Trademark Image Retrieval Based-Color Features Using Statistical Methods

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Abstract:

Since the number of registered trademarks are increasing rapidly, manage these images and identifying similar trademarks by human in response to user queries has become a significant problem and time-consuming. To deal with this problem, design and implement an effective queried by Image Retrieval System (IRS) called Trademark Image Retrieval Based-Color Feature (TIRBCF) which is able to retrieve trademark image based on visual low-level image content from a big database of trademark images described by descriptors of color feature is presented as the major objective of this work. TIRBCF is based over the index of Hue (H), Saturation (S) and Value (V) of HSV color space because it is so close to human visual vision. TIRBCF is automatically selects appropriate color descriptor using statistical method to discriminate trademark images. Color retrieval is achieved by utilizing four statistical color descriptors including HSV Color Histogram (HCH), Mean HSV Color, and Median HSV Color (MHC) of an image as a feature set. Intersection Distance (ID) measurement for HCH and Euclidean Distance (ED) for other color descriptors are used as the color vector matching because its simplicity and effectiveness. The user provides query image through user interface, the system will extract color descriptors from it, then compared with those extracted from the trademark images database in order to retrieve similar trademarks. Experiments have been conducted on a database of 3000 trademark images and the results demonstrate the accuracy of the precision/recall estimates in comparison to human-judge.

Key word: Trademark retrieval, Color descriptors, Similarity measures, Image database

1. Introduction

A trademark can be defined as the name of brand and a distinguishing sign used as an intellectual ownership by any organization or any individual that includes any name, logo, figure, word, letter symbol, design, or combination of them (Nigam A, etc., 2011). In several countries, trademarks must be formally registered with the national patent office to gain legal protection (Pinjarkar, L., & Sharma, M., 2013).

The purpose of trademark is to distinguish and identify the products or goods of one tradesman or supplier from those of others, and to show the source of the services or goods. To ensure using the trademark exclusive by its owner, the trademark should be registered at the government patent office, so, every a new trademark that submitted for registration should be not conflict with other registered trademark (Ranjeet Kumar, etc., 2011). In the traditional checking, firstly, the existing trademarks were grouping into several similar classes depending on features like shape, color groups to specific class order, then matching process is performed between the new trademark with all existing trademarks manually. Because of the excessive increase in the registered trademarks over the world every day, where millions of trademarks being submitted for registration need to have distinctiveness from the existing trademarks. So, the manual matching process becomes very difficult and time-consuming (Pinjarkar, L., & Sharma, M., 2013, M.S. Hitam, etc., 2008). Therefore, the need to design and implement an effective electronic system to retrieve the similar trademark images it become necessary to avoid the problems of traditional process and to ensure the non-recurrence of a registered trademark previously. This system is call **C**ontent **B**ased **I**mage **R**etrieval (**CBIR**) system because it is still a very active area of research for building and managing large multimedia databases such as trademark registration, medical diagnosis, face recognition, fingerprint identification, art collections, crime prevention, and photograph archives, etc. (Eakins, etc., 2003).

The trademarks Images can be classified into four types as shown in figure (1) including: *Firstly*, word-in-mark, contains purely words or characters only. So, the character recognition is required to distinguish this type. *Secondly*, a device-mark that contains graphical, symbolic elements, icons or images only, the key element to distinguish this type is a geometric shape. *Thirdly*, composite-mark that consists of the first and second type. *Lastly*, complex-mark that contains a complex image (M.S. Hitam, etc., 2008, C. Wei, etc., 2009).

Fig. 1: Trademark Types: a) Word-in-mark b) A device-mark; c) A device-mark; d) Complex-mark

Image feature is the main key in CBIR system; shape, texture, and color are considered as visual and low-level image features that are used in IRS. Most of previous related works of Trademark Image Retrieval (TIR) system are based on shape feature using different shape descriptors as illustrate in the next section although most of trademark images contain different colors as noted in figure (1), but rarely used color feature in the previous of TIR systems.

To consider an IRS as an efficiently system, it must provide high accuracy and a high speed of retrieval results. Therefore, in this paper, the main contribution is to design an effective TIR system using a query by example to retrieve similar trademark images based on color feature using different statistical methods including color histogram, mean color, and median color to achieve a high retrieval performance of proposed TIR system.

The rest of this paper included the following sections: Section 2 provides a brief survey of the related work and the existing TIR systems. The phases of CBIR is presented in section 3. The algorithm of proposed TIRBCF system is described in section 4. The performance evaluation of the proposed TIRBCF system is described in section 5. Section 6 present the results and discussion. Finally the conclusions and future work are presented in section 7.

