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RESEARCH ARTICLE

Enhanced Multistage Content Based Image Retrieval

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Abstract— content based image retrieval (CBIR) considers the characteristics of the image itself, for example its shapes, colors and textures. CBIR has many applications areas such as, education, commerce, military, searching, bio medicine and web image classification. The domain of CBIR is expanding day by day, the requirements have become complex and so are the algorithms. CBIR is a new but widely adopted method for finding images from vast and unannotated image databases. In this paper we will discuss a technique known as Multistage CBIR. The proposed technique consists of a three layer feed forward architecture i.e. the first layer consists of comparison of color features the second consist of comparing texture feature and the last is comparing shape features.

Key Terms: - CBIR; Content Based Image Retrieval; Multistage Content Based Image Retrieval; Color Feature Extraction; Texture Feature Extraction; Shape Feature Extraction

I. 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 user's requests in the form of a query image. The commercial CBIR system available up to date is Simplicity [1], QBIC [2], Virage [3], Netra [4], Visual Seek [5], PicSom, FIRE and AltaVista. Similarly, a large number of academic and commercial retrieval systems have been developed by universities, government organizations, companies, and hospitals. Comprehensive surveys of these techniques and systems can be found in ([10] – [12]). Almost all CBIR system is based on color, texture and shape features of images [6]. Content based image retrieval (CBIR) has received much attention in the last decade, which is motivated by the need to efficiently handle the rapidly growing amount of multimedia data. It covers versatile areas, such as image segmentation, image feature extraction, representation, mapping of features to semantics, storage and indexing, image similarity-distance measurement and retrieval making CBIR system development a challenging task.

Content-based image retrieval uses the visual contents of an image such as *color*, *shape*, *texture*, and *spatial layout* to represent and index the image. In typical content-based image retrieval systems, the visual contents of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. To retrieve images, users provide the retrieval system with example images or sketched figures. The system then changes these examples into its internal representation of feature vectors. The similarities /distances between the feature vectors of the query example or sketch and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. The indexing scheme provides an efficient way to search for the image database. Recent

retrieval systems have incorporated users' relevance feedback to modify the retrieval process in order to generate perceptually and semantically more meaningful retrieval results.

In this paper, an existing scheme for CBIR, Multistage content based image retrieval proposed by Nishant Shrivastava et al. [7] is enhanced. To index images in database, global feature based on color and texture are computed .These features are combined with contour based shape feature to form a single feature vector to be indexed in the database. When a query image is presented to the system, the retrieval of similar images occurs in stages based on color, texture and shape similarity respectively. Experiments have shown that the system has produced the good results.

The remainder of the paper is organized as follows: section 2 gives the brief description of extracting features in the technique. Section 3 contains the technique of image retrieval. Section 4 contains the similarity measure used in the technique. Section 5 contains the experimental results and section 6 contains the conclusion.

II. TECHNIQUE

In the proposed technique three feature vectors are extracted from all the images which are color, texture, and shape but before extracting the features we need to smooth the image by applying averaging filter. The color feature vector consists of mean, standard deviation, median, variance, skewness and kurtosis; while the texture vector consists of all the haralick features; and at last the shape vector consists of BoundingBox, Eccentricity, Extent, EquivDiameter and Solidity by applying regionprops on the output generated by region growing algorithm.

A. *Color feature extraction*

Color is most commonly used features in image retrieval. Its three dimensional space makes its discriminating power superior to one dimensional gray level image. The mean, variance and standard deviation of an image are known as color moments. Color Mean is obtained by taking the average of all of the three color layers i.e. red, green and blue resp. for this all the pixels of a particular layer are added and divided by the total number of pixel in the image. Skewness - measures the degree and direction of symmetry or asymmetry of the distribution. A normal or symmetrical distribution has a skewness of zero (0). But in the real world, normal distributions are hard to come by. Therefore, a distribution may be positively skewed (skew to the right; longer tail to the right; represented by a positive value) or negatively skewed (skew to the left; longer tail to the left; with a negative value). Kurtosis - measures how peaked a distribution is and the lightness or heaviness of the tails of the distribution. In other words, how much of the distribution is actually located in the tails? A normal distribution has a kurtosis value of zero (0) and is said to be mesokurtic. A positive kurtosis value means that the tails are heavier than a normal distribution and the distribution is said to be leptokurtic (with a higher, more acute "peak"). A negative kurtosis value means that the tails are lighter than a normal distribution and the distribution is said to be platykurtic (with a smaller, flatter "peak").

Below equations define the mean, variance and standard deviation of an image of size *n* x *m*.

$$Mean = \sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij}/mn$$

$$Variance = \frac{1}{mn}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(x_{ij} - Mean\right)^2$$

$$\sigma = \sqrt{Variance}$$

$$skewness = \frac{\sum(x-\mu)^3}{\sigma^3}$$

$$kurtosis = \frac{\sum(x-\mu)^4}{\sigma^4}$$

Where x_{ij} is the Pixel value of the i^{th} row and j^{th} column

B. *Texture feature extraction*

Texture is a property that represents the surface and structure of an Image. Generally speaking, Texture can be defined as a regular repetition of an element or pattern on a surface. Image textures are complex visual patterns composed of entities or regions with sub-patterns with the characteristics of brightness, color, shape, size, etc. An image region has a constant texture if a set of its characteristics are constant, slowly changing or approximately periodic. Texture can be regarded as a similarity grouping in an image.

Everyday texture terms - rough, silky, bumpy - refer to touch.

