Content based Image Retrieval: A Quantitative Comparison between Query by Color and Query by Texture

Sunkari Madhu
School of computing science & Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India
Email: madhu.dtu@gmail.com

***Abstract*—Effective and efficient image retrieval techniques have become the fast and active research area because of explosive use of digital images. User interaction in CBIR system consists of a query formation. The user has problems in declaration of a query with different schemes which has been introduced in literature. In this paper, we analyze the two retrieval method, query by texture and query by color .Texture features involves the invariant histogram characteristics to retrieve the images and color features carry the color histogram in RGB color space to retrieve the images. It is observed from the experimental results, that the query by texture is more effective than the query by color for retrieving the general images.**

***Index Terms*—invariant histogram, Image retrieval performance, query by Texture, query by color**

I. Introduction

The term CBIR can be defined as to retrieve the image from low level features like color, texture, shape and spatial information [3], [10].The most important challenge of CBIR system is to determine the exact/approximate matching image of database to the query image. Interaction of users in CBIR system is of vital worth [4], [24]. CBIR techniques extract content based features namely color, texture and shape from the image systematically and by comparison between query and database image determined by the corresponding difference between the features of images from distance function. Content based visual features are categorized into two domains; that is common visual content and Field Specific visual content like face recognition, task dependent applications we discuss only general visual contents here. This paper mainly focuses on the two features of CBIR i.e. Color and Texture. According to the features of these two, they both performed well in the retrieval process of general images, other features of CBIR Shape and spatial location performs well for example bio medical images , object oriented images such as buildings and tower [1]. From the comprehensive experimental results it is found that , Invariant Histogram perform well in many task dependent application , so it can be recommended for every general image retrieval application .

Features of Color mainly color histogram and RGB color space have been addressed in detail in Section 2. Later on texture features have been discussed in section 3, experiment results and performance evaluation of CBIR system in Sections 4. In the end, in Section 5 we concluded the paper.

II. Color Feature

Color is a dominant and distinguishable feature for image retrieval. Mostly CBIR systems use color space, histogram, moments and color coherence vector to represent color [7]. Color feature is one of the most widely used features in low-level feature [18]. Compared with shape feature and spatial location feature, its results shows efficient stability and also have insensitive results to the rotation and zoom of image. Color histogram [19] is widely used to represent color feature. In this paper, histogram-based search method is investigated in RGB color spaces.

A. Color Spaces

Color space consists of three dimensional spaces and color is used as a vector in it. Color Spaces are required for description of color based retrieval of image [11]. Mostly RGB, LAB, LUV, HSV, YCrCb and opponent color space are used for color space. The selection of color space is done from *uniformity* characteristics [12], [23] and uniformity means to have colors points that have similar distance in color space as perceived by human eye.

B. Color Histogram

It is a standard demonstration of color characteristic in CBIR systems [13], [20]. It is very efficient in description of both local and global features of colors [14]. This computes the chromatic information and invariant of image along the view axes for translation and rotation ,when the large scale image data base computes histogram, its efficiency is not satisfactory and to overcome this conflict joint histogram technique is introduced [15], [22].Color histograms is a fundamental technique for retrieving images and extensively used in CBIR system [8], [25]. The color space has segmentation, for every segment the pixels of the color within its bandwidth are counted, which shows the relative

Manuscript received September 16, 2013; revised November 27, 2013.

doi: 10.12720/jiii.2.2.108-112

frequencies of the counted colors. We use the RGB color space for the histograms. Only minor differences have been observed with other color spaces for the histogram in [19]. Color Histogram H(m) is a distant probability function of the image color [1].This probability function is used for the determination of joint probability function for the intensities of the three color channels. Further informally, the color histogram is defined as [9], [21].

$$h_{a,b,c}=N.prob(a,b,c)$$

where a, b, c represent the three color channel (RGB)

$$H\,(m) = [h_{1,}\ h_{2\ldots}h_n]$$
$$H_{k=}n_k/N,\ \mathrm{k}{=}1,\ 2\ldots.n;$$

where N is the number of pixel image M and n_k is the number of pixel with the image value k.

III. Texture Features

Texture is an essential feature for general images .But yet still not the comprehensive definition of it exist .Even though rough definition of it described in [2] as, A texture can be defined as gray level basic elements and spatial organization of these. The gray level elements may be single pixels and the Spatial location may be random, depend on one or more periodic primitives etc. based on corresponding matrices, autocorrelation, digital transformation techniques, textural edginess, morphological methods, A comprehensive detail of these techniques has been given in [4]. Texture feature definition for computer vision application is defined as a description of local shape and color feature or in a more comprehensive way it is defined as structure and randomness [16]. Structural methods consist of graphical method which tends to be more effective when applied to the texture [17].