2. Related Work and Existing TIR systems

A number of related works of automatic TIR systems have been done using various techniques of the image features is given as following:

M.S. Hitam, etc., (2006) have proposed a TIR system based integrate Zernike moments descriptor as shape feature and color-spatial as color feature. The experimental results show that integrate both features can really enhance the retrieval results by recognition the similarity trademark images efficiently. *Euripides G.M. Petrakis , etc., (2006)* have proposed a TIR system on the web based combining image content and text into retrieval process using Falcon and reweighting method, then allow the user to give his opinion about which image is similar and which one is not similar. The experimental results proved that the proposed method comparing with other methods to be more efficient. *Chia HungWei, etc., (2009)* have proposed a TIR system using a global and local canny edge detector as shape feature and achieve a procedure normalization of shape feature. Where the local features represent the indoor details of the trademarks images while the global features represent the essential information of all objects located in the trademark image. The proposed method gives a high precision and recall values with 0.90 and 0.42 respectively. *Iwanaga, T., etc., (2011)* have proposed an efficient retrieval system using an image example as query then retrieve trademark images from trademark and patent office's digital archives based the semantic content using means of the Vienna codes, and the visual contents (image feature) using shape and color features. The feature vector of trademark descriptors were indexed using hashing data structure to perform k-NN search in high-dimensional spaces. The results list of each feature is sorted ascending based on the value of similarity distance, then combined them using a weighted Condorcet method. Relevance feedback technique was used to refine the obtained results. The experimental results is done using a dataset of 30000 real trademark images that categorise into 1350 various Vienna categories. The proposed method gives a high precision and recall values with 0.98 and 0.96 respectively. *Zhenhai Wang, & Kicheon Hong, (2012)* they proposed a TIR system based integrate the local features and the image global features using Zernike Moments (ZMs). The similarity distance values are sorted ascending. Scale Invariant Feature Transform (SIFT) features were used for matching between the query image with database images. Experimental results shown that SIFT method give a high precision and recall more than the single ZMs feature. *Fatahiyah Mohd Anuar, etc., (2013)* have proposed a trademark retrieval technique using Zernike moment's coefficients as global shape descriptor and the edge-gradient co-occurrence matrix as local shape descriptor.

It observed from literature review listed above that most of TIR systems were designed based on shape feature. Therefore, in this paper, proposed TIR system based on different descriptors of color feature is present to handle all trademark images types.

The accuracy of various statistical color descriptors are discussed. The motivation is to select the best color descriptor to be used in another image retrieval application.

3. CBIR Phases

Typically, CBIR consist of three phases as shown in figure (2): Firstly, *Off-line* phase which include three process; Image database collection, feature extraction process to get Feature Vectors (FVs) for all image collection, and lastly save these FVs in a database to get Database of Feature Vectors (DFVs). Secondly, the *On-line* phase which include two process, query image selection, feature extraction to get Query Feature Vectors (QFV), and finally, the *Retrieval* phase, which include matching process between QFV and DFVs using one of similarity measurement to compute the distance values, then display the similar images that have smallest distance value.

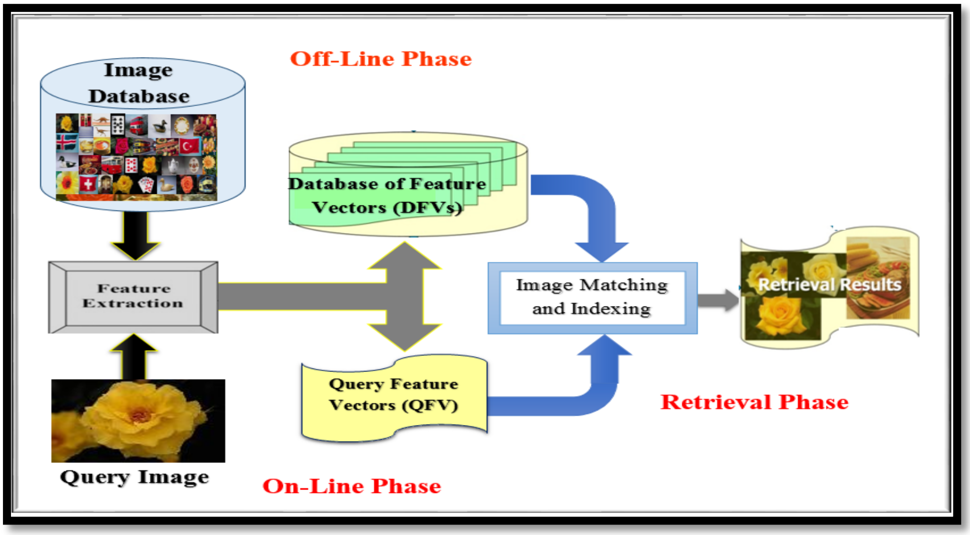

Fig. 2: General Diagram of CBIR system

4. Proposed TIRBCF System Algorithm

The algorithm of proposed **T**rademark **R**etrieval **B**ase-**C**olor **F**eature **M**ethod (**TIRBCF**) system include many stages as shown in figure (3), starting with trademark image collection stage, trademark image pre-processing stage, color feature extraction stage, the image query stage including the same processes applied on database images, and lastly retrieval stage to retrieve similar images based each color descriptor. Each stage we will be discuss in some details in the following sections.

