Trademark Recognition Using a Weighted Combination of Different Image Features

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***Abstract*—Large image databases find diverse applications in real-life situations. It is essential to develop an efficient technique to grasp required information from these databases. A good number of researchers are involved in developing techniques for object retrieval and recognition using different image features, such as color histogram, distance, and shape parameters. Efficient retrieval and robustness are two main criteria for recognition of an object using image databases. Keeping this in mind, the present paper describes a hybrid method using a weighted combination of color histogram, distance, and moment parameters for trademark recognition. Our experimentation with a database containing 200 trademark images confirms the superiority of the present method in comparison to the techniques with single feature.**

***Index Terms*—Color histogram, distance parameter, image recognition, moment invariant, trademark.**

I. Introduction

Image retrieval from databases finds diverse applications, such as trademark registration and recognition, fingerprint identification and face recognition. However, all these applications need to handle large image databases with huge memory space. Although, advancement of compression techniques has reduced the storage requirements to some extent, it is very cumbersome for users to search through the entire database, which consists of huge amount of images. Therefore, an efficient and robust image recognition system is an ultimate necessity to resolve the retrieval problem.

At the present time, there are many techniques available for image retrieval. The image retrieval based on image content is more desirable in a number of applications. Traditionally, textual features such as filenames, captions, and keywords have been used to annotate and retrieve images. However, there are many difficulties with this traditional approach. In general, human-being uses color, shape, and texture to understand and recollect the contents of an image [1]-[3].

A good number of articles have been published in the field of image retrieval based on feature extraction [4]-[14]. The methods described in literature can be broadly classified into two categories. One is spatial information preserving method, such as polygonal approximation of the object of interest, physical modelling, and principal component analysis (PCA). The other is non-spatial information preserving method based on statistical features, such as histogram intersection, moment invariant, and texture. Both categories extract features based on the cues, such as color and shape [1].

Recently, Swain and Ballard [4] proposed a color matching method, which is known as histogram intersection method. Beside this, Babu M. Mehtre, Mohan S. KanKanhalli, A. Desai Narasimhalu, and Guo Chang Man [2] proposed distance and reference color methods. However, these schemes do not preserve the spatial information in the image. In addition, Jain and Vailaya [1], [14] proposed shape based matching techniques, which gives better performance in comparison to the above methods.

This paper describes a hybrid method using a weighted combination of different image features mainly color histogram, distance, and moment parameters, which addresses efficiency and robustness - the two fundamental issues of trademark recognition. Our method outperforms the existing three techniques with single feature.

II. Proposed Method

In large image databases, use of a single attribute such as color or shape may not be sufficient enough to discriminate object in images. Besides, histogram is a coarse characterization of an image, thus, images with very different appearances can have similar histograms. Hence, image retrieval using only histogram may enhances the chance of false recognition. For these reasons we have combined shape and color attributes of images by hybridizing a weighted contribution of histogram, distance, and affine moment invariant parameters in order to improve the accuracy of image retrieval. Fig. 1 shows the block diagram of our proposed image retrieval system. The image database used in this study has been created by scanning and downloading trademarks. Currently, it consists of 200 trademarks in jpeg format where 100 trademarks are directly downloaded from the Internet and the remaining 100 are taken using scanning process with a scanner (Canon: CanoScan Lide 100, 2400 × 4800 dpi). These 200 trademark images in our database have similar shape and color to make the retrieval problem more challenging.

Color is the most widely used attribute in image retrieval and object recognition. Human beings recognize object though there is a small variation in color as well as gray level values.

Manuscript received July 23, 2012; revised September 25, 2012.