A. Invariant Image Features

Invariant image feature have certain trans-formations that is translation, rotation and scaling .The characteristic of image features is, it does not change when the transformation are applied. In these work, invariant feature histograms is used as described in [5]. The proposed method is to compute the invariant features with transformation from the integration over all considered on transformation features and construction of image features technique for the gray scale image described in [6]. We will address image features which are invariant with respect to rotation and translation transformation. For a given an image M and complex valued function $f(M)$ it is possible to construct an invariant features $A[f](M)$ by integrating $f(gM)$ over the transformation group G:

$$A\,[f]\,(M) = dg$$

This averaging technique for constructing the image feature is explained in detail [11] for general transformation group.

B. Invariant feature Histogram

Initially invariants mention above can be used for describing an image invariantly, although for texture categorization we have stochastic texture. We therefore see an advantage of using invariant histogram of the local computations instead of the summation of these.

As the histogram is invariant with respect to the image translation, we may consider the histogram equation in [2] as

$$A\,(f)\,[M] = d$$

Which are the local computations within the two step integration. Note that $A(f)[M]$ is not a scalar anymore but of the same dimension as M i,e for each image point M (i,j) a local invariant feature $[A(f)[M](i,\,j)\,]$ is calculated from circular neighborhood around$(i,\ j)$. The feature value of a pixel remain same as the one of its transformed pixel, which is generally located at another index. So $(A(f)[M](i,\,j)$ is itself not invariant but the histogram of A $(f)[M]$ is.

IV. Experiments

The performance evaluation has been investigated to examine the behavior of Query by Color and Query by Texture .User were assigned to search for target image from mat lab application of CBIR system. Image queries have been conventionally presented using example image query image or the group of example image (query by group example) in CBIR systems .Mat lab application has been developed as prototypes of QBC and QBT.

A. Image Database

In the experiment, different image classification has been used for small image database .Comprehensive set of images having sub set of images like flowers, leaves, sky, faces. tiger, cone shapes , mountains etc.

Procedure:

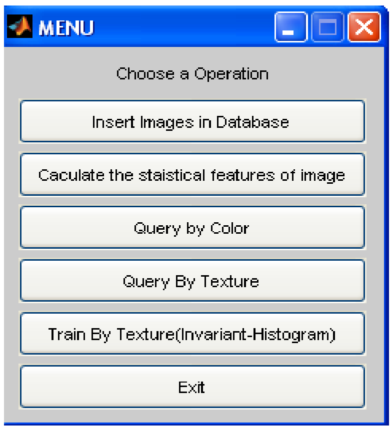

Figure 1. Feature dialog

CBIR system's job is to compute the most relevant images for given image query. User were given two jobs in mat lab application, retrieving the images by QBC and finding pre-selected target image from texture features .Subject were asked to select menu options using a feature dialog as shown in Fig. 1. Features of the images in the application were scheduled in a tree-structure foam. For example in the flower image database, No. of flowers and major color of the flower is listed. Subject have choice to carry on their image retrieving process as much as they want to have relevant images .In the prototype of QBT, subjects were given a query images, and resubmit the queries unless they searched the exact image .The time taken to complete the task has been observed for both query features.

B. Graphical User Interface of QBC and QBT

The user was first given the GUI as shown in Fig. 1. The first and second menu option is used for inserting more images in database and calculating the statistical feature of database images.

Once the user done with the image inserting, then the user interface as shown in Fig. 2 appeared if QBC for Red is clicked. When the user started the searching process, an example image has been provided from the database. The best most similar images are retrieved from the database as a results as shown in Fig. 3. Upon receiving the results, user verify the result are relevant or not and resubmit another query image from the result to get the best results. The user may keep on doing the same process to refine the query for obtaining better results.

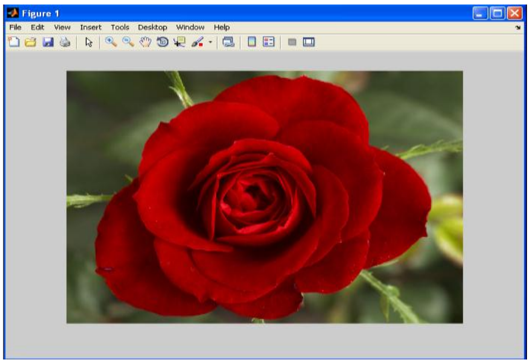

Figure 2. User interface of query image by color for Red

And next frame shown search result images. The order of ranking was top to bottom; left to right. The first rank was omitted because it was the example image for the query.