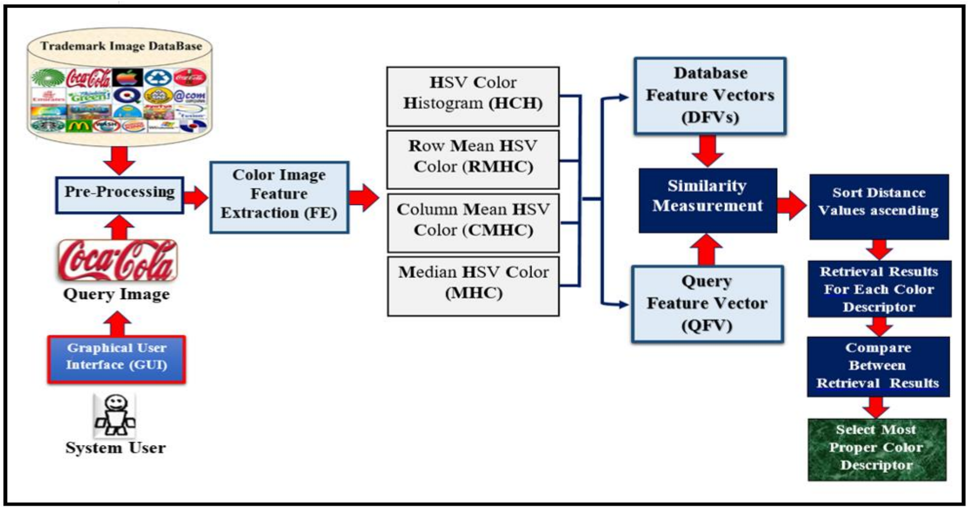

Fig 3: Diagram of proposed (TIRBCF) system

4.1 Trademark Image Collection Stage

The Trademark Image DataBase (TIDB) that used to evaluate the performance of proposed TIRBCF system is contains of 3000 different trademark images randomly collected from different websites, 50 trademark images are used as querie images.

4.2 Pre-Proccessing Stage

Different processes will be done on each trademark image database in this stage including:

1. Typically, trademark images are designed in different sizes, therefor, in order to build an efficiently IRS by reducing the retrieval time, all images in the database are resize to 256*256 pixels.
2. Convert RGB color space to Quantization HSV (QHSV) color space. The colors in the images is represented through one of any common color spaces such as RGB, HSV, XYZ, YUV, L*a*b*, etc. (T. Gevers, 1998). RGB can be converted to another color spaces in order to improve the color space to become close to the human vision such as HSV, CIE, LUV, etc. (S. Mangijao Singh & K. Hemachandran 2012).

A color space is a method that create, specify, and visualize color. The color space of trademark image is RGB and because it is not perceptually uniform, therefor it should be select the appropriate color space to get a better retrieval results. Therefore, Convert RGB to HSV color space which contain the three integral parts [Hue (**H**), Saturation (**S**) and Value (V)] is the second pre-processing that will be done before feature extraction process because HSV has positive effect on retrieval results and has information about each true color in a way very clear to human and simply converted from the RGB color space. Figure (4) shows an example of convert an RGB image color to HSV. For more details about conversion model RGB to HSV mathematical, see (Shiv Raj Singh, & Dr. Shruti Kohli, 2015).

Fig. 4: Convert RGB image color to HSV color

Another reason for using HSV in IRS that it is give a good color feature like color histogram comparing with another color spaces. The most significant reason for using HSV color space, that is gives a natural description of color neighborhood or color distance, thus we can easily compute non-membership of an selected color (S. Manimala and K. Hemachandran, 2011; Shaoping Xu, etc., 2012). In order to reduce the computation of color feature extraction and to decrease the process speed, color quantization process should be used to reduce the number of color bins in an image which is equal to 2^{24}=16777216 without any bad effective on image quality by collect the similar colors to each other in the same bin (Jagbir Singh Gill, etc., 2016). In this case, Color Quantization is helped on decreasing the information about the image content without losing any important information; thus it will help on reducing the storage space, reduce the processing time, and increase the accuracy of the results. The positive effect of color quantization on IRS has been stated by many researchers (X. Wan & C. C. J. Kuo, 1996 & 1998; M. Lew, etc., 2006; Ruba A. A. Salamah, 2015**;** Fatin A. M, 2016). In this paper, quantize each pixel in HSV color space to 256 bins by using non-uniform quantization is done. As the (Hue) component is very important in human visual system than the (Saturation) and (Value), therefore, assign a large number of bins in the histogram to the Hue (16), Saturation (4) and Value (4) (T. Ojala, etc., 2001).