A texture that is rough to touch has:

- A large difference between high and low points, and
- A space between highs and lows approximately the same size as a finger.

Silky would have

- little difference between high and low points, and
- The differences would be spaced very close together relative to finger size.

Image texture works in the same way, except the highs and lows are brightness values (also called grey levels, GL, or digital numbers, DN) instead of elevation changes. Instead of probing a finger over the surface, a "window" - a (usually square) box defining the size of the probe - is used.

In our algorithm we will use grey level co-occurrence matrix to understand the relationship between pixels. Robert haralick proposed 13 most significant features which can describe the texture qualities of an image and they are as follows energy, contrast, correlation, sum of variances, inverse difference moment, sum average, sum variance, sum entropy, entropy, difference variance, difference entropy, information measures of correlation.

C. *Shape feature extraction*

For extraction of shape features image is first filtered using averaging filter to remove noise and then regionprops function of matlab is applied and properties like eccentricity, extent, solidity, orientation and equivdiameter are calculated. The feature vector consists of the largest bounding box value obtained by regionprops.

1) Extent: It gives the proportion of the pixels in the bounding box that are also in the region. It is computed as the area divided by the area of the bounding box.

$$Extent = \frac{Area}{Boundingbox\ Area}$$

2) Eccentricity: It is the ratio of the minor axis to the major axis of the best fitting ellipse of the shape. Its value lies between 0 and 1.

3) Equivalence Diameter: It is defined as the diameter of a circle with the same area as the region.

$$Equivalence\ Diameter = \sqrt{4 * Area/\pi}$$

4) Solidity: It gives the extent to which the shape is convex or concave. Solidity for full convex contour is always 1.

$$Solidity = \frac{Area}{Convex\ Area}$$

III. IMAGE RETRIEVAL

In this technique images are indexed in database, global feature based on color and texture are computed .These features are combined with contour based shape feature to form a single feature vector to be indexed in the database. When a query image is presented to the system, the retrieval of similar images occurs in stages based on color, texture and shape similarity respectively.

The process of querying and retrieving similar images from database is divided in to three stages, which are as follows

In the first phase, color feature vector of the example image are calculated in the similar manner. This feature vector is compared with color feature of all other images in the database using Euclidean Distance. The images having Euclidean distance less than a specified threshold value are retrieved and presented as output of I stage.

In the second stage texture feature of the example image are calculated. This texture feature vector is compared only with the texture feature vectors of output images of I stage using Euclidean distance. Again the images having distance measure less than a specified threshold value are presented as output of the second stage.

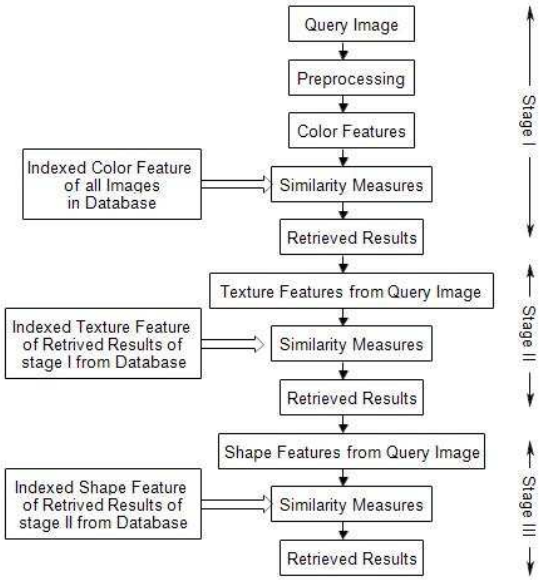

Fig 1. Retrieving results

In the third stage shape feature vector of the example mage is compared with the shape feature of the all the images which were presented as output of the second stage. Again the images which pass the threshold test are presented as final output of the system.

IV. SIMILARITY MEASURE

For similarity measure we use Euclidean distance. It is well known that Euclidean distance is the simplest and best possible measure to find the similarity between two vectors. It can be calculated by the following equation

$$ed = \sqrt{(I_q - I_{dB})^2}$$

Where I_q is the feature vector of the query image and I_{db} is the feature vector of the image to be compared with.

V. EXPERIMENTAL RESULTS

In pattern recognition and information retrieval, precision (also called positive predictive value) is the fraction of retrieved instances that are relevant, while recall (also known as sensitivity) is the fraction of relevant instances that are retrieved. Both precision and recall are therefore based on an understanding and measure of relevance.

Suppose a program for recognizing dogs in scenes identifies 7 dogs in a scene containing 9 dogs and some cats. If 4 of the identifications are correct, but 3 are actually cats, the program's precision is 4/7 while its recall is 4/9. When a search engine returns 30 pages only 20 of which were relevant while failing to return 40 additional relevant pages, its precision is 20/30 = 2/3 while its recall is 20/60 = 1/3.

In simple terms, high recall means that an algorithm returned most of the relevant results, while high precision means that an algorithm returned substantially more relevant results than irrelevant

The experiments were performed on Corel database and have shown good precision rate on images having rough texture and high contrast. This technique can be further extended to improve the results.

VI. CONCLUSION AND FUTURE WORK

Multistage works on a three layer feed forward architecture and considers both local and global features in image retrieval thus it is possible to add further layers to smooth the process and increase its efficiency or add some other features to increase the precision and recall value since this algorithm uses simple equations to

calculate features it is relatively easy to understand and faster to implement. It can become a base algorithm and we can apply k-means clustering and relevance feedback for a better output.

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