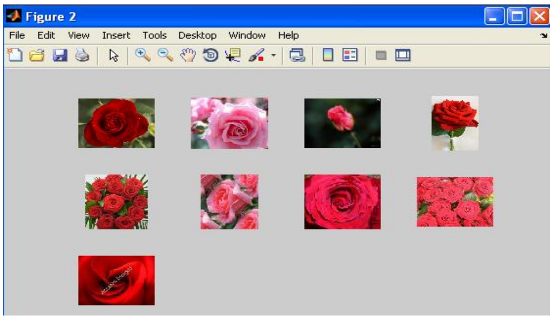

Figure 3. User interface of result panel of QBC for Red

The user interface as shown in Fig. 4 appeared if QBC is clicked. When the user started the searching process, an example image has been provided from the database. The best most similar images are retrieved from the database as a results as shown in Fig. 5. Upon receiving the results, user verify the result are relevant or not and resubmit another query image from the result to get the best results.

And next frame shown search result images. The order of ranking was top to bottom; left to right. The first rank was omitted because it was the example image for the query.

Figure 4. User interface of query image by color for green

Figure 5. User interface of result panel of QBC for Green

The user interface as shown in Fig. 6 appeared if QBC is clicked. When the user started the searching process, an example image has been provided from the database. The best most similar images are retrieved from the database as a results as shown in Fig. 7. Upon receiving the results, user verify the result are relevant or not and resubmit another query image from the result to get the best results.

Figure 6. User interface of query image by color for Blue

And next frame shown search result images. The order of ranking was top to bottom; left to right. The first rank was omitted because it was the example image for the query.

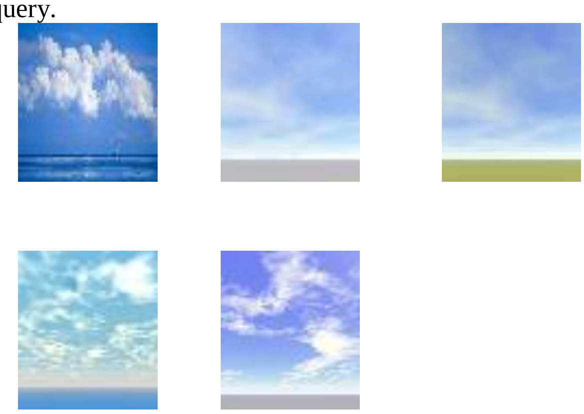

Figure 7. User interface of result panel of QBC for Blue

If the QBT prototype was clicked by the subject, the same dialog box was given to the subjects as appeared in Fig. 4 similar to that for query image by color. And the searching process is similar to the above mentioned task, except it ended only when the subject found the target image. Subject carried out a searching process until the target was found and the time taken is recorded. The example query image and results of query by texture are shown as in Fig. 4 and 5.

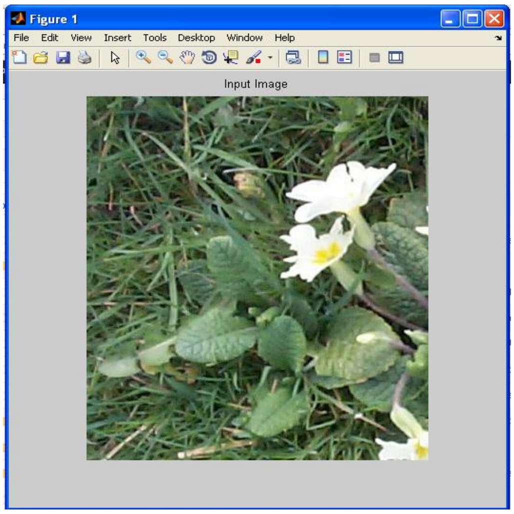

Figure 8. User interface of query image by texture

And next frame shown search target image.