4.3. Color Feature Extraction

Feature extraction process is the third process in proposed TIRBCF system. To perform the trademark function of uniquely identifying the commercial origin of products or services, at least one color is used. Therefore, the color plays an important role in distinguishing the trademark images. The proposed TIRBCF system extracts color features including different color descriptors from entire trademark to generate a feature vector of each image, then store these feature vectors in the database to generate Database of Feature Vectors (DFVs). Color is one of the most straightforward feature used by persons for visual recognition (S. Nandagopalan, etc., 2008). In this paper, extraction color feature as one of the image feature due to the following reasons (J. M. Fuertes, etc., 2001; Y. K. Chan & C. Y. Chen, 2004):

1. Color features is one of the most important properties that people uses to discriminate between objects.

2. Color features have been found to be effective for searching of color images in image databases.

3.Color features is recognize in simplicity and speedy in extraction process.

In this process, important color content in a trademark image will be extracted using different effective statistical color descriptors to represent the color feature of trademark image including HSV Color Histogram (HCH), Mean HSV Color including (Row Mean HSV Color (RMHC)) and Column Mean HSV Color (CMHC)), and Median HSV Color (MHC). These features are extracted from each (H), (S), and (V) channel separately forming separate DFVs according to the different methods. Following is the algorithm steps of color feature extraction based statistical methods:

Step 1. Load TIDB from specific path.

Step 2. Read an image from TIDB.

Step 3. Convert RGB color space into HSV color space.

Step 4. Extract all the color feature descriptors that mentioned above.

Step 5. Repeat step 1 to step 4 for all images in TIDB to construct DFVs.

Step 6. Load and read an example image as query image.

Step 7. Repeat step 3 to step 4 for Query image to get QFV**.**

Step 8. Compute the similar distance between QVF and DFVs using similarity measurement to compute the similarity distance.

Step 9. Retrieved the images which are similar to the input query image which have smallest distance and displayed them for the system's user through interface window.

Step 10. Evaluate the performance of each color descriptor in terms of retrieval time and accuracy to determine the color descriptor that give a higher retrieval accuracy and lower retrieval time.

4.3.1 HSV Color Histogram (HCH)

The color histogram is one of the features that are widely used in IRS because the image size and its trend is not effect on color histogram values. The original idea about using color histogram in IRS is based on (M. Swain, D. Ballard, 1991). Color histogram is defined as the representation of colors distribution in an image. For digital image, it represents the total number of pixels of the same color in uniformly quantized color space which display the distribution of each channel H, S, and V of HSV color space (Pinjarkar, L., & Sharma, M. 2013). In this paper, extracted HSV Color Histogram (HCH) with (16*4*4) bins of whole image is represent by an N-dimensional vector (256) dimensions as:

HCH(I) = {CH [0], CH [1], CH [2], CH [3], ………. CH [i], ………, CH[n]}

Where, HCH(I) represent color histogram and CH[i] represents the total number of pixels of color i in an image, n is the total number of bins that used in CH. In order to compare images of different sizes, HCH should be normalized (NHCH) by dividing it with the total number of image pixels (image size) as:

$$\mathbf{NHCH} = \frac{\mathbf{HCH}}{\boldsymbol{p}}$$

Where, p is the image size (total number of pixels). Figure (5) shows an example of histogram of H, S, and V.

