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Effective Content Based Image Retrieval techniques using clustering for multiple features

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Abstract: Content based Image Retrieval System overcomes the drawback of traditional text based image retrieval systems because of large image database, it is much time consuming and labour intensive. In CBIR system search will analyze these image contents rather than metadata of images as keywords and other descriptions related to image. Purpose of this paper is to include more visual features simultaneously rather than using them individually. Here we implement a series of algorithms for combining colour and texture features extraction in CBIR for more accurate results, colour feature vectors and clusters are formed using statistical colour moments along with hierarchical and K-means clustering technique and for texture feature extraction Gabor wavelets algorithm is applied and on retrieved images relevance feedback analysis is performed for automatic indexing of images for future.

Keywords: CBIR , RGB, Hierarchical, K-means, Centroid, Statistics distance, Gabor wavelet, Colour Moment

I. INTRODUCTION

The basic idea of CBIR technique is to generate automatically image descriptions directly from the image content by analyzing the content of the images [1]. No any particular single feature is perfect or sufficient in similar image retrieval. Here in CBIR system, for all images which are stored in database first feature extraction is performed and are compared with query image by CBIR system, In our proposed technique the features vectors which are used to create the tree cluster are color features, so to create the clusters only the color features are computed firstly. All others features are computed after clustering. When a new search is made, system finds the cluster that better match with the query image and extract/compare features of this cluster with query image features to improve fast speed and better performance.

Before any search, in system initialization or when a new database is loaded or when a new image is added to DB, the system creates clusters in database, grouping images by its similarity in color features. All these occur without user intervention. The clustering results are stored and only changes if the database location changes or a new image is added (because re-calculation is needed).Search algorithms begin finding the cluster more similar to the query image. All the retrieval algorithms start from this best-match cluster and computes features only on cluster images for faster speed.

Image retrievals based in Color, Shape, Texture and Spatial features can be computed individually and simultaneously in the combination option, when all the algorithms are applied one after the other, and each algorithm is applied only over the result images of its predecessor. Starting from clustering formed by color features, the Combination sequence continues with texture, shape and spatial, in that order. Here we are extracting only 2 features color and texture as shown in this figure-.

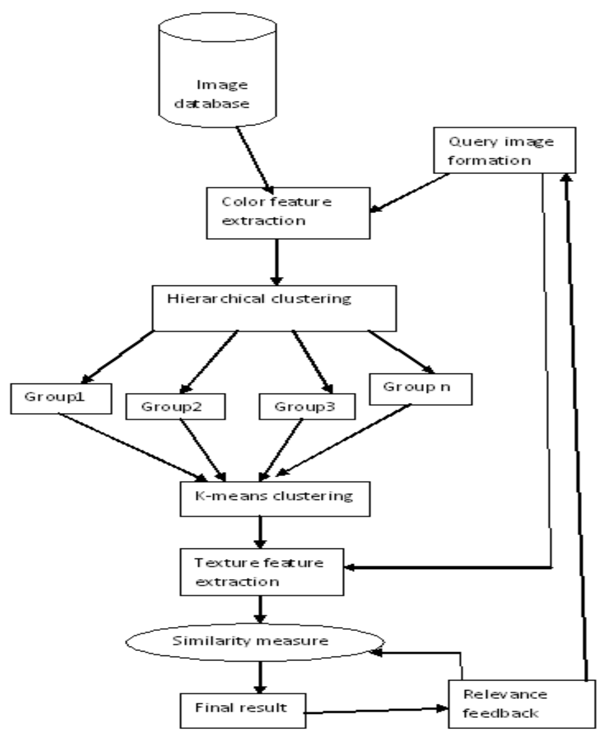

Figure 1.Working model of CBIR system

In the current CBIR system, feature extraction technique used for retrieval are treated as equal importance. No any particular feature is perfect or dominates in similarity retrieval. The feature that is more suited for particular image retrieval is used.

In this paper section 2 describes methods used for features extraction, cluster forming and similarity measurement, in section 3 we discuss performance measurement, in section 4 we discuss results and in section 5 we discuss technique applied for relevance feedback according to user's concepts and in section 6 we conclude for future work.

II. PROPOSED TECHNIQUE

A. Color feature extraction:

For color based image retrieval color can also be represented in many ways [4]. Most commonly used color descriptors are: Color moments and color histograms. Color moments feature vectors are the statistical moments of the probability distributions of colors. Color moments used especially when image contain just the objects. Images are divided into color components; to each color (RGB) the first order(mean), the second(variance) and the third order (skewness) color moments have been proved to be effective and efficent in representing color distribution of images.
Color moments are computed as follows-

$$\mu_i = \sigma_i = \frac{1}{N}\sum_{j=1}^{N} f_{ij}$$

$$var = \sigma_i = \left[\frac{1}{N}\sum_{j=1}^{N}(f_{ij} - \mu_i)^2\right]^{\frac{1}{2}}$$

$$\text{skewness} = s_i = \left\{\left[\frac{1}{N}\sum_{j=1}^{N}(f_{ij} - \mu_i)^3\right]^{\frac{1}{2}}\right\}$$

Where f_{ij} is the value of the i-th color component of the image pixel j, and N is the total number of pixels in the image. Feature vectors are: $(\mu_R, \sigma_R, s_R, \mu_G, \sigma_G, s_G, \mu_B, \sigma_B, s_B)$.

