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Similarity Between Two Images Using Color Correlogram and Inner Product Metric

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***Abstract* - Color features are important to pictures and they are easy to calculate. Therefore, the features are widely used in Content Base Image Retrieval. The color correlogram is a simple statistics descriptor of a color image that has been widely used for content base image retrieval systems. To measure similarity between two images using the correlogram, the conventional approaches use the relative distance. Here to improve performance of the content base image retrieval systems, the inner product metric is used to measure similarity of images instead of the relative distance. Results of experiments proved that the content base image retrieval using the inner product metric has better performance than the one using the relative distance.**

Keywords – Color Correlogram, Image Similarity, Relative Distance.

I. INTRODUCTION

With the rapid development of the internet and digital equipment, the amount of multimedia information being produced and stored is increasing rapidly, so people pay more and more attention to multimedia information. Images as a kind of multimedia description have been loved by men for a long time. And now to retrieve the target ones among the larger numbers of images immediately. At present content based image features such as color, texture, shape etc. But now a day, the amount of image resources which are available on the World Wide Web has been massively increasing. Hence efficient and flexible content based image retrieval system for automatically retrieving a set of " similar " images to a query image have been becoming real demand to save time and effort of browsing the entire database. To build such systems, it is important that image descriptors used for measuring similarity of images are comparable to those used by humans.

The color correlogram is a simple statistical descriptor of a color image that has been widely used for content base image retrieval system [2-6], It is the extension of the color histogram [7-8]. The problem of the color histogram is that only color distribution and the spatial correlation. The color correlogram expresses how the spatial correlation of color changes with distance.

Huang [2] used a relative distance for measuring similarity between two images using the color correlogram. Though, the relative distance has a serious draw back as follows. It is reasonable that a bigger value of the correlogram should be more important than smaller one. But in the relative distance, the reciprocal of value of the correlogram is regarded as a weight for difference value of the correlogram. Therefore due to draw back, some results of the image retrieval are not so effective.

This paper is organized as follows. The correlogram is reviewed in section 2. Section 3 explains the problem of using relative distance. Section 4 described inner product metric. Section 5 implementation in content based image retrieval. Section 6 is devoted to concluding remarks.

II. The Color Correlogram

Let I be a color image with the size of n1 x n2. Usually the colors in I are represented by RGB color model. BY this model, a color is represented by a three dimensional vector: (R, G,B). The magnitude of each component is from 0 to 255, so totally 2563 = 16,777,216 types of colors can be represented. In this paper, to reduce the size of correlogram, each color is quantized into m color bins, c1-------cm. For a pixel p =(x,y) Є I, p Є I c means that color of p is c. Then the colorrelogram of I is defined for i, j Є { 1,2,............,m}, and k Є { 1,2,............,n} by:

$$\gamma_{c_i,c_j}^{(k)}(I) \triangleq \Pr_{\substack{p_1 \in I_{c_i} \\ p_2 \in I}} \left[p_2 \in I_{c_j} \middle\| p_1 - p_2 \right| = k \Big], \quad (1)$$

Where $|p_1 - p_2| = \max\{ |x_1 - x_2|, y_1 - y_2 |\}$ [2]. That is given any pixel with color c_i, the correlogram gives the probability of finding a pixel with color cj at a distance k from thegiven pixel. The correlogram of I, $\gamma^{(k)}_{ci,\, cj}(I)$ captures spatial correlation between c_i and c_j.

In order to reduce the size of the correlogram, Huang et al. [1] have defined autocorrelogram which is a subset of the correlogram. The autocorrelogram of / captures spatial correlation between identical colors only and is defined by:

$$\alpha_c^{(k)}(I) \triangleq \gamma_{c,c}^{(k)}. \quad (2)$$

Given c_t, c_p and k, to measure the similarity between two correlograms or autocorrelograms, a relative distance $d_1 (r,s) = \backslash r - s\backslash/(1 + r + s)$ was proposed. The 1 in the denominator of the d_1 is added to prevent division by zero. The relative distance d_1 of the correlogram and autocorrelogram descriptors are defined by:

$$\left|I_1 - I_2\right|_{\gamma,d_1} = \sum_{\substack{i,j\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} d_1\left[\gamma^{(k)}_{c_i,c_j}(I_1),\gamma^{(k)}_{c_i,c_j}(I_2)\right], \tag{3}$$

and

$$\left|I_1 - I_2\right|_{\alpha,d_1} = \sum_{\substack{i\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} d_1\left[\alpha^{(k)}_{c_i}(I_1),\alpha^{(k)}_{c_i}(I_2)\right]. \tag{4}$$