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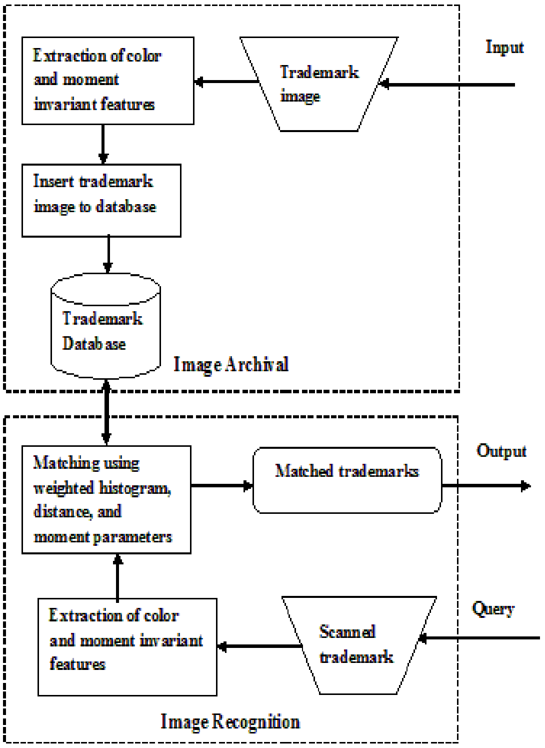

Fig. 1. Block diagram of the proposed image retrieval method.

An RGB color image is an $M\times N\times 3$ array of color pixels, where each color pixel is a triplet corresponding to red, green, and blue components. The data class of the image components determines their range of values. Here, we use the range of values [0, 255] for RGB images. We have represented the color information (RGB) by three 1-D histograms T_R, T_G, T_B for original image stored in the database and Q_R, Q_G, Q_B for the query image. All the histogram data are normalized. The histogram intersection method [2], [4] and the Euclidean distance of the color histogram method [1], [2] are represented as follows

$$S_H(T,Q)=\frac{\sum \min(T_R(r),Q_R(r))+\sum \min(T_G(g),Q_G(g))+\sum \min(T_B(b),Q_B(b))}{3} \quad (1)$$

$$S_D(T,Q)=1.0-\sqrt{\frac{\sum (T_R(r)-Q_R(r))^2+\sum (T_G(g)-Q_G(g))^2+\sum (T_B(b)-Q_B(b))^2}{2*3}} \quad (2)$$

where S_H denotes the similarity value between the original image T and query image Q using histogram intersection method. Similarly, S_D denotes the similarity value between T and Q using Euclidean distance method.

It is known that apparently different images may produce the similar color histogram even if their contents are different. So, it becomes imperative to use additional image attributes for an effective recognition. Here, we have considered affine moment invariants [15] of the original and query images as an additional parameter. Affine moment is invariant to translation, rotation, and scaling variations. The similarity between the query and original images can be written as

$$S_M(T,Q)=1.0-\frac{|T_m-Q_m|}{\max|T_m-Q_m|} \quad (3)$$

where $T_m=\frac{\mu_{T20}\mu_{T02}-\mu_{T11}^2}{\mu_{T00}^4}$ and $Q_m=\frac{\mu_{Q20}\mu_{Q02}-\mu_{Q11}^2}{\mu_{Q00}^4}$

The value of S_M denotes the similarity between original (T) and query (Q) images and it lies in the interval [0, 1]. If the query and the original images are identical then $S_M(T, Q)=1$. The values of the affine moment invariant of the original image and the query image are represented by T_m and Q_m, respectively.

We have integrated the contributions of the shape and color based retrievals by combining the weighted similarity values obtained by color histogram, distance, and moment invariant as follows

$$S=\frac{w_h\times S_H+w_d\times S_D+w_m\times S_M}{w_h+w_d+w_m} \quad (4)$$

where w_h, w_d, w_m are the weights assigned to the results of the histogram intersection, the distance, and the affine moment invariant, respectively. However, their values are very crucial for accurate recognition. Through matching, we have taken three most similar images on the basis of the hybrid similarity index S. We have normalized the value of S, dividing it by $w_h+w_d+w_m$, so that the value of S also lies in the interval [0, 1].

