A Relevance Feedback Image Retrieval Scheme using Combination of Color and Shape Features*

YUEXIANG SHI[1] , DONGHUI ZHU[1], LI WEN[1]
[1]School of Information Engineering
XiangTan University
XiangTan 411105
China

Abstract: In content-based image retrieving, studying focuses on how to retrieve image to satisfy the user quickly and accurately. Color and shape features are usually presented by color histogram and edge histogram in HSV color space. But in this paper, the combination of color and shape features has been used in the feedback. In matching of similarity computing, the Gaussian model is used to normalize the different sub-characters distance. This distance is preparing for retrieving integer by combining different sub-characters. And with relevance feedback mechanism, the satisfy retrieval results can be gained by adjusting weights. Experiments showed that this method is effective in image retrieval.

Key- words: Color histogram, Edge histogram, Feedback, Feature combination

1 Introduction

With the explosion of getting image from all approaches, organizing and accessing these images is becoming an urgent task. How fast to access the great image data and accurately to get it is important for exploring with their correct orientation. Unfortunately, this is currently done by manually and the work can't fit the demands for the development of image application. There is not like the people using text retrieval system. If people hope to retrieve as text, the first work is to annotate the image. But now the annotation is not accurate and automatic in the application. So the technology of content_based image retrieval(CBIR) is becoming the important field. At present, more and more new methods and tools are developing for image retrieval. People have been working deeply and have gotten a series approaches. Many kinds of retrieval system have been pushed to markets. This is the beginning of new idea in image retrieving.

People get information mostly from vision. The rate probably nears 80%[1]. There are much low-level features like color, texture, shape, figure and so on. In order to get the best precision and recall, the extraction of low-level features must be identical with the perception of human's vision. If people want to retrieve without any field knowledge to support it, color technique is a method can be used in content-based retrieval[2]. Shape of an object is an important feature for image and multimedia similarity retrievals[3]. The color and shape are two normal features have been used in image retrieving. Song presented image retrieval based on color and shape[4] and Jain offered the image retrieval using color and shape[5]. The two kinds of retrieval were not mention feedback. Based on that, in the studying of image retrieval, the higher precision and recall usually need the feedback design. This paper presents a method to extract the feature of color and shape. It also gives a result with higher precision and recall by using feedback.

2 Extraction of Color Feature

In image retrieving, color is an important low-level feature. It has many stability features like rotating, moving and invariable scale. It is usually used as the retrieving object. And the color identical can be restrained in spatial. At present, the color spatial was presented as RGB, CMY, HIS, HCV, HSV and HSB. Among these, the HSV is the best one which identical with human perception. In the HSV spatial, the ability of description in H is the approach to human vision and can be clear distinguished with others. In this paper, the RGB will be converted to HSV and will to use the HSV in retrieving. The

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converting is according to the reference [5]. When the HSV was constructed, the retrieving can be withdrew to 1-D. The method simples the operation and highs the computing speed. The feature of color selection was shown as histogram equation.

$$H(k)=\sum_{i=o}^{K}\frac{n_i}{N} \qquad (k=0,1,\ldots,L-1) \qquad (1)$$

k represents the eigenvalue, L is the number of features, n_i represents the pixels number of feature i, N is total number of pixels.

3 Extraction of Shape Feature

When the image has been converted into HSV, the H, S and V is independent, the process will just be occurred on H. There are four kinds of board detecting operator shown as a, b, c and d in figure 1. There is a convolution will be generated with the detecting operator and image together. There are will be four kinds board figures in direction 0^0,45^0,90^0,135^0. These shape[8] figure are represented as H(a), H(b), H(c) and H(d) with cumulating histogram. In the case, a represents 0^0 direction, b represents 45^0 direction, c represents 90^0 direction, d represents 135^0 direction. It is shown as fig. 1.

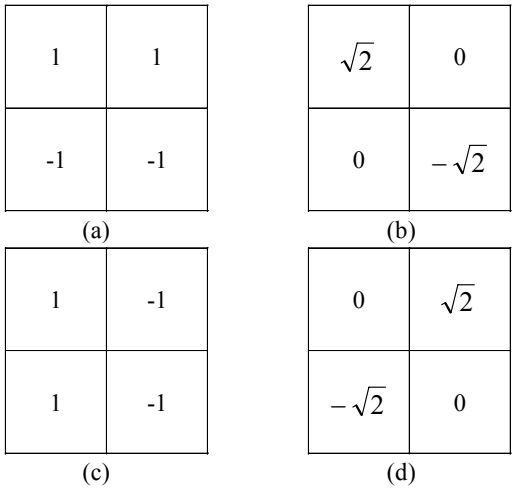

Fig. 1 Board detecting operator and its representation. a,b,c,d represents direction 0^0,45^0,90^0,135^0

