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# CBIR BASED ON COLOR AND TEXTURE

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In this paper a generalized approach for image retrieval based on semantic contents is presented. The method presents feature extraction techniques namely color and texture histogram descriptor. There is a provision to add new features in future for better retrieval efficiency. Any combination of these methods, which is more appropriate for the application, can be used for retrieval. The image properties are analyzed in this work by using image processing algorithms. For color the histogram of images is computed, for texture histograms of image are computed and entropy, smoothness and uniformity are calculated. For retrieval of images Euclidean distance measure is used. The system was tested on Corel database on only a fixed size images and with some modification can be applied to variable size images also.
Keywords: Content Based Image Retrieval (CBIR), Histogram, Feature Vector, Euclidean Distance

## 1. Introduction

Content Based Image Retrieval (CBIR) is a technique which uses visual contents, normally known as features, to search images from large scale image databases according to users' requests in the form of a query image. The commercial image search engines available as on date are [1, 8]: QBIC, VisualSeek, Virage, Netra, PicSOM, FIRE, AltaVista, etc. Region-Based Image Retrieval (RBIR) is a promising extension of CBIR. Almost all the CBIR systems designed so far widely use features like color, shape, textures, and spatial all together or few of these.

In this paper, generalized texture and color feature extraction algorithms are discussed. Their relative performance is also discussed. The focus of this paper is to compare CBIR on the basis of color and texture features based on histograms. This comparison is based on the statistical parameters obtained from the H.S.V channel of the image. The parameters include mean, median, and standard deviation of Red, Green, and Blue channels of color histograms. Then the texture features such as mean, second moment, third moment, forth moment, smoothness, uniformity are retrieved. Finally the comparison between these two techniques is discussed.

The rest of the paper is organized as follows. Since there was lot of work done in this area, a comprehensive survey of CBIR is dealt in Section II. Section III describes the overview of the proposed CBIR framework. Section IV and V focuses on extraction of color, texture features respectively. In Section VI, experimental setup and result is discussed. In section VII scope for future work is mentioned.

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## 2. Literature Review

Early work on image retrieval can be traced back to the late 1970s. In 1979, a conference on Database Techniques for Pictorial Applications was held in Florence [1]. Since then, the application potential of image database management techniques has attracted the attention of researchers. In the early 1990s, as a result of advances in the Internet and new digital image sensor technologies, the volume of digital images produced by scientific, educational, medical, industrial, and other applications available to users increased dramatically [2]. It is observed that there has been an exponential increase in computing power and storage capacity. The difficulties faced by text-based retrieval became more and more severe. The efficient management of the rapidly expanding visual information became an urgent problem.

## 3. Proposed CBIR Model

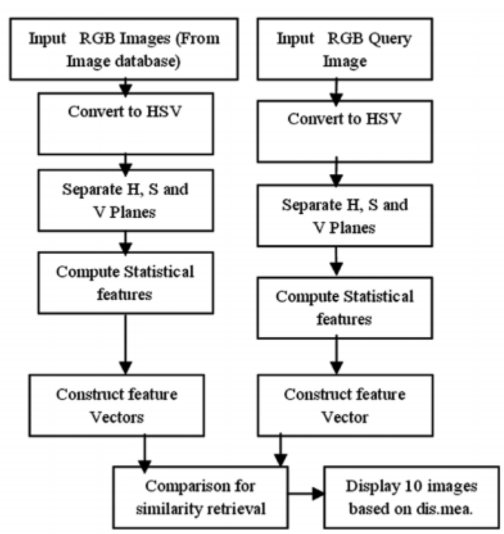


Fig. 1: Proposed CBIR Model

The proposed CBIR framework is shown in Figure 1. The images are kept in a database called Image Database. After preprocessing, images are segmented. Only the dominant segments are considered for feature extraction namely color histogram features and texture features. Then a single feature vector is constructed. When a query image is submitted by the user, the feature vector for the query image is obtained by same procedure.. For similarity comparison between the query image and the database image, the Euclidean distance method is used. Using an appropriate threshold, images that are semantically closer are retrieved from the database and displayed.

## 4. Color

In image retrieval systems color histogram is the most commonly used feature. The main reason is that it is independent of image size and orientation. Also it is one of the most straight-forward features utilized by humans for visual recognition and discrimination. Statistically, it denotes the joint probability of the intensities of the three color channels [9]. The original RGB image is converted into HSV image because RGB color model is not suitable for describing colors in terms that are practical for human interpretation [9]. Then the image is quantized.. All the three planes that is H plane, S plane and V planes are separated [8]. Each plane is now a two dimensional image matrix of a fixed size i.e. 384X256. This image matrix is now partitioned into 96 cells each having dimensions 32X32. Although this process involves large number of computations and also computation time increases but it outputs better retrieval efficiency. For each partitioned cell histogram is plotted and statistical data is extracted from histogram. The major statistical data that are extracted are histogram mean, standard deviation, and median for each channel i.e. Hue, Saturation and Value.

Let z be a random variable denoting gray levels and let $p(z_i)$, i = 0,1,2,3,…,L – 1, be the corresponding histogram, where L is the number of distinct grey levels. Then the $n^{th}$ moment of z about the mean is

$$\mu_n(z) = \sum_{i=0}^{L-1} (z_i - m)^n \, p(z_i) \qquad (1)$$

where m is the mean value of z that is the average gray level.

$$m = \sum_{i=0}^{L-1} (z_i)\, p(z_i) \qquad (2)$$

The second moment is variance and it plays a important role in the texture description. The square root of variance is known as standard deviation.

The median $\xi$ of a set of values is such that half the values in the set are less than or equal to $\xi$, and half are greater than or equal to $\xi$.

