

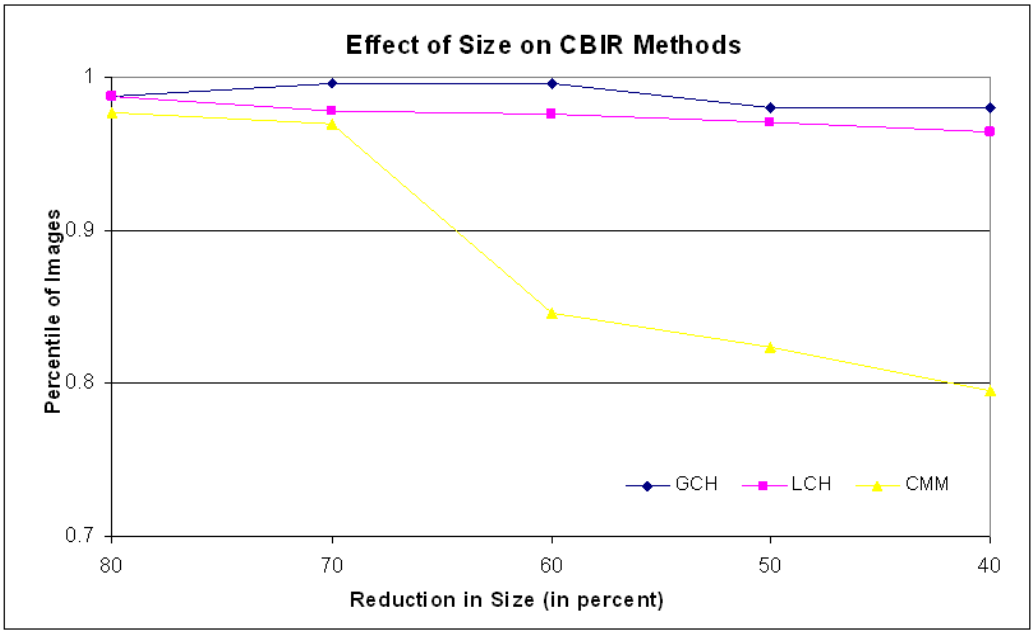
2.2 Methodology

The relevant images are identified based on different color features. The histogram based image retrieval consists of two techniques: Global Color Histograms (GCH) and Local Color Histograms (LCH). The GCH represents images with single histogram. First the GCHs of database images are computed and stored them in a database. Then the GCH of the query image is computed. The Euclidian distance metrics is used to measure the similarity between the query image and the database images. In order to identify the relevant images a fixed threshold is used. In case of LCH, images are divided into 16 equal blocks. For each block, its color histogram is obtained. The same procedure followed for GCH is applied for identifying the relevant images. In third approach, Color Middling Method (CMM), the images are divided into blocks of 10x10 pixels and representative color of each block is stored in database.

In proposed system we have prepared a database which has a number of images. The user inputs query image. Low level features are then extracted for query image. Similarity distances are measured and calculating linear coefficient of correlation between query image and images in database. On the basis of coefficient of correlation two categories (relevant and irrelevant) are formed. The images from database on the basis of similarity ranking are taken and shown to the user.

3. Results and Discussion

A general purpose image database consists of 5500 images is used for the experiment[11-15]. The database consists of different categories such as Desert, Flowers, Snow, Mountains and Movie sequences. All the categories are used for retrieval. These images are stored in JPEG format with size 440X320 and each image is represented with RGB color space. In order to measure retrieval effectiveness for an image retrieval system, precision and recall values are used. Five different images of each category are used as query images. These images are selected so that some of them have uniform color distribution, some others have non-uniform color distribution and the other having average color distribution. Once the images are retrieved, the parameters are fixed. Now the test image is reduced in different sizes and the tests are run again to retrieve images. Graph 1 summarizes the experiment results.



Graph 1: Effect of size on CBIR methods

4. Conclusions

An experimental comparison of a number of different color descriptors for content-based image retrieval was carried out for differently sized images. The retrieval efficiency of the color descriptors was investigated by means of recall and precision.

According to the results obtained it can be said that global color histogram, and local color histogram approaches produced almost same results till the test images are reduced to 40 percent, where as the performance of other approach CMM has reduced significantly when the size is reduced below 70 percent. The performance depends on the color distribution of images. The test results indicate that color histogram performs well compared to other descriptors when images have mostly uniform color distribution.

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