III. Experimental Results and Discussion

A weighted combination technique based on color and shape features of images has been implemented, which is tested on our experimental databases. Gaussian noise with mean 0 and variance 0.000007 to 0.0001 are added in an increasing order with the query image to test the accuracy and stability of our system. With the increasing level of noise the Signal-to-Noise Ratio (SNR) of query images vary from 38.3327 dB to 17.7100 dB. We have considered three different databases: 100 scanned images, 100 downloaded images, and (100+100=) 200 combined images. In each case, a query image is picked from a database, noise is added and then matching is searched using the entire database. This process is followed individually for every image of all databases. For a given query image, the retrieval is marked accurate when the most similar image in the database is recognized as the best retrieval. The weights w_h, w_d, w_m are determined empirically.

The values of the weights are set to w_h=46.0, w_d=8.5, w_m=45.5 through experimentation. It is found that the value of similarity indices produced by different methods for the same pair of query and original images are numerically distant. In such instances, multiplication of weights with similarity indices of all images in the database may places some low rank images with higher similarity value as the best retrieval, which causes a false recognition. To overcome this problem, we proposed the weighted combination technique where the corresponding weights are multiplied with only the three best similar retrieved images using each method. Therefore, it enhances the probability of the correct image recognition from nine most similar images using histogram, distance, and moment invariant while reducing the chance of false recognition. Finally, the results are divided by $w_h+w_d+w_m$ to keep the similarity indices in between 0 and 1, i.e. normalized.

Table I summarizes the results of number of recognized images using different methods with different Signal-Noise-Ratio. From this table we can find that, the performance (no. of recognized images) of our proposed system increased by 1% to 18% than color histogram method, 1% to more than 40% than distance method, and 1% to more than 30% than moment invariant method where the SNR decreased from 38.3327 dB to 17.71 dB.

TABLE I: COMPARISON OF NUMBER OF TRADEMARK IMAGES RECOGNIZED USING DIFFERENT METHODS

	Methods	**SNR = ∞**	**SNR= 38.33 dB**	**SNR= 29.51 dB**	**SNR= 28.85 dB**	**SNR= 28.24 dB**	**SNR= 27.72 dB**	**SNR= 27.30 dB**	**SNR= 26.90 dB**	**SNR= 20.48 dB**	**SNR= 17.71 dB**
Database of Scanned Images (100)	**Color histogram**	100	100	100	100	100	99	99	99	89	86
	Distance	100	100	87	81	78	74	73	71	65	51
	Moment invariant	100	100	90	89	87	85	84	80	69	60
	Weighted combination	100	100	100	100	100	100	100	100	97	96
Database of Downloaded Images (100)	**Color histogram**	100	99	96	94	51	88	85	84	73	68
	Distance	100	99	65	62	58	56	55	55	<50	<50
	Moment invariant	100	98	93	93	90	88	88	87	77	65
	Weighted combination	100	99	98	97	97	97	97	96	89	86
Combination of Downloaded and Scanned Images (200)	**Color histogram**	200	199	195	194	189	182	180	179	158	154
	Distance	200	198	147	135	130	122	121	118	<100	<100
	Moment invariant	200	196	167	164	164	157	157	155	116	<100
	Weighted combination	200	199	197	195	194	194	193	193	176	167

In Fig. 2 we present comparison graphs for scanned trademark where the recognition rate of different methods degrades with the diminution of Signal-to-Noise Ratio (SNR). These graphs pertinently show that the rate of recognition degrades much slowly in our weighted combination technique than the other techniques, which confirms the superiority of our system. Fig. 3 shows the retrieval results of trademark image obtained using color histogram, distance, moment invariant, and hybrid methods.

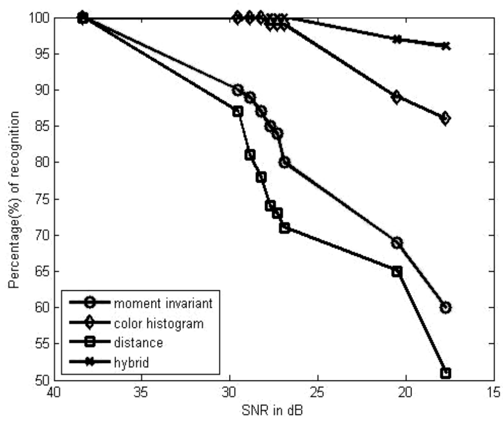

Fig. 2. Recognition rate with respect to signal-to-noise ratio (SNR) obtained from color histogram, distance, moment invariant, and hybrid methods.