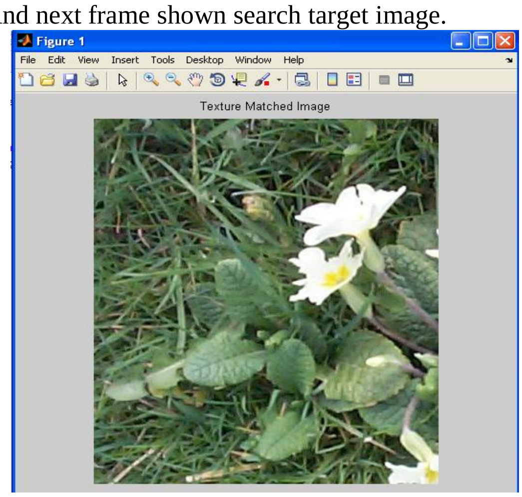

Figure 9. User interface of result panel of QBT

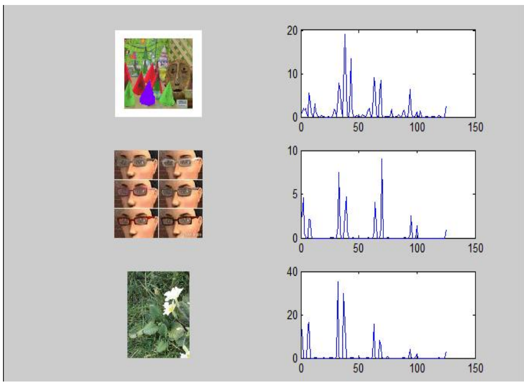

Figure 10. Graphical representation of images' invariant histogram

Subject might found the relevant image in the pop up window of result panel, and might continue to explore further results; until they decided to exit the system. The texture feature has been extracted using invariant feature Histogram.

The Histogram of an image described the every pixel of image and its brightness level. The bottom of the graph represent the brightness level of each bin, corresponding to each brightness level, there is a vertical line which represent how many of pixel are there.

C. Experimental Results

The experimental result of both query interface are shown in Table I. Comparison are made between QBC and QBT using a small image database .T-test is conducted to determine if the difference is significant between these to query example. It is found that more relevant images are found using query by texture on every type of general images. The constraints of QBE is that the accomplishment of most similar image set is strongly depends on the initial set of image queries Experimental results shows that there is significant difference among the performance of both query method, and QBT is proven to produce better results in terms of identifying more relevant images and successfully retrieving a target image. The difference is found to be significant at p. 05 for the small image database. However, when the size of image database is large, the difference in total time taken and the average time taken per query between QBC and QBT are insignificant; it's mainly due to the more significant number of interactions with QBT prototype. The page zero problem in QBC avoids identifying more relevant images because they are not able to acquire better examples to submit as queries after a number of trails. It is understandable that user is more able to find a target image using QBT. In QBT the task is to find a target image instead of as many relevant images as possible. There are no significant difference between using QBT and QBC in other measurement except in the number of queries, at the p 0.01. We conclude that QBT provides more functionalities and capabilities to produce better performance in terms of identifying more relevant and approximately retrieving a target image successfully.

TABLE I

Prototype	Statistical features	QBT	QBC	p-value
No. of relevant images	Mean	118.34	104.28	.05*
	Std	78.68	84.10	.05
No .of queries	Mean	29.05	27.89	.05
	Std	24.20	17.43	.05
Total time taken	Mean	25.61	29.56	.05
	Std	22.11	26.78	.05

V. CONCLUSION

In this paper, we investigated two features for the query image of content based image retrieval, query by color and query by texture. These features have different characteristics to retrieved the more relevant images Retrieving process is done on the basis of Color histogram in RGB space for query by color and Invariant histogram for query by texture. Invariant histogram has more functionalities and capabilities for the most relevant image to the representative labeled images on GUI. The results of a user evaluation shows that QBT out performs QBC. Considerably more most relevant images are recognized when the query image is taken QBT. A noticeable efficient rate in searching a most similar image is obtained.

REFERENCES

[1] C. C. Yang, "Content-based image retrieval: A comparison between query by example and image browsing map approaches," *Journal of Information Science*, 2004.

[2] S. Siggelkow and H. Burkhart, "Local invariant feature histogram for texture classification," 1997.

[3] W. M. Arnold, M. W. Smeulders, S. Santini, A. Gupta, and R. Jain, "Content-based image retrieval at the end of the early years," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no. 12, December 2000.

[4] N. Baaziz, O. Abahmane, and R. Missouri, "Texture feature extraction in the spatial-frequency domain for content-based image retrieval," *Computer Vision and Pattern Recognition*, Department of Computer Science and Engineering, University du Québec en Outaouais 101 rue Saint Jean Bosco, C. P. 1250, Gatineau, Québec, J8X 3X7 Canada, 2010.

[5] S. Siggelkow, "Feature histograms for content-based image retrieval," Ph.D. thesis, University of Freiburg, Institute for Computer Science, Freiburg, Germany, 2002.

[6] A. H. El-Kholy and A. M. Abdel-Haleim "Content-based image retrieval using combined features and weighted similarity," in *Proc. 2nd International Conference on Computer Technology and Development*, 2010.