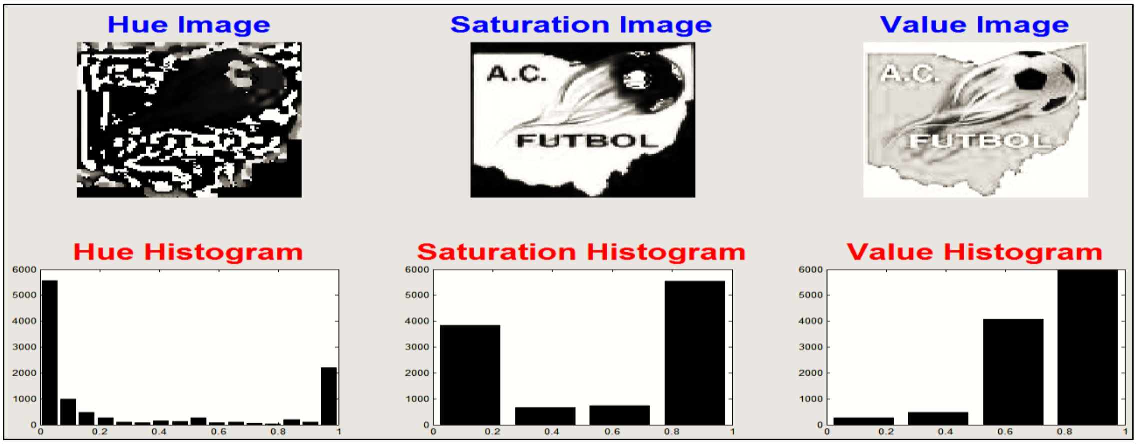

Fig. 5: HSV color histogram of (H, S, and V)

Color histogram statistically refer to the probability of the intensities distribution of the three color channels (S. Nandagopalan, etc., 2008).

4.3.2 Mean HSV Color

The mean method is the second statistical color feature extraction used in proposed TIRBCF system to retrieve similarity trademark images. The feature vector that resultant using mean method over all image pixels is reduced the retrieval time and complexity because it is very simple in calculating and has a low-dimensions (Kekre, etc., 2010). Two feature vector can be extracted using mean method:

4.3.2.1 Row Mean HSV Color (RMHC)

In this method, compute the mean feature of all row pixels of each channel (H, S, and V) to get a column vector containing 256 value for each channel because the image size is **(256*256)** as shows in figure (6). These feature vectors will represent the predominant color of an image. The length of feature vector is equal to (256 * 3) dimension.

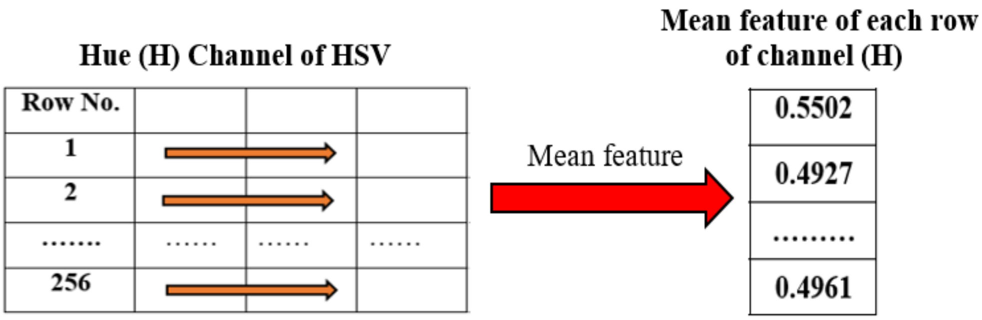

Fig. 6: Row Mean feature vector of Hue channel

4.3.2.2 **C**olumn **M**ean **H**SV **C**olor (**CMHC**)

In this method, compute the mean feature of all column pixels of each channel (**H**, **S**, and **V**) to get a row vector containing **256** value for each channel because the image size is (**256*256**) as shows in figure (7). These feature vectors will represent the predominant color of an image. The length of feature vector is equal to (3 * 256) dimensions.

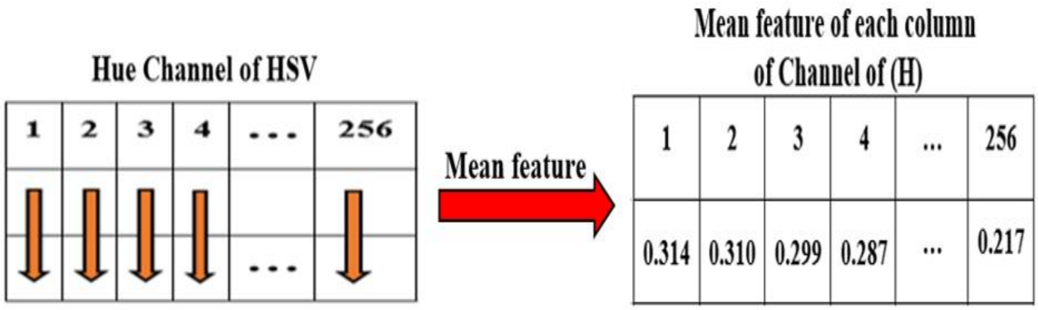

Fig. **7**: Column Mean feature vector of Hue channel

4.3.3 Median HSV Color (MHC)

The Median HSV Color (MHC) feature represent another statistical method that we used in proposed TIRBCF system to retrieve similarity trademark images. MHC is the value that is splitting the top half (the small values) of a values, or a probability distribution, from the down half (the high values). Also, Median is defined as the middle value in the column or row values of each channel (H, S, and V). To compute the median, firstly, sorted the columns or row values in ascending order, then, check the total number of the value; if it is odd number, formula (1) is used, if it is even number formula (2) is used:

$$\textbf{Median} = \frac{n+1}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\textbf{Median} = \frac{\left(\frac{n}{2}\right)+\left(\frac{n}{2}+1\right)}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, n represent the total number of each column or row values.