III. Problem of the Relative Distance

This paper will show that using the relative distance d1 to measure the similarity does not provide good performance. It is reasonable that in this similarity measurement, a larger value of correlogram should be more important than a smaller one of the correlogram Example,

For r1 =0.1, s1=0.105 and r2 =0.01, s2 =0.015, │ r1 - s1 │= │ r2 - s2 │= 0.005, but │ r1 - s1 │ should be more regarded as more important than │ r1 - s1 │. However in the definition of the relative distance d1 (r,s) = │ r - s │x 1 / 1+r+s, 1 / 1+r+s can be regarded as weighting value to │ r - s │. Therefore the weighing value values for │ r1 - s1 │& │ r2 - s2 │are 1/(1+0.1+0.105)=0.83and 1/(1+0.01+0.015)=0.98,respectively. That is the weighing value for │ r1 - s1 │is smaller than │ r2 - s2 │. This fact shows that in the relative distance │ r2 - s2 │is regarded to be more important │ r1 - s1 │.

IV. The Definition of Inner Product

Because of the problems described in the previous section, to improve performance of content base image retrieval systems, so here proposes the inner product metric to measure similarity between two images. The inner product metric of the correlogram and autocorrelogram defined as:

$$\langle I_1, I_2\rangle_\gamma = \sum_{\substack{i,j\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} \frac{\gamma^{(k)}_{c_i,c_j}(I_1)\,\gamma^{(k)}_{c_i,c_j}(I_2)}{\left\|\gamma(I_1)\right\|_2\left\|\gamma(I_2)\right\|_2}, \tag{5}$$

and

$$\langle I_1, I_2\rangle_\alpha = \sum_{\substack{i\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} \frac{\alpha^{(k)}_{c_i}(I_1)\,\alpha^{(k)}_{c_i}(I_2)}{\left\|\alpha(I_1)\right\|_2\left\|\alpha(I_2)\right\|_2}, \tag{6}$$

where $\left\|\gamma(I)\right\|_2 = \sqrt{\sum_{\substack{i,j\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} \left[\gamma^{(k)}_{c_i,c_j}(I)\right]^2}$ and

$$\left\|\alpha(I)\right\|_2 = \sqrt{\sum_{\substack{i\in\{1,\dots,m\}\\ k\in\{1,\dots,n\}}} \left[\alpha^{(k)}_{c_i}(I)\right]^2}.$$

V-a. *Implementation of Content Based Image Retrieval System Using Correlogram*

In my experiment s, the conditions of implementing of the relative distance d1 and the inner product metric are as follows:

1) Each color of attested image is quantized into 64 color bin { c1, c2, c3, c4,------------ c64}.

2) k Є{ 1,3,5,7}.

Nxt, CBIR is applied to three image databases. The first database was subset of COREL database[8] with 1000 images with the size of 384x256x384 in 10 categories as listed in table 1.

Moreover in order to test performance of the CBIR system for database of images with the different sizes, the two databases are generated by reducing the size of the original images to 50 %, 33 %

Table 1. The average rank of the correlogram

Similarity Method / c (Category)	Database 1		Database 2		Database 3	
	the inner product	the relative distance d_1	the inner product	the relative distance d_1	the inner product	The relative distance d_1
1 (Africans)	174.76	284.11	169.78	322.36	158.32	281.36
2 (Beaches)	233.49	353.45	274	384.93	279.32	376.73
3 (Buildings)	256.12	159.18	257.35	170.6	246.89	166.6
4 (Buses)	228.36	376.71	202.62	378.19	197.7	421.14
5 (Dinosaurs)	119.8	121.95	85.61	99.48	63.31	73.83
6 (Elephants)	252.88	221.56	238	212.26	255.54	250.12
7 (Flowers)	300.72	248.37	282.22	232.73	265.32	239.76
8 (Horses)	207.5	241.37	213.06	241.47	226.92	255.8
9 (Mountains)	248.94	226.23	256.52	219.8	238.16	213.92
10 (Food)	134.35	212.83	142.76	279.87	170.63	309.19
Total Average Rank	215.69	244.57	212.19	254.17	210.21	258.84

5-b. *The Query Images and performance Evaluation*

30 images from each category are randomly selected as query images. So total query images are 300. Therefore for a query image, a retrieved image has been considered as correct match if it belongs to the same category of the query image. But the correlogram of the inner product metric was compared with the correlogram of the retrieve distance d1 in terms of the average rank defined below.