[7] G. Rafiee, S. S. Dlay, and W. L. Woo "A review of content based image retrieval database," *Science Citation Index Expanded (SCI-EXPANDED) and Conference Proceedings Citation Index-Science (CPCI-S)*.

[8] T. Deselaers, D. Keysers, and H. Ney, "Features for image retrieval: An experimental comparison," *Image Understanding and Pattern Recognition*, 2008.

[9] J. H. Wu, Z. R. Wei, and Y. L. Chang, "Color and texture feature for content based image retrieval," *International Journal of Digital Content Technology and Its Applications*, vol. 4, no. 3, June 2010.

[10] T. Deselaers, D. Keysers, and H. Ney, "Features for image retrieval: A quantitative comparison," *Lehrstuhl Für Informatik VI*, 2004.

[11] H. Schibulz-Mirbach, *Invariant Gray Scale Features*.

[12] J. Puzicha, Y. Rubner, C. Tomasi, and J. Buhmann, "Empirical evaluation of dissimilarity measures for color and texture," in *Proc. Int. Conf on Computer Vision*, Sept. 1999, vol. 2, pp. 1165–1173.

[13] A. B. Rao, R. K. Srihari, and Z. F. Zhang, "Spatial color histograms for content-based image retrieval," in *Proc. 11th IEEE International Conference on Tools with Artificial Intelligence*, 1999, pp. 183-186

[14] P. Aigrain, H. Zhang, and D. Petkovic, "Content-based representation and retrieval of visual media: A state of the art review, multimedia tools and applications," *Multimedia Tools and Applications*, vol. 3, pp. 179-202, 1996.

[15] Siggelkow, "Feature histograms for content-based image retrieval," Ph.D. thesis, University of Freiburg, Institute for Computer Science, Freiburg, Germany, 2000.

[16] H. Tamura, S. Mori, and T. Yamawaki "Texture features corresponding to visual perception," *IEEE Trans. on Systems, Man, and Cybernetics*, vol. Smc-8, no. 6, June 1978.

[17] H. Voorhees and T. Poggio, "Computing texture boundaries from images," *Nature*, vol. 333, pp. 364-367.

[18] Th. Gevers, *Color Based Image Retrieval*, Springer Verlag GmbH. 2001, pp. 886-917.

[19] H. B. Kekre1, P. Mukherjee, and S. Wadhwa, "Image retrieval with shape features extracted using gradient operators and slope magnitude technique with BTC," *International Journal of Computer Applications*, vol. 6, no. 8, September 2010.

[20] H. B. Kekre and S. D. Thepade, "Image retrieval using augmented block truncation coding techniques," in *Proc. International Conference on Advances in Computing, Communication and Control*, 2009.

[21] M. Mocofan, I. Ermalai, M. Bucos, M. Onita, and B. Dragulescu, "Supervised tree content based search algorithm for multimedia image databases," in *Proc. 6th IEEE International Symposium on Applied Computational Intelligence and Informatics*, Timioara, Romania, May 19-21, 2011.

[22] G. J. Lu, "Techniques and data structures for efficient multimedia retrieval based on similarity," *IEEE Transactions on Multimedia*, vol. 4, no. 3, September 2002.

[23] J. M. Kim, W. D. Cai, D. G. Feng, and H. Wu, "A new way for multidimensional medical data management: Volume of interest (VOI)-based retrieval of medical images with visual and functional features," *IEEE Transactions on Information Technology in Biomedicine*, vol. 10, no. 3, pp. 598-607, 2006.

[24] T. Yeh, K. Tollmar, and T. Darrell, "Searching the Web with mobile images for location recognition," in *Proc. IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 2004.

[25] L. Xavier, B. M. I. Thusnavis, and D. R. W. Newton, "Content based image retrieval using textural features based on pyramid-structure wavelet transform," in *Proc. 3rd International Conference on Electronics Computer Technology*, 8-10 April 2011, pp. 79-83

Sunkari Madhu, Nizamabad, Andhra Pradesh, India completed his Master of Technology (M.Tech) in Information Systems from Delhi Technological University, DELHI. Before that he completed his Master of computer applications (M.C.A) from University College of Engineering, Osmania University, Hyderabad, and Andhra Pradesh. His area of interest is Image processing.

Madhu qualified National Eligibility Test(N.E.T) with Junior Research Fellowship(J.R.F) which was conducted by University Grants Commission(U.G.C),India. He has Qualified Andhra Pradesh State Eligibility Test(A.P.S.E.T) which was conducted by Osmania University,Hyderabad,Andhra Pradesh and also qualified Graduate Aptitude Test in Engineering (*GATE*) 2 times(2010,2012)Which was conducted by Indian Institute of Technologies(IITs).