The main advantage of the median feature comparison to the average is that it is not skewed so much by a very large or a very small values, so it give a better idea of image content (R. Venkata Ramana Chary, etc., 2012).

4.4. Similarity Measurement

The similarity measurement between images is one of main importance for **IRS** based on its content, the lower value is represents the higher similarity between the images. It is refer to the similarity between query trademark image with one or more trademark image database. Selection the suitable similarity distances is depend on the feature descriptors that extraction from database images. Histogram intersection of images with different sizes can be done, and the range of similarity value is between 0 and 1 determines the extent of the relationship between the images. The (0) value represent the exactly similar, the values that near to zero is the most similar images, where the values that near to (one and equal to one) represent the dissimilar images. Histogram Intersection and Euclidean distance measure are two similarity measures are used in this paper to compute the similarity between database and query image (Shaoping Xu , etc., 2012).

4.4.1. Histogram intersection Measure

To compute the degree of similarity distance between two trademark image color histograms, Intersection similarity measurement is used. Also, it might be called Intersection Distance (ID) is one of the more reliable histogram comparison techniques implemented (S. P. Xu, C. Q. Li, S. L. Jiang, et al. 2012). It calculates the distance between color histograms of each image in the database (HCH_d) with the color histogram of the query image (HCH_q) using the following formula:

$$D_{q,t} = \sum_{m=0}^{M-1} min[HCH_q(m),\ HCH_d(m)] \text{ .... } (4)$$

Where HCH_q and HCH_d are query and database histogram respectively with m bins each.

4.4.2. Euclidean Distance

Euclidean Distance (ED) also known as L2 metric is the second distance measure used as a similarity measure to compute the distance value between QFV with DFVs of RMHC, CMHC, and MHC descriptors using equation (5), which represent the root of squared differences between QFV and DFVs . The length of feature vector should have same dimensions (Gill, Jagbir Singh, et al., 2016).

$$ED = \sqrt{\sum_{i=1}^{n} (\mathbf{QFV} - \mathbf{DFV})^2} \text{ .... } (5)$$

5. Proposed System Evaluation

The implementation and testing the performance of proposed **TIRBCF** system took place on Intel® Core-TM, 2.2 Duo CPU, 8.00 G memory RAM, system type 64-bit operating system and using the experimental database that mentioned in section (4.1). During the search process, an image query is selected randomly and entered through user interface. Initially, the similarity distance between the query image and each image in the database is calculated with each color descriptor. Note that after the distance values are sorted in ascending order and the system display the 9 top images which are most similar to the query image. Several tests for each search is performed using different statistical color descriptors that mentioned in previous sections in order to make a complete comparison between the accuracy retrieval results and the retrieval time of each descriptor. In this paper, two statistical comparison metrics called ***precision*** and ***recall*** are used to measure the accuracy of proposed **TIRBCF** system using equation (6) and (7) respectively. *Precision* (***P***) is the ratio of the number of relevant (***Nr***) images that is similar to the query image retrieved with respect to the total number of images retrieved (***Tr***), whereas *recall* (***R***) is defined as the ratio of (***Nr***) to the total number of correct images (***Nt)*** in the database. (Kekre, H.B., Thepade, S.D., Maloo, A., 2010).

$$\mathbf{P} = \frac{\boldsymbol{Nr}}{\boldsymbol{Tr}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots.\ldots\ldots.(\mathbf{6})$$

$$\mathbf{Racall} = \frac{\boldsymbol{Nr}}{\boldsymbol{Nt}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots(\mathbf{7})$$

6. RESULTS AND DISCUSSION

For testing the performance of proposed TIRBCF system, the retrieval process is performed to all trademark image database using the four statistical color descriptors extraction methods with appropriate distance measure as discussed previously. Per each descriptor, 50 queries are selected randomly. In each testing, the whole database must be scanned sequentially and the similarity distance for each image need to be calculated. Tables (1) depict the average of retrieval accuracy and the average of retrieval time for the each color descriptor. From this table, we can compare between the results and found that the HCH give a better results (85.84%) than RMHC (68.77%), CMHC (66.89%) and MHC (60.12%), where RMHC give a better results than CMHC and MHC. Lastly, CMHC give a better results than MHC. The resulting search times show that the RMHC and CMHC take longer time comparing with another color descriptors because it have a feature vector with high-dimensional. The quality of the retrieval results was very good and the interested images were successfully located.

