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Higher Image Retrieval Efficiency Using Color Features

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Abstract

Image retrieval techniques are useful in many image processing applications. Content based image retrieval systems works with whole images and searching is based on comparison of the query. In this paper we present a novel frame work for the color information and achieve higher retrieval efficiency using dominant color feature. An image is partitioned into sub blocks of equal size as a first step. Color of each sub block is extracted by using the RGB color space. A one to one matching scheme is used to compare the query and target images. Minkowski distance is used to retrieving the similar images. The experimental results demonstrate the efficiency of the method.

Keywords: Content based image retrieval (CBIR), dominant color descriptor (DCD), Similarity measure.

1. Introduction

Now a days, people are interested in using digital images. So the size of the image database is increasing enormously. Lot of interest is paid to find images in the database. There is a great need for developing an efficient technique for finding the images. Hence, content based image retrieval (CBIR) has been a very active research topic in the last decade. CBIR[1] usually indexes images by low level visual features such as color, texture and shape. The important task of CBIR is extraction of good visual features which represents a query image.

Color is one of the most reliable used low level visual features and is invariant to image size and orientation. The use of low level visual features is to retrieve relevant information from image databases. The MPEG-7 consists of number of histogram descriptors and dominant color descriptors[2]. MPEG-7 specifies seven color descriptors. It consists of color space, color quantization, dominant colors, scalable color histogram, color structure, color layout and GOF/GOP color. The dominant colors are used to reduces the quality of image content. In this paper, we will implement an effective representative color quantization algorithm and improve the similarity measure for DCD[4]. The DCD contains two main components, they are

1. Representative colors and
2. Their percentages in the image or region.

Texture is another important visual feature that has been intensively studied in pattern recognition. It refers the surface properties of an object and their relationship to the surrounding environment. Texture consists of some basic primitives, and also describes the structural arrangement of a region and the relationship of the surrounding regions. Texture features can be classified into two categories, firstly spectral features such as Gabor filter and discrete wavelet transformation. Secondly, statistical features such as wold feature tamura feature and gray level co occurrence matrix representation.

Shape features can also provide powerful information for content based image retrieval. Humans can recognize objects solely from their shapes. The shape features are different from other elementary visual features, like color or texture features. The shape features[8] can be classified into two categories, firstly boundary based and secondly region based. Invariant moments are then used to record the shape features.

The some applications of the content based image retrieval are Fingerprint identification, crime prevention, biodiversity information systems, digital libraries, historical research, fashion and graphic design, publishing, advertising and medicine.

The basic difference between textual and visual information is the nature of retrieval process. The retrieval of textual information is based on discovering semantic similarity between textual entities. The visual information retrieval is based on discovering perceptual similarity.

The concept of perceptual similarity is made by examining the type of queries that users to use when retrieving images from the image databases. The fig 1 represents the Block diagram of the content based image retrieval (CBIR).

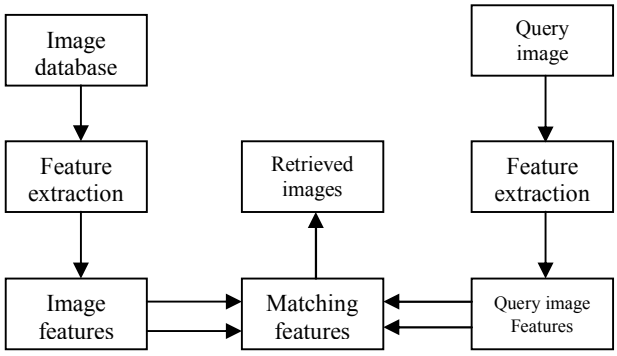

Fig 1 Block Diagram of CBIR

This paper is organized as follows. The second section introduces the color quantization. The third section contains the description of similarity measure for image retrieval. The fourth section describes the experimental results and some performance evolutions. Some concluding remarks are given in the last section.

2. Color Quantization

To generate the dominant colors from an image, a color quantization algorithm has to be pre determined. The colors of an image are very common to use the modified generalized Lioyd algorithm or fast color quantization algorithm with clusters merging. And then a small number of representative colors and their percentages of an image can be obtained. For simplicity without loss of generality the RGB color space is used. The RGB color space consists of three primary color components R(Red), G(Green) and B(Blue).

2.1 Algorithm

The following steps describe the process of Fast color quantization algorithm.