B. Cluster Formation:

In order to reduce the search order, images clusters are created to group them by similar features. The features vectors used to create the tree cluster are color features [2].

Before any search, in system initialization or when a new database is loaded or when a new image is added to DB then Two clustering algorithms are applied subsequently one after the other. First, hierarchical clusters are formed defining a coefficient threshold. As result, k clusters are created. The k clusters obtained from Hierarchical Clustering (and its centroids) are used as inputs to K-Means Clustering, ensuring good initial centroids. K-Means is a really fast clustering algorithm but its major deficiency is that usually select the initials clusters centroids randomly. Then, depending of that random centroids, the clusters are better grouped or not. So, using Hierarchical algorithm first, we determined a good set of centroids to be passed to K-Means, ensuring better clusterization

When a search is performed, the system finds the minor distance between the query image and each cluster, deciding where is most likely to find similar images.

Hierarchical and K-Means computation uses the Statistics ToolBox in MATLAB

C. Texture feature extraction:

This feature includes the information about the structural arrangement of surfaces as clouds, leaves, sea and bricks Gabor wavelet transform (GWT) is a classical method for multichannel, multi-resolution analysis that represents variations of image at different scales. Gabor wavelet transform provides a flexible method for designing efficient algorithms to capture more orientation and scale information [3]. Feature vectors are based on the correlation between each image and a group of wavelets (the Gabor filters), with each wavelet capturing energy at a specific frequency and a specific direction. A Gabor filter is obtained by modulating a sinusoid with a Gaussian, defined as

$$g(x, y, \theta, \phi) = \exp\left(-\frac{x^2 + y^2}{\sigma^2}\right)\exp\left(2\pi\theta i(x\cos\phi + y\sin\phi)\right)$$

Texture features can then be extracted from this group of energy distributions

$$G(x, y, \theta, \phi) = \sum\sum I(p, q) g(x - p, y - p, \theta, \phi)$$

D. Similarity measurement:

In all cases, similarity measurements between two features vectors are based in the statistics distance, defined as:

$$d_{\chi^2}(Q, T) = \sum_{i=0}^{N-1} \frac{(Q_i - m_i)^2}{m_i}$$

Where. This quantity measures how unlikely it is that one distribution was drawn from the population represented by the other.

In order to give a more compressive human similarity measurement, the percent of convergence between the query image and each of the result images are calculated. To do that, a threshold distance limit is defined for each algorithm. We arbitrary decided assigns to the image in the threshold an 80% match and lineally calculates the matching percent until a 100% match for distance zero (similar features vector).

III. PERFORMANCE MEASUREMENT

The performance measurements are based on Precision and Recall. The user selects items relevant to the query from the dataset results.

$$\text{Precision} = \frac{\text{number of relevant retrieved images}}{\text{number of retrieved images}}$$

$$\text{Recall} = \frac{\text{number of relevant retrieved images}}{\text{total number of relevant images in DataBase}}$$

Precision measures the retrieval accuracy while recall measures the ability of retrieving relevant items from the database. Precision and recall are inversely related, i.e., precision normally degenerates as recall.

IV. RESULTS

Number of inconsistencies arise when we consider only one feature as parameter at one time for image retrieval. Here we considered the extraction of color feature for image retrieval then some non-relevant(not required)images are displayed Even unrelated images having color distance smaller than similar ones but when we considered texture feature along with this feature then results were improved till some extent. Inconsistency was reduced from earlier. The improved results of the system is first determined by the uses of the combined Hierarchical and K-Means clustering, allowing search with fast speed in larger database. Here in figure 2 image retrieval color based image retrieval is shown and in figure 3 texture based image retrieval is shown and in figure 4 due to both combination improved result is shown-