Let database i=1,2,3 denote those of 100%,50%, 33% sizes of images and let c=1,---,10. Denote 10 categories of tested images. Next let R (c) denote a set of selected query images from a category c, and let Ai (Iq) denote the set of all correct matched images to a query image Iq.Also let s denote the number│ s│ in the set s. The average ranks for images belonging to the category c from the database i is defined as follows:

$$C_i(c) = \frac{\sum_{I_q\in R_i(c)} \sum_{I_R\in A_i(I_q)} Rank(I_R) / \left|A_i(I_q)\right|}{\left|R_i(c)\right|}, \tag{7}$$

Where IR is the retrieved image. Finally the total average rank is

$$\overline{C_i} = \sum_{c=1}^{10} C_i(c)/10. \tag{8}$$

NOTE That performance of the content based image retrieval is to be good, if its total average rank is small.[9] From the table 1 in term of the total average rank, the content based image retrieval system using the inner product metric provides better performance than the relative distance d_1.

The correlogram, performance of the inner product metric will increase, if the size of the images are decreased. On the other hand performance of the relative distance d will decrese, if the sizes of the images are also decereased. This propertiy of the inner product is very useful, because the small image uses less computation time than the bigger one.

VI. Conclusion

This paper has shown that the correlogram using the relative distance d in similarity measurent phase do not provide good performance. The reason is that the larger magnitude of a correlogram should be considered to be more important than a smaller one of the correlogeram. However, the relative distance d_1 weights the large one with a small weighing value or vice versa. But inner product metric is proposed to solve this problem. With the help of experiment the inner product metric provides better performance than the relative distance d_1.

But finally another very important advantage of using the inner product metric is that this is provide better performance if the size of the test images are decreased. This property is very useful. Because the smaller images cost the smaller computation time.

VII. References

[1] Brunelli, R., and Micho, “Histogram Analysis for image retrieval, Patteren Recognition, vol. 34 pp-1625-1637,2001

[2] J.Huang, S. R. Kumar, M. Mitra, W. J. Zhu, and R. Zabih, “Image Indexing Using Color correlogram”, IEEE Conf. Comp. Vision and Pattern Recognition, pp. 762-768, San Juan, 1997.

[3] G. Qiu, “Color Image Indexing using BTC,” IEEE Trans. on Image Processing, Vol. 12, Iss. 1, pp. 93-101, Jan. 2003.

[4] T. Ojala, M. Rautiainen, E. Matinmikko, and M. Aittola, “Semantic Image Retrieval with HSV Correlograms,” Proc. 12th Scandinavian Conference on Image Analysis, Bergen, Norway, 621-627.

[5] M. Rautiainen and D. Doermann, “Temporal Color Correlograms for Video Retrieval,” Proc. 16th International Conf. on Pattern Recognition, Vol. 1, pp. 267-270, 11-15 Aug., 2002

[6] K.H. Yap and K. Wu, “A Soft Relevance Framework in Content-Based Image Retrieval Systems,” IEEE Trans. on Circuits and Systems for Video Technology, Vol. 15, No. 12, pp. 1557-1568, Dec., 2005.

[7] M. Swain and D. Ballard, “Color Indexing,” In Intl. Journal of Computer Vision, 7(1): 11-32.

[8] J. Li., J. Z. Wang, and G. Wiederhold, “Simplicity: semantics sensitive integrated matching for picture libraries,” IEEE Trans. Pattern Anal. Machine Intell., 23(9):947-963, Sep. 2001.

[9] Thurdsak LEAUATONG Kiyoki ATSUTA Shozo KONDO “New CBIR Using Color Correlogram”-8TH Internationa workshop on image analysis and multimedia interactive service-2007