1. Select the images from the image database with each image having size of m x n x 3.
2. Resize the images into 128 x 128 x 3
3. Separate RGB spaces from images.
4. Divide the images into 8 coarse partitions. They can be $\{I_1, I_2, I_3 \ldots\ldots I_i\}$ where i = 8.
5. The centroid of each partition can be selected as its dominant color.
6. Calculate the average value of each partition center using the following formula.

$$\overline{Z_i} = \frac{\sum_{z \in O_i} Z}{\sum_{z \in O_i} I} \quad (1)$$

7. The quantized color of each partition center is

$$O_i = \left(\overline{Z_i}^R, \overline{Z_i}^G, \overline{Z_i}^B\right) (1 \leq i \leq 8) \quad (2)$$

8. Calculate the difference between two diagonal intensity probabilities let be $\{ X_{i+1}. X_{j+1} - X_i. X_j \}$ where X = R, G,B respectively and I, j = 1,2,3…….. N.
9. Check whether it is less than T_d, merge the similar colors.

$$Z^R = Z_1^R \times \left(\frac{P_{R,1}}{P_{R,1} + P_{R,2}}\right) + Z_2^R \times \left(\frac{P_{R,2}}{P_{R,1} + P_{R,2}}\right)$$

$$Z^G = Z_1^G \times \left(\frac{P_{G,1}}{P_{G,1} + P_{G,2}}\right) + Z_2^G \times \left(\frac{P_{G,2}}{P_{G,1} + P_{G,2}}\right) \quad (3)$$

$$Z^B = Z_1^B \times \left(\frac{P_{B,1}}{P_{B,1} + P_{B,2}}\right) + Z_2^B \times \left(\frac{P_{B,2}}{P_{B,1} + P_{B,2}}\right)$$

Where P_R, P_G, P_B represents the percentages in R, G and B components respectively.

10. The merge process is repeated until the difference between diagonal intensity probabilities is greater than T_d.
11. Calculate the mean and standard deviation.
12. Store the two features of every image in the database in training.
13. Repeat the same procedure for query image.
14. Calculate the mean and standard deviation of query image.
15. Minkowski distance is used to retrieve the similar images from the image database.

In our paper, we set the T_d as 25 and T_m as 6%, and the sum of P_i =1. As a result we obtained a set of dominant colors and the final number of dominant colors is constrained to 4-5 on average.

3. Similarity Measure

The color features are extracted, the retrieval system stores these feature vectors, calculate the similarity between the

combined feature vector of the query image and that of each target image in the image database, and retrieves the number of most similar target images.

3.1 Color feature similarity

The color feature similarity measure is given by

$$S_{color}(Q,I) = \sum_{i=1}^{N_Q} \sum_{j=1}^{N_I} d_{i,j} S_{i,j} \quad (4)$$

Where N_Q and N_I denotes the number of dominant colors of the query image Q and the target image I respectively.

When retrieving the images we calculate the similarity between the query image and each target image in the image database, and then sort the retrieval results according to the similar value using minkowski distance.It is given by

$$\text{Minkowski Distance} = \left(\sum_{i=1}^{n} |x_i - y_i|^p\right)^{1/p}$$

Where n is the number of samples and P is the order
P=1 for Manhattan distance, P=2 for Euclidean distance

The following figure represents the flowchart of color based image retrieval for the proposed method.

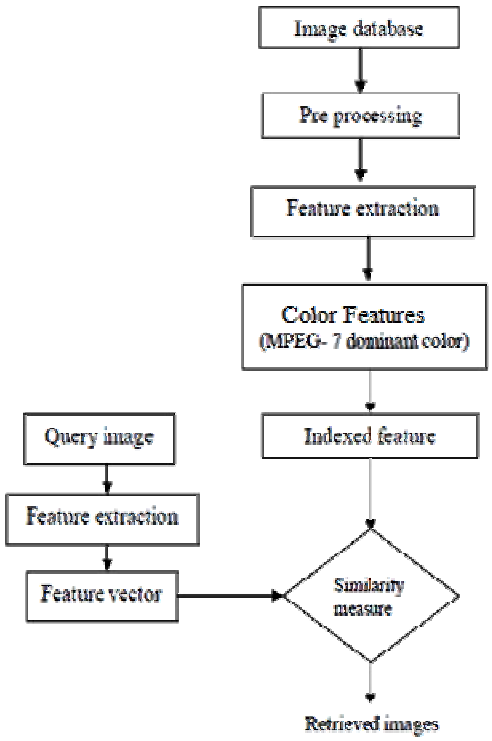

Fig.2 Flow chart of the proposed method.