4 Combination and Computation of Similarity Distance

The color and shape were presented as histogram in this discussion. The similarity distance can be calculated in Euclid. Let $H_Q(k)$ and $H_D(k)$. Each represents the histogram of one feature from the image Q and D. The similarity distance d(Q,D) can be calculated as follow by histogram.

$$d(Q,D)=\sqrt{\sum_{k=1}^{L-1}[H_Q(k)-H_D(k)]^2} \qquad (2)$$

k represents the eigenvalue, L is the number of features. The similarity distance will be equaled 0(the similarity degree equals 1) when the two histogram are equaled. Otherwise, the similarity distance will be a number between 0 and 1. Usually exist some uncompared among the features. The different features must be withdrew before used in retrieving. So the extend Gauss was used in various withdrew process of features. Let the distance of sub_feature is dM. The relevant average and standard of training are μM and σM. On the assuming of Gauss model, the relevant withdrew dM can be defined as:

$$\hat{d}_M(Q,D)=\frac{d_M(Q,D)-(\mu_M-3\sigma_M)}{6\sigma_M} \qquad (3)$$

In these, Q and D respective represent the relevant sub_feature M of two random images. If M=1, the Q and D represent the extraction of color vector features. If M=2, the Q and D represent the description of shape feature with an angle of 0^0. If M=3, the Q and D represent the description of shape feature with an angle of 45^0. If M=4, the Q and D represent the description of shape feature with an angle of 90^0. If M=5, the Q and D represent the description of shape feature with an angle of 135^0.

5 Relevance Feedback System Design

5.1 Relevance Feedback of Retrieval Process

(1) Initial the weighted $W = [W_i, W_{ij}, W_{ijk}]$, shown as follow:

$$W_i = 1 / I \qquad (4)$$

$$W_{ij} = 1 / J_i \qquad (5)$$

$$W_{ijk} = 1 / K_{ij} \qquad (6)$$

In the time, all types of weighted have the function. In above, I represents the number of feature set. J_i is the vector number of feature's table f_i. K_{ij} is the length of feature vector r_{ij}.

(2) According the weighted W_i, the user's demands will be distributed into relevant features f_i.

(3) Among the feature f_i, calculating the weighted W_{ij}, the user's demands will be distributed into relevant features future.

(4) The object result fitting with querying will be calculated as the relevant similar detecting m_{ij} and weighted W_{ijk} shown as follow.

$$S(r_{ij}) = m_{ij}(r_{ij}, W_{ijk}) \quad (7)$$

(5) Combining each similar value with weighted W_{ij}, then calculate the feature similarity. It will be shown as follow.

$$S(f_i) = \sum_j W_{ij} S(r_{ij}) \quad (8)$$

(6) Combining the feature similar value with weighted W_i together again, calculate the total similar value as follow.

$$S = \sum_i W_i S(f_i) \quad (9)$$

(7) According the total similar value and sorted by descent to get the N image in front of the image database.

(8) The retrieval image will be labeled according to the querying demands and the vision perception. Classification with 5 degrees: excellent similarity, similarity, normally, unallied and extreme out of match.

(9) Adjust the weighted by feedback information. Then the querying images approach to users demands.

(10) Go back to step 2. The system will query next time with the adjusted weighted. The querying will be halted until getting the content results.

Among these, $F = \{ f_i \mid i = 1, 2, \cdots, I\}$ is a series of low-level features. Such as: color and shape. $R = \{ r_{ij} \mid i = 1, 2, \cdots, I; j = 1, 2, \cdots, J \}$ is a relevant series vectors of low-level features f_i. Such as: color histogram and edge histogram. Every r_{ij} can include K vectors. It can be shown as $r_{ij} = [r_{ij1}, r_{ij2}, \cdots, r_{ijk}]$. The weighted has third classes. W_i fits with feature f_i. W_{ij} fits with feature vector r_{ij}. And W_{ijk} fits with the element r_{ijk}. The goal based on weighted adjust and feedback [5][6][7] is to query the best result for users.

5. 2 Adjust of weighted

In the above of step (9), there are two kinds of weighted need to adjust. One is W_{ij} and this adjust was called as internal. Another is W_{ijk} and this adjust was called as external. It will be introduced as follow.