Table (1): Percentage of Retrieval Accuracy for Statistical Color Feature Extraction Methods

Methods	Average Retrieval Accuracy of 5o query image for top 9 (%)	
	Average Accuracy	Average Time Taken (Sec.)
HCH	85.84	1.280
RMHC	68.77	1.451
CMHC	66.89	1.457
MHC	60.12	1.358

Figure (6) shows the TIRBCF results of three different query images using all statistical color features.

Fig. 6: **TIRBCF** results of three different query images using Four statistical color features.

We can say here, that all the feature descriptors was retrieved the image which is most similar to the query image as the first image in the retrieval list. Most of the retrieval results by HCH are similar in the color and does not take into account the shape of the trademark, while the RMHC, CMHC and MHC descriptors were retrieved the images which are similar to the query image in the shape like in all query images , even though it is difference in color. So, from our point, they are a better descriptors than HCH in the case of retrieval trademark images because it can be ensure the non-recurrence of a registered trademark previously.

7. Conclusion and Future Work

8.1. Conclusion

This paper provides TIRBCF system that supports search by query image and search by color contents to help a trademark registry staff to retrieve similar images from a huge trademark database. The method adopts the whole image colors and describe the properties of an image. In this method, a dynamic programming algorithm is used to compute the similarity between two images based on their color. The experimental results show TIRBCF system obtains from conventional HCH has a better performance than RMHC, CMHC and MHC descriptors, and takes a shorter time than other descriptors.

Where RMHC, CMHC and MHC retrieved the images which are similar to the query image in the shape, even though it is difference in color which ensure the non-recurrence of a registered trademark previously. So, it become a better descriptors than the HCH in the case of retrieval trademark images.

8.2. Future work

Following developments can be made in the future to increase the TIRBCF system performance:

1. Search by color, based on local color information (of specific image parts),

2. Search by shape feature to distinguish between two trademarks.

3. Search by combined color, shape to increase the retrieval accuracy.

4, Improvement of the search times by using neural network.

References

- Ford and A. Roberts, 1998. “Color space conversions” available at URL http://www.wmin.ac.uk/ITRG/docs/coloreq/coloreq.
- Wei, Y. Li, W. Chau, and C. Li., 2009. “Trademark Image Retrieval Using Synthetic Features for Describing Global Shape and Interior Structure”. Pattern Recognition, 42(3):386–394.
- Chia HungWei, YueLi,Wing-YinChau, Chang-TsunLi, 2009. “Trademark image retrieval using synthetic features for describing global shape and interior structure”, Elsevier,Pattern Recognition, 42 :386 – 394.
- Eakins, J. P., Riley, K. J., and Edwards, J. D., 2003. “Shape feature matching for trademark image retrieval”, In Proceedings of the 2nd International Conference on Image and Video Retrieval. (July), Springer-Verlag, Berlin Heidelberg, 28–38.
- Euripides G.M. Petrakis ,Klaydios Kontis, Epimenidis Voutsakis, 2006. “Relevance Feedback Methods for Logo and Trademark Image Retrieval on the Web”, SAC’06(ACM), PP: 23 -27.
- Fatahiyah Mohd Anuar, F., Setchi, R. and Lai, Y. K., 2013. “Trademark Image Retrieval Using an Integrated Shape Descriptor, Expert Systems with Applications”, ElSEVIER, Vol. 40, No.1, pp. 105–121.
- Fatin A. M., 2016. “A New Features Fusion Technique for Image Retrieval System Using Colour, Texture, and Shape Descriptors”, PhD A Dissertation, University of Babylon/Faculty of Information Technology/Department of Software.
- Gill, Jagbir Singh, et al., 2016. "CBIR of Trademark Images in different color spaces using XYZ and HSI" Journal of Network Communications and Emerging Technologies (JNCET) www. jncet. org 6.5.
- Iwanaga, T., Hama, H., Toriu, T., Tin, P. and Zin T. T., 2011. “A Modified Histogram Approach to Trademark Image Retrieval”, IJCSNS International Journal of Computer Science and Network Security, Vol.11, No.4, pp. 56–62.
- J. M. Fuertes, M. Lucena, N. P. D. L Blanca and J. C. Martinez, 2001. “A Scheme of Color Image Retrieval from Databases”, Pattern Recognition Vol. 22, No. 3, pp- 323-337.
- Jagbir Singh Gill, Ranjeet Singh, Pankaj Palta, Tejpal Sharma, Gaurav Goel, 2016. “CBIR of Trademark Images in different color spaces using XYZ and HIS”, Journal of Network Communications and Emerging Technologies (JNCET) www.jncet.org Volume 6, Issue 5.
- Kekre, H.B., Thepade, S.D., Maloo, A., 2010. “CBIR feature vector, dimension reduction with eigenvectors of covariance matrix using row, column and diagonal mean sequences”. Int. J. Comput. Appl. 3, 39–46.
- M. Lew, N. Sebe, C. Djeraba and R. Jain, 2006. “Content-Based Multimedia Information Retrieval: State of the Art and Challenges” ACM Transactions on Multimedia Computing, Communications and Applications, vol. 2, no. 1, pp. 1-19.
- M. S. Hitam, H.J.W. Yussof W.N. Jawahir, and M.M. Deris., 2008. “Hybrid Zernike moments and color-spatial technique for content-based trademark retrieval”. In Proceedings of the International Symposium on Management Engineering.
- M. Swain, D. Ballard, 1991. “Color indexing”, International Journal of Computer Vision, 7, pp-11–32.