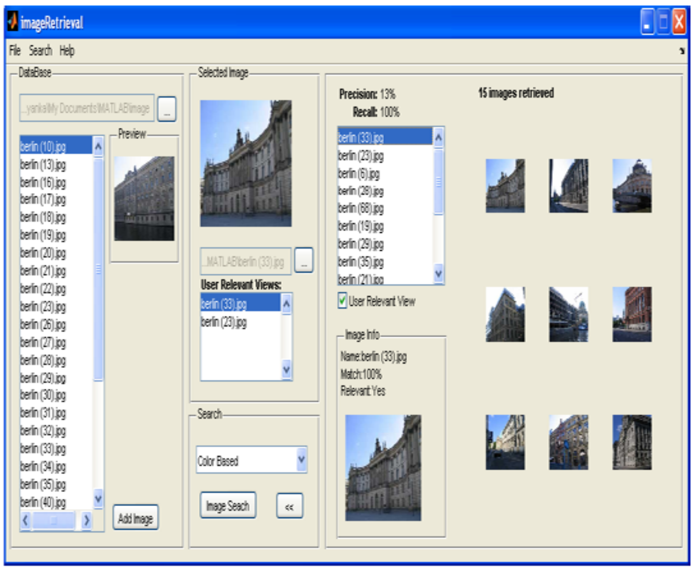

Figure 2

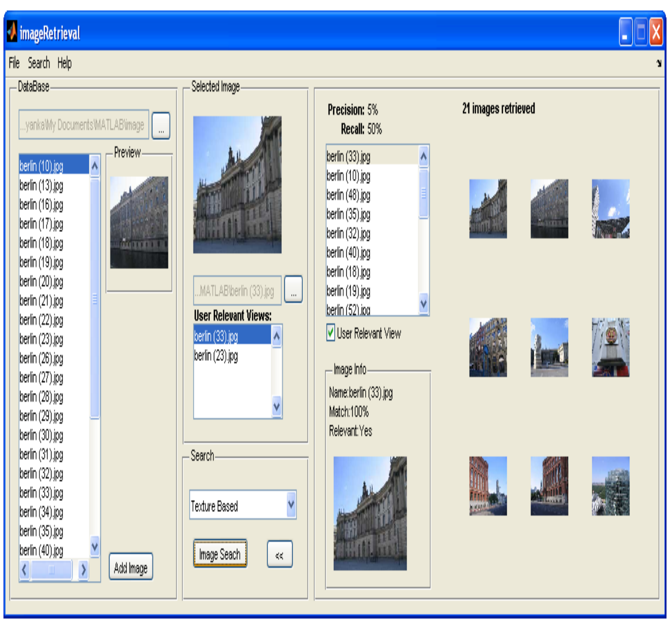

Figure 3

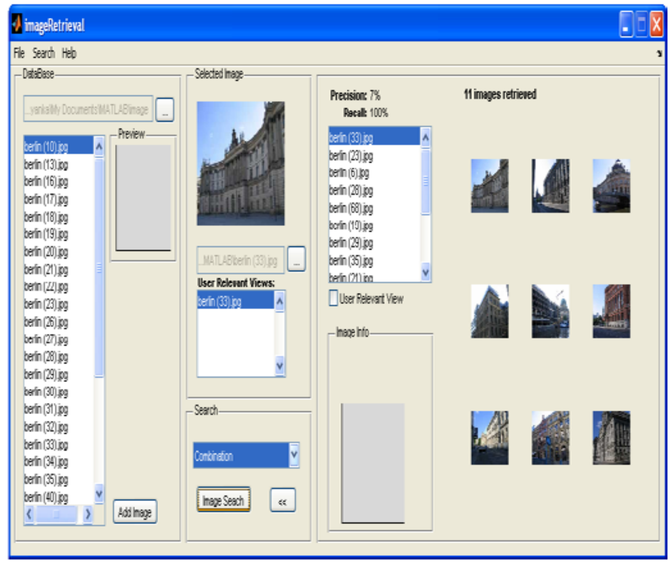

Figure 4

Here considering only textute freature as parameter also unrelated images are displayed in figure 3.so No any single feature is sufficient or perfect for content based image retrieval.

V. RELEVANCE FEEDBACK

Retrieval image results which are based on the similarities of low level visual features are not necessarily semantically meaningful or correct. To resolve this problem, relevance feedback technique is used, it is iterative and automatic refinement of a query. The relevance feedback mechanism [5][6]makes it possible for CBIR systems to know user's views. Here users provide some positive and negative image labeling information according to their view and requirements, which helps systems to dynamically adapt and modify the relevance of images to be retrieved and automatic indexing in future for the same query image . Once a new database has been loaded, the system groups the images in clusters, according to its similarity of color features. Which images are in which cluster, and the centroid of each cluster, are stored in a XML file 'data\clusters.xml', in the working directory. In that folder are also stored another XML: 'database.xml', with the location of the last database used.

When a user marks relevant images, a new file with the name of the query image is created in the data folder. For example, for the query image 'redflower.jpg', with 3 relevant images, a file 'data\redflower.jpg.xml' storing information of its relevant views.

Images marked as user relevant views are the first retrieved results when the same query is put again in future, order by percent of match. After the relevant images, the rest of the retrieved results, if any, are shown. . Neither a single feature nor a combination of multiple features has explicit perfect semantic meaning .Although relevance feedback provides a way of filling the gap between semantic search and low-level feature match.

VI. FUTURE SCOPE

As we have considered color and texture feature results simultaneously, for future we will also consider shape and spatial features match along with these features simultaneously to improve the relevance, speed, efficiency and accuracy in image retrieval.

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