So totally 96X3 = 288 features per channel are obtained.. Thus total number of features obtained per image will be equal to 288X3 = 864. In order to reduce computation time only dominant cells can be considered, and it may not significantly affect the end result.

## 5. Texture

There is no precise definition for texture. However, one can define texture as the visual patterns that have properties of homogeneity that do not result from the presence of only a single color or intensity [1]. The texture descriptors provide measure of properties such as smoothness, coarseness and regularity [8]. Statistical approaches yield characterization of texture as a smooth, coarse, grainy and so on. Texture determination is ideally suited for medical image retrievals.

A texture can be classified on set of values such as mean, standard deviation, normalized relative smoothness, third moment, forth moment, uniformity and entropy [9].

The smoothness R is defined as

$$R = 1 - 1/(1 + \sigma^2(z)) \qquad (3)$$

Where $\sigma^2$ (z) is the second moment or variance obtained by putting n = 2 in the equation no. 1.

Second moment is the measure of grey level contrast. Third and forth moments can be calculated by putting n = 3 and n = 4 in the equation no. 1. The third moment is the measure of skewness of the histogram [9] and forth moment is the measure of its relative flatness. The fifth and higher order moments are not so easily related to histogram shape, but they do provide further quantitative discrimination of texture content [9]. For simplicity of calculations and to reduce the computation time which is arising due to huge sized feature vector the fifth and higher order moments are not considered here.

Another useful measure based on histogram is the uniformity which is given by

$$U = \sum_{i=0}^{L-1} p^2(z_i) \qquad (4)$$

Measure U is maximum for an image in which all grey levels are equal i.e. maximally uniform and decreases from there. Another important measure of variability which is recalled from basic information theory is the entropy.

$$e = -\sum_{i=0}^{L-1} p(z_i) \log_2 p(z_i) \qquad (5)$$

The value of entropy is 0 for constant image.

The feature vector now has several elements namely mean, standard deviation, smoothness, third moment, forth moment, uniformity and entropy. For a image of size 384X256 again we have 96 cells and for each cell these values are calculated from histogram. Thus for each channel we get in all 96X7=672 features and for three channels 2016 features. Here also some cells can be neglected as they do not contribute as important measure for texture classification. Also neglecting them will not affect the retrieval efficiency.

### a. Similarity Comparison

For similarity comparison, we have used Euclidean distance, d using equation [1, 9]

$$d = \sqrt{\sum_{i=1}^{N}(F_Q[i] - F_{DB}[i])^2} \qquad (6)$$

where $F_Q[i]$ is the i th query image feature, and $F_{DB}[i]$ is the corresponding feature in the feature vector database. Here, N refers to the number of images in the database.

## 6. EXPERIMENTAL SETUP AND RESULTS

A Dell Precision Pentium Core2 Duo with 2GB RAM computer is used for conducting the experiments. The main software tools used is matlab7.1 image processing toolkit. Corel Image database with 500 natural images were used for testing the proposed CBIR system.

### a. Retrieval Efficiency

The common evaluation measures used in CBIR systems are precision, defined as

$$\text{precision} = \frac{\text{No of relevent images retrieved}}{\text{Total number of images retrieved}} \qquad (7)$$

$$\text{recall} = \frac{\text{No. of relevent images retrieved}}{\text{Total no. of relevent images in the database}} \qquad (8)$$

The retrieval efficiency, namely recall and precision were calculated using 500 natural color images (50 in each category) from Corel image database. Figure 2 shows the query images used in conducting the experiment. Figure 3 shows the screenshot of the framework. Standard formulas have been used to compute the precision and recall for 5query images.

By randomly selecting five query images from the Corel Image Database, the system was tested and the results are shown in Table I.

In Table I, the first line in each query image indicates precision and the second line indicates recall. Figure 3 shows the query images used in conducting the experiment.

Fig. 2: Query Images 1 to 5 (Top Left to Bottom Right)

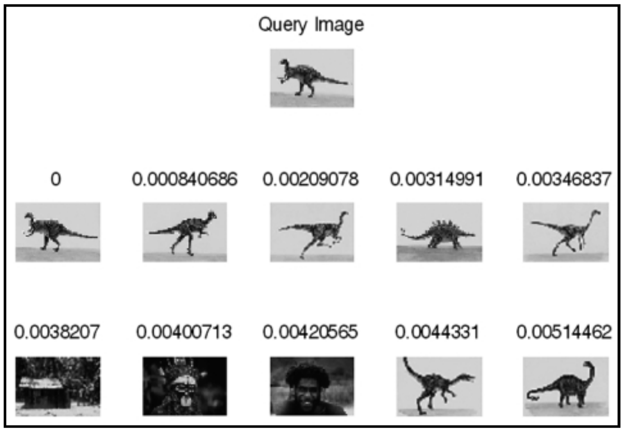


Fig. 3: Screenshot of CBIR Based on Color

Table 1
Precision and Recall Values in Percentage

| Query image | color | texture |
|---|---|---|
| 1 | 30 | 50 |
| | 35 | 45 |
| 2 | 30 | 40 |
| | 26 | 35 |
| 3 | 25 | 35 |
| | 20 | 30 |
| 4 | 26 | 50 |
| | 28 | 20 |
| 5 | 80 | 90 |
| | 90 | 60 |

In Table I, the first line in each query image indicates precision and the second line indicates recall. Figure 3 shows the query images used in conducting the experiment.

## 7. CONCLUSION AND FUTURE WORK

This paper proposed a universal model for the Content Based Image Retrieval System by combining the color and Texture features or individually. Users were given options to select the appropriate feature extraction method for best results. The advantages of global and local features together have been utilized for better retrieval efficiency. The results are quite good for most of the query images and it is possible to further improve by fine tuning the threshold and adding relevance feedback.

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