It is found that recognition process using color histogram, distance, or moment invariant only assigns high similarity value to similar images, but it may also assigns high similarity value to perceptually different images. This may affect the rank order of the correct match as well as the accuracy of using one parameter. Combining the weighted contributions of the above three distinct parameters reduces the number of false retrievals as it is highly unlikely that three perceptually different images are assigned high similarity values by corresponding feature. Therefore, the performance of our proposed hybrid technique of using the weighted combination of color histogram, distance, and moment invariant is better than that of using any of the three parameters individually.

IV. CONCLUSIONS

We presented a weighted combination of color histogram, distance, and moment invariant for automated retrieval of trademark color images. Our experimental results show that this new technique provides better and more robust performance than either of the individual methods. However, our system is a little bit slow as we performed linear search using three methods in a combined manner. Future work deals with making the system more robust and stable, as well as speedy by adding more features and including indexing technique.

Fig. 3. Sample example of image retrieval obtained using color histogram, distance, moment invariant, and hybrid techniques.

REFERENCES

[1] A. K. Jain and A. Vailaya, “Image retrieval using color and shape,” *Pattern Recognition*, vol. 29, pp. 1233–1244, August 1996.

[2] B. M. Mehtre, M. S. KanKanhalli, A. D. Narasimhalu, and G. C. Man, “Color matching for image retrieval,” *Pattern Recognition Lett.*, vol. 16, pp. 325–331, March 1995.

[3] I.-S. Hsieh and K.-C. Fan, “Multiple classifiers for color flag and trademark image retrieval,” *IEEE Trans on Image Processing*, vol. 10, pp. 938-950, June 2001.

[4] M. J. Swain and D. H. Ballard, “Color indexing,” *International Journal of Computer Vision*, vol. 7, pp. 11-32, Nov. 1991.

[5] J. R. Smith and S.-F. Chang, “Tools and techniques for color image retrieval,” in *Proc. IS&T/SPIE*, 1996, vol. 2670, pp. 426-437.

[6] R. Schettini, “Multicolored object recognition and location,” *Pattern Recognition Lett.*, vol. 15, pp. 1089-1097, November 1994.

[7] H.-L. Peng and S.-Y. Chen, “Trademark shape recognition using closed contours,” *Pattern Recognition Lett.*, vol. 18, pp. 791-803, August 1997.

[8] G. Pass and R. Zabih, “Comparing images using joint histograms,” *Journal of Multimedia Systems*, vol. 7, pp. 234-240, May 1999.

[9] M. A. Nascimento, V. Sridhar, and X. Li, “Effective and efficient region-based image retrieval,” *Journal of Visual Languages and Computing*, vol. 14, pp. 151-179, April. 2003.

[10] R. Phan and D. Androutsos, “Color logo and trademark retrieval and tracking in unconstrained image sequences using colour edge gradient co-occurrence histograms,” in *Proc. CCECE’09*, 2009, pp. 225-228.

[11] Z. Hong, Q. Jiang, and M. Wu, “Combining block and corner features for content-based trademark retrieval,” *Wuhan Univrsity Journal of Natural Sciences*, vol. 12, pp. 907-911, Sept. 2007.

[12] G. Cortelazzo, G. A. Mian, G. Vezzi, and P. Zamperoni, “Trademark shapes description by string-matching techniques,” *Pattern Recognition*, vol. 27, pp. 1005-1018, August 1994.

[13] Z. Li, K. Hou, Y. Liu, L. Diao, and H. Li , “The shape recognition based on structure moment invariants,” *International Journal of Information Technology*, vol. 12, pp. 97-105, 2006.

[14] A. K. Jain and A. Vailaya, “Shape-based retrieval: a case study with trademark image databases,” *Pattern Recognition*, vol. 31, pp. 1369-1390, Sept. 1998.

[15] J. Flusser, T. Suk, and B. Zitová, *Moments and Moment Invariants in Pattern Recognition*, 1st ed., UK: Wiley, 2009.

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