In this adjust of weighted W_{ij} with r_{ij}, the process will be occurred with the feedback. Assume T is the best similar image set with number N according the total similar value S. S_{Tl} is a evaluation of image T_l(l=1,2,. . . ,N). If the result is excellent similar with the querying image, the S_n will be evaluated 3. The others four kinds: similarity, normally, unallied and extreme out of match will be relevant evaluated 1, 0, -1, -3. For every r_{ij}, $T_{ij,l}$ will be assigned to the best similar image according to S (r_{ij}). The process can be described as this:

let $W_{ij} = 0$

if $T_{ij,l} \in T_l (l = 1,2,3,\cdots,N)$ $W_{ij} = W_{ij} + S_n$

otherwise $W_{ij} = W_{ij}$

There is a array will be constructed with the followed data: selecting L images from querying results N and filtered with the eigenvalue of excellent and similarity. The array likes this:

$$\begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1L} \\ r_{21} & r_{22} & \cdots & r_{2L} \\ \cdots & \cdots & \cdots & \cdots \\ r_{K1} & r_{K2} & \cdots & r_{KL} \end{pmatrix}$$

So each range in the array is a rank r_{ijk} with length K. The standard inverse variance σ_{ijk} is a good evaluation of weighted W_{ijk} in r_{ijk} rank. It can be shown as follow. And adjusted control structure shown as figure 2(G is a detecting value and G_0 is the goal value).

$$W_{ijk} = 1 / \sigma_{ijk} \quad (10)$$

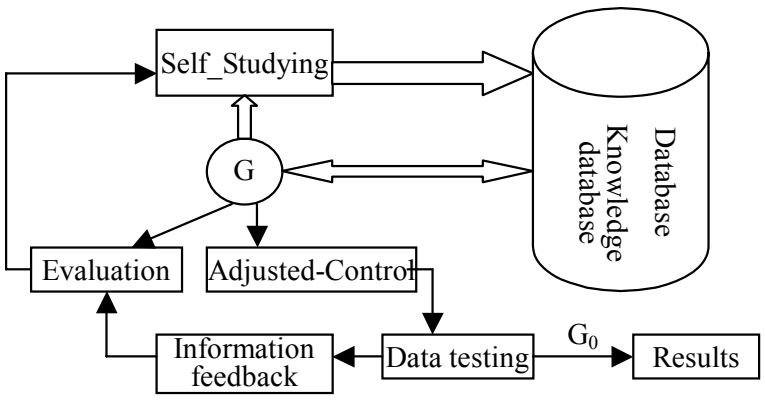

Fig.2 Relevance feedback and control system structur

6 Experiment Results

This experiment has been designed on Matlab. The experiment has selected 1000 image from Corel's Image Database. There are landscapes, architectures, animals, mountains, flowers etc. Each class has 100 images. The image size is 384*256. Every time, 100 images will be selected by random and one of them will be assigned as a sample. Then use the retrieval system to query. The querying results are shown as follow.

Table 1 the experiment results and comparisons

Experiment Methods	Architectures	Flowers	Mountains	Animals	Cars
Retrieving Without Feedback	77.5%	70.2%	68.4%	80.2%	81.3%
Retrieving With Feedback	87.3%	76.1%	74.5%	86.4%	88.5%

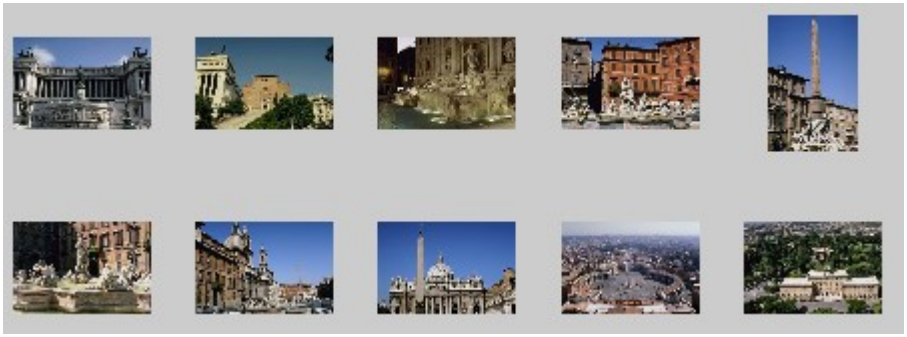

Fig.3 The retrieval result with similarity by the first image sampl

7 Conclusions

The image retrieval results mainly connect with the extraction of low-level features. In this paper, the color feature is stability and edge histogram of shape feature is sensitive. So this retrieval idea is to combine the two features and to use in retrieval. The result shows the best for the stable images. The next working is to get different parameters for the feedback in the retrieval situation.

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