Color and Shape Based Image Retrieval

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***Abstract* – Image retrieval based on some good feature could be extremely inefficient in some cases. As there is no some all-purpose method to achieve suitable retrieval results, we forced to combine different image features to improve quality of image retrieval. Invariant moments and color autocorrelogram are considered in this paper.**

Key words – content based image retrieval, color, shape, autocorrelogram, invariant moments.

I. Introduction

Humans can perform comparison of images simply and intuitively, however corresponding comparison algorithm have not been implemented yet, because of insufficient knowledge about human vision physiology.

There are several approaches targeted to specific classes of images, but the most difficult to solve this problem for the case of arbitrary images. User queries to image collections traditionally classified into three levels of abstraction [1]: primitive level (color, shape, texture) logic level (identification presented), an abstract level (accounting significance scenes). Primitive level features such as invariant moments and color autocorrelogram are considered in this paper.

II. Autocorrelogram

Color correlogram is stable characteristic to change of the camera position, changes of the background, significant changes of the object's form, etc. [2]. But if we consider all possible combinations of color pairs, the size of the correlogram is very large – $O(N^2d)$, where N – number of color palettes and d – size of the distances array. Sometimes trying to find a compromise by selecting a number d, where the volume calculation will be reduced without significant loss of search efficiency. But in practice, often used a simplified version of correlogram – autocorrelogram, which reduces the dimension of the problem to $O(Nd)$ [3].

To compare two autocorrelograms to determine the similarity of the corresponding images can be used distance measures functions L_1 and L_2. Distance measure function L_1 is called Manhattan distance and L_2 is the usual Euclidean distance. Using distance measure function L_1 or L_2, to calculate the distance between two autocorrelograms doesn not significantly affect the results of the comparison [6]. Therefore it is advisable to choose L_1 due to the smaller number of CPU operations required for its calculation compared to L_2.

III. Invariant Moments

Considering the characteristics of the objects shape can conclude that it is more advisable to use region based methods to determine objects shapes, unlike contour based methods.

The classic shape feature is invariant moments. They were proposed by Hu in 1962 [4]. They are resistant to minor changes in the contour of the object, scaling, rotation and translation [5]. This feature has a relatively small size and relatively high computation speed. The main disadvantage of this feature and any other methods of shape description – need of image segmentation.

When comparing invariant moments together, better to use Euclidean distance as the coordinate vector of characteristics given double floating point precision. Coordinates of vectors describing the shape of objects that have different shapes may vary thousandth, so better to use a distance L_2 compared to L_1.

IV. Autocorrelogram Experiments

Since each user has its own search result expectations, there is no exactly the correct query result [6]. Assume that the user wants to find images similar to a given sample (Fig. 1, *a*) and there is only one image in database, which is the most visually similar to a given (Fig. 1, *b*).

a *b*

Fig. 1. Finding images similar to a given sample: *a* – query image, *b* – image to find

For building images features with different parameters and to compare this features special software system was designed and implemented. It allows to convert images in different color spaces, perform segmentation and build features for whole image and it's segments as well.

For the experiments using autocorrelogram was selected palette of 25 basic colors that have been successfully used for image segmentation by quantization [7]. Autocorrelograms for images from Fig. 1 were built in the RGB color space and HSV with different sizes of the array of distances. Distances between corresponding autororrelograms are shown in Table 1.

According to Table 1, we can see that with increasing array of distances to build autocorrelogram, increasing the distance between the derived feature vectors. The relationship between the size of the array of distances and distance is almost linear. Taking for example, experiments 1 and 5, we see that increasing the size of the array three times the distance induced increase in the distance between the characteristics of almost 3.08 times. Array of distances has no great influence on the quality of the comparison of autocorrelograms, therefor only pixels that are at a distance 1 from the current one should be used for building this kind of feature.

TABLE 1

IMAGE COMPARISON BY AUTOCORRELOGRAMS

№	Bluring param	Color space	Distances	Distance
1	-	RGB	1,3,5	1.67
2	-	RGB	1,3,5,7	2.26
3	-	RGB	1,3,5,7,9	2.82
4	-	RGB	1,2,3,4,5	2.83
5	-	RGB	1,2,3,4,5,6,7,8,9	5.15
6	-	HSV	1,3,5	3.60
7	-	HSV	1,3,5,7	4.32
8	-	HSV	1,3,5,7,9	4.89
9	-	HSV	1,2,3,4,5	6.01
10	-	HSV	1,2,3,4,5,6,7,8,9	8.74
11	-	RGB	1	0.48
12	-	HSV	1	1.52
13	-	RGB	1,2,3,4,5,6,7,8,9	5.15
14	-	HSV	1,2,3,4,5,6,7,8,9	8.74
15	1	RGB	1	0.48
16	1	RGB	1,2,3,4,5,6,7,8,9	5.15
17	1	HSV	1	2.17
18	1	HSV	1,2,3,4,5,6,7,8,9	11.43
19	1,5	RGB	1,2,3,4,5,6,7,8,9	5.071
20	1,5	HSV	1,2,3,4,5,6,7,8,9	12.97

The experiments have shown that the transfer of the image in HSV color space and applying a blur, only worsen the comparison results.

V. Invariant Moments Experiments

Comparison of shape features was carried out using a distance measure L_1 and L_2, as well as different sizes of segments. To perform segmentation efficient graph based image segmentation algorithm has been used. Comparison of images (Fig.1, *a* and Fig.1, *b*) by shape features are presented in Table 2.

TABLE 2

IMAGE COMPARISON BY INVARIANT MOMENTS

№	Color space	Bluring param	Dist.	Segment size	Distance
1	RGB	-	L1	100px	4.65E-05
2	RGB	-	L1	500px	3.32E-06
3	RGB	-	L1	1000px	2.78E-06
4	RGB	-	L1	10000px	1.88E-07
5	RGB	1.5	L1	10000px	1.60E-07
6	RGB	1.5	L2	10000px	1.36E-07
7	HSV	-	L1	100px	7.32E-04
8	HSV	-	L1	500px	6.20E-05
9	HSV	-	L1	1000px	9.93E-06
10	HSV	-	L1	10000px	5.33E-07
11	HSV	1.5	L1	10000px	1.00E-06
12	HSV	1.5	L2	10000px	4.19E-07

According to Table 2 we can conclude that HSV color space is inappropriate for efficient graph-based image segmentation algorithm. And we can also conclude that a slight blur improves the image segmentation results.

The general conclusion concerning the construction and the comparison of invariant moments features:

- Preferable to use color space RGB than HSV;
- Apply Gaussian blur function to the image before segmentation with sigma parameter (standard deviation) from range between 0.7 and 1.5;
- Use an initial color comparation threshold for efficient graph based segmentation algorithm equal to 1;
- Set the minimum segment size of 1% of the image size.

Also it makes sense to build several shape features for results of segmentation with different segment size to achive better retrieval result.

Conclusion

The combination of form and color image features can be done by assigning each feature some weighting factor, which will be multiplied by the distance between the comparable properties. Next derived weighted distance can be added together and compared with some predefined threshold to determine whether comparable images are similar in these characteristics.

Another way to combine the color and shape features for image comparison – is to find the distance between the features of the same type, and among these distances to choose minimum that will be compared with a certain threshold of similarity. Alternatively, for each type of feature set similarity threshold and if the distance between the features of at least one type is greater than this threshold, images can be considered as different.

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