4. Experimental Results

In this paper, we have tested the performance with a general purpose image database that consists of 11000 images of 110 categories from the corel image gallery. Corel images have been widely used by the CBIR research communities.

In order to conform the validity of the proposed algorithm we random the selected 40 images as query images from the corel image database. Each kind is extracted 5 images and each type returns the first 10 most similar images as retrieval results.

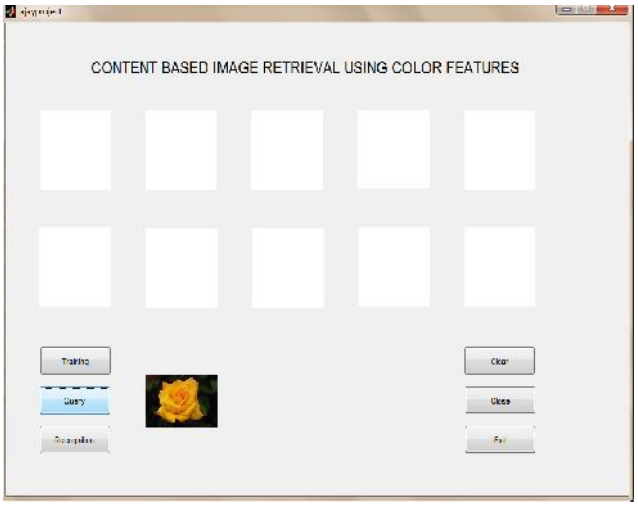

Fig.3 Sample image from corel database.

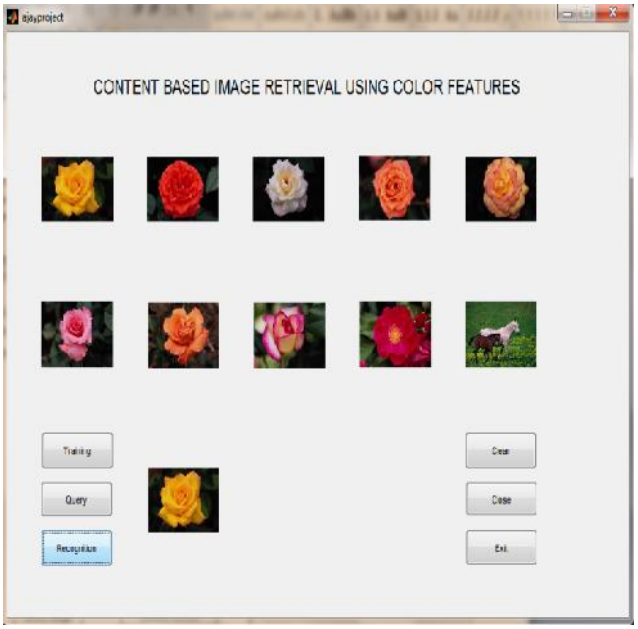

Fig.4 Retrieved images.

Table 1 Recognized rate on corel data base

	Number of top matches				
Methods	1	3	5	7	10
Variance	100	58.5	50.5	44.2	36.25
MPEG-7 DCD (proposed)	100	80	76	72.5	65.75

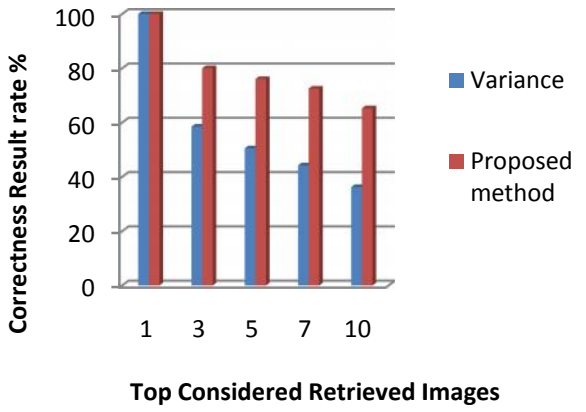

Fig 5. Comparative recognition rates

5. Conclusions

The CBIR has become an important research field in pattern recognition, image processing and computer vision. In this paper, we proposed the MPEG-7 dynamic dominant color feature using RGB color space. Experimental results show the proposed method yields higher retrieval accuracy than other methods. As further studies the proposed retrieval method is to be evaluated for more various databases and applied to video retrieval.

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