- Nigam A, Garg AK, Tripathi RC., 2011. "Content based trademark retrieval by integrating shape with color and texture information". Int'l, Journal of Computer Applications, 2011,22(7):40-45.
- Pinjarkar, L., & Sharma, M., 2013. "Content Based Image Retrieval for Trademark Registration": A Survey", International Journal of Advanced Research in Computer and Communication Engineering, Issue-11, ISSN:2319-5940 Vol. 2, pp. 4424-4430.
- R. Salamah, 2010. "Efficient Content Based Image Retrieval" Master dissertation,Computer Engineering Department, Islamic University of Gaza, Palestine.
- R. Venkata Ramana Chary, Dr.D.Rajya Lakshmi and Dr. K.V.N Sunitha, 2012. "Feature Extraction Methods For color Image Similarity", Advanced Computing: An International Journal, (ACIJ), Vol. 3, No., 2.
- Ranjeet Kumar, R.C.Tripathi, M.D. Tiwari, 2011. "A Comprehensive Study on Content Based Trademark Retrieval System", International Journal of Computer Applications (0975 – 8887) Volume 13– No.6
- Ruba A. A. Salamah, 2010. "Efficient Content Based Image Retrieval" Master dissertation, Computer Engineering Department, Islamic University of Gaza, Palestine.
- S. Manimala and K. Hemachandran, 2011. "Performance analysis of Color Spaces in Image Retrieval", Assam University Journal of science & Technology, Vol. 7 Number II 94-104.
- S. Mangijao Singh , K. Hemachandran, 2012. "Content-Based Image Retrieval using Color Moment and Gabor Texture Feature" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 5, No 1, pp.299-309.
- S. Nandagopalan, Dr. B.S. Adiga, and N. Deepak, 2008. "A Universal Model for Content-Based Image Retrieval" World Academy of Science, Engineering and Technology 46.
- S. P. Xu, C. Q. Li, S. L. Jiang, et al., 2012. "Similarity measures for content-based image retrieval based on intuitionistic fuzzy set theory". Journal of Computers, vol. 7, 2012, pp. 1733-1742.
- Shaoping Xu , Chunquan Li , Shunliang Jiang, 2012. "Similarity measures for content-based image retrieval based on intuitionistic fuzzy set theory", Journal of computers, Vol. 7, No. 7.
- Shiv Raj Singh, Dr. Shruti Kohli, 2015. "Enhanced CBIR using Color Moments, HSV Histogram, Color Auto Correlogram, and Gabor Texture", International Journal of Computer Systems (ISSN: 2394-1065), Volume 02– Issue 05, Available at http://www.ijcsonline.com.
- T. Gevers, Color in image Database, Intelligent Sensory Information Systems, University of Amsterdam, the Netherlands. 1998.
- T. Ojala, M. Rautiainen, E. Matinmikko, and M. Aittola., 2001. "Semantic image retrieval with HSV correlograms," In 12th Scandinavian Conference on Image Analysis, Bergen, Norway, pp. 621 – 627.
- X. Wan and C. C. Kuo, 1996. "Image retrieval with multi-resolution color space quantization", In Electron Imaging and Multimedia System.
- X. Wan and C. C. J. Kuo, 1998. "A new approach to image retrieval with hierarchical color clustering", IEEE transactions on circuits and systems for video technology, Vol. 8, no. 5.
- Y. K. Chan and C. Y. Chen, 2004. "Image retrieval system based on color-complexity and color-spatial features", The Journal of Systems and Software, Vol. 71, pp-65-70.

– Zhenhai Wang, Kicheon Hong, 2012. "A Novel Approach for Trademark Image Retrieval by Combining Global Features and Local Features", Journal of Computational Information Systems 8(4), pp.: 1633–1640.