Color and Shape Based Image Retrieval

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Abstract--Content based image retrieval is the task of retrieving the images from large collection of database on the basis of visual content. This paper proposes the CBIR system which uses low level features shape and color information to retrieve images. Shape feature is found by calculating some second order and third-order moments. The images are retrieved based on similarities features. The proposed system is tested on a database consisting of color images. To assess the retrieval effectiveness the statistical comparator parameters precision and recall are calculated.

Keywords-- CBIR, feature extraction, shape, color.

I. INTRODUCTION

Content Based Image Retrieval is the task of retrieving the images from large collection of database on the basis of their visual contents. The term Content based Image Retrieval was originated in 1992 by T. kato.

Content Based means that search will analyze the actual contents of an image. The term Content in this context might refer to color, shape that can be derived from image itself.

The feature used for retrieval can be either primitive or semantics, but the extraction process must be predominantly automatic Retrieval of images by manually assigned keywords is definitely not CBIR as the term is generally understood even if the keywords describe image content.[1,2,3]

There are many Content Based Image retrieval systems such as QBIC, Virage, VisualSEEK, Photobook, Chabot and VIPER. The medical imaging, multimedia art history, geology and satellite images etc are some application areas of CBIR.

II. THE SYSTEM STRUCTURE

From the function the image retrieval system can be divided into Image Management Module, Image Processing Module and Image Query Module. The typical content Based Image Retrieval system is shown in fig.1.

Image management module: The main function is to extract the features from image database and create image feature database. Image processing module: The main function is to analyze the images, extract color, shape features and carry on normalization processing to features and establish image library. Image query model: The main function is to make scheme matching for the features of the sample image and image library and provide the retrieval results.[5,6]

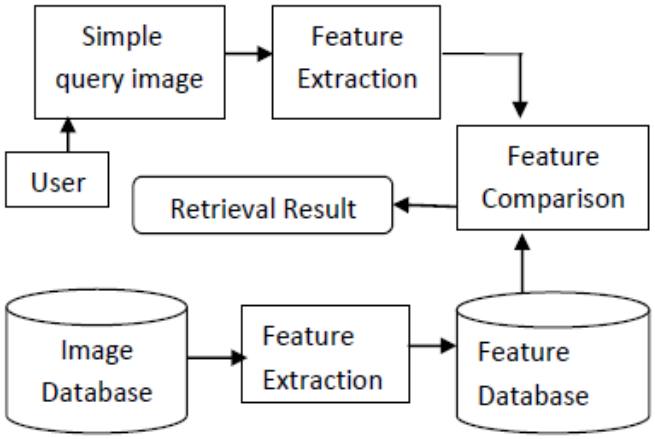

Figure.1.The System structure of Image Retrieval

III. THE IMAGE FEATURE EXTRACTION

A. SHAPE FEATURE EXTRACTION

Shape is one of the most important visual features.In general shape representation can be divided into two categories. First one is the Boundary based which uses only the outer boundary of the shape. Another is RegionBased which uses the entire. The shape extraction methods are straight line description, spline fitting curve, Fourier descriptor, Gaussian parameters curve.[5]

This paper has adopted the extraction method of the shape feature based on invariant moments. If the object R is represented as a binary image, the central moments of order p + q for the shape of object R are defined as:

$$\mu_{p,q} = \sum_{(x,y\in R)} \left(x - x_c\right)^p \left(y - y_c\right)^q \quad (1)$$

Where (x_c, y_c) *is the center of the object.*

The Central moments can be normalized to be scale invariant.

$$\acute{\eta}_{(p,q)} = \frac{\mu_{(p,q)}}{\mu_{(0,0)}^{\gamma}} \quad (2) \qquad \gamma = \frac{p+q+2}{2} \quad (3)$$

The seven invariant moments are obtained by combining some second order and third order central moments can be derived as:

$$\emptyset_1 = \mu_{2,0} + \mu_{0,2} \quad (4)$$

$$\emptyset_2 = \left(\mu_{2,0} - \mu_{0,2}\right)^2 + 4\left(\mu_{1,1}\right)^2 \quad (5)$$

$$\emptyset 3 = \left(\mu_{3,0} - \mu_{1,2}\right)^2 + \left(\mu_{0,3} - \mu_{2,1}\right)^2 \quad (6)$$

$$\emptyset_4 = \left(\mu_{3,0} + \mu_{1,2}\right)^2 + \left(\mu_{0,3} + \mu_{2,1}\right)^2 \quad (7)$$

$$\emptyset_5 = \left(\mu_{3,0} - 3\mu_{1,2}\right)\left(\mu_{3,0} + \mu_{1,2}\right)\left[\left(\mu_{3,0} + \mu_{1,2}\right)^2 - 3\left(\mu_{0,3} + \mu_{2,1}\right)^2\right] \quad (8)$$

$$\emptyset_6 = \left[\left(\mu_{2,0} - \mu_{0,2}\right)\left(\mu_{3,0} + \mu_{1,2}\right)^2 - \left(\mu_{0,3} + \mu_{2,1}\right)^2\right] + 4\left(\mu_{1,1}\right)\left(\mu_{3,0} + \mu_{1,2}\right)\left(\mu_{3,0} + \mu_{2,1}\right) \quad (9)$$

$$\emptyset_7 = \left(3\mu_{2,1} - \mu_{0,3}\right)\left(\mu_{3,0} + \mu_{1,2}\right)^* \left[\left(\mu_{3,0} + \mu_{1,2}\right)^2 - \left(\mu_{0,3} + \mu_{2,1}\right)^2\right] \quad (10)$$

B. COLOR FEATURE EXTRACTION

Color is most extensively used visual content for image retrieval. Its three dimensional values makes discrimination potentially superior to single dimensional values of images [2]. There are many kinds of methods for the extraction of color feature: color histogram method, accumulation histogram method, color coherence vector method, color correlogram method and so on.

This paper has adopted color moments method. The most of information can be captured by low order moments (mean), second and third order moments (variance and skewness).

If the value of the i-th color channel at the j-th image pixel is Pij , then color moments are defined as:

$$\text{Mean}: \quad \mu_i = \sum_{i=1}^{n} P_{i,j} \quad (11)$$

$$\text{Variance: } \sigma_i = \sqrt{\left(\frac{1}{n}\sum_{i=1}^{n}\left(P_{i,j} - \mu_i\right)^2\right)} \quad (12)$$

$$\text{Skewness: } S_i = \sqrt[3]{\left(\frac{1}{n}\sum_{i=1}^{n}\left(P_{i,j} - \mu_i\right)^3\right)} \quad (13)$$

Where n is the number of pixels in an image. Since, only nine (three moments for each of three color

components) numbers are used to represent the color moments of each image.

C. SIMILARITY MEASURES

Instead of matching, Content Based Image Retrieval calculates visual similarities between a query image and images in database. In this paper, we adopted the Mahalanobis Distance calculation. The Mahalanobis distance metric is appropriate when each dimension of image feature vectors dependent on each other and is of different importance.

$$D_{i,j} = \sqrt{(X_i - X_j)^T S^{-1} (X_i - X_j)} \qquad (14)$$

S is the covariance matrix of feature vectors.

The mahalanobis distance can be simplified, if feature dimensions are independent. Only variance of each feature component S is needed.

$$d(x', y') = \sqrt{\sum_{i=1}^{N} \frac{(x_i - y_i)^2}{(s^{-1})}} \qquad (15)$$

In this paper, the distance between individual color feature and shape feature of query image and image from database are individually calculated. In next step,shape and color feature of query image is put in singlematrix and another matrix created for shape and colorfeatures of the image from database. The Mahalanobis distance between these two matrices is calculated. [7]

D. IMAGE FEATURE FUSION

The Image Feature is the integration of multiple characteristics. It provides the good results for image retrieval. In this paper, Gaussian normalization is being adopted. First, the distance d(x,y) (x≠y) between image x and y are calculated. The average mΔ of all distances and variance ∂Δ is calculated.

Secondly, the calculation of similar distance between q and each image of library by d(1,q), d(2,q), d(3,q) ….d(m,q) where m is the number of images in library. Third, according to (16) , the normalization of d(2,q), d(3,q) ….d(m,q) to d'(2,q), d'(3,q) ….d'(m, q).

$$d'(x,q) = \left[\frac{d'(x,q) - m\Delta}{3\partial\Delta} + 1 \right] / 2 \qquad (16)$$

The distance d'(x,q) is range having range[0 1]. The d'shape and d'color are obtained.

Forth, the weights are selected by trial and error method. The threshold can be assigned for search by content.[7]The distance d'color(x,q) ,d'shape(x,q) are similarity measure normalized between the image x and q:

$$dmin(x,q) = \frac{Wcolor * d\ color + Wshape * d\ shape}{Wcolor + Wshape} \qquad (17)$$

The weight of color and shape is arbitrarily set by the user to adapt to the different searcher search requirement.

IV. THE EXPERIMENTAL RESULT

In this work, 2 images are taken from the data set which consists of 5-different categories. The commonly used performance measurement is the precision- recall pair.

At every image in the database used as the query the ground truth is known for whole database. For each query, the precision of the retrieval at each level of the recall is obtained.

The precision is defined as the ratio of the number of retrieved relevant images to the total number of retrieved images. Precision measures the accuracy of retrieval.[6]

Precision Table:

TABLE I. The precision Table for Image Retrieval

Category	Apple	Flowerpot	Mobile	Box	Gun
Shape	0.38	0.50	0.40	0.77	1.0
Color	0.64	1.00	0.80	0.33	0.64
Shape + color	0.39	0.50	0.30	0.55	0.44
Feature fusion	1.00	1.00	0.96	0.77	0.60

The recall is defined as the ratio of the number of retrieved relevant images to the total number relevant imagesin the whole database. Recall measures the robustness of retrieval.

Recall table:

Table II : The Recall Table For Image Retrieval

Category	Apple	Flowerpot	Mobile	Box	Gun
Shape	0.24	0.10	0.24	0.17	0. 40
Color	0.24	0.17	0.28	0.23	0.60
Shape + color	0.26	0.17	0.25	0.35	0.60
Feature fusion	0.24	0.10	0.22	0.13	0.19

V. CONCLUSION

In this paper, we proposed a content based image retrieval system. The image feature fusion method is giving higher precision and recall as compared to individual distance calculation on shape feature, color feature and both together. The experimental result shows that the image feature fusion outperforms color moments and invariant moments of shape descriptor. The feature fusion is efficient and could be used in many applications where traditional color moments and invariant moments of shape descriptor is applied.

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