Image Retrieval Based on Integration Between YC_bC_r Color Histogram and Texture Feature

M. H. Saad, H. I. Saleh, H. Konbor, and M. Ashour

Abstract—**Content-Based Image Retrieval (CBIR) allows automatically extracting target images according to objective visual contents of the image itself. Content-based image retrieval has many application areas such as, education, commerce, military, searching, biomedicine and web image classification. This paper proposes a new image retrieval system, which uses color and texture information to form the feature vectors and Bhattacharyya distance and new similarity measure to perform the feature matching. This framework integrates the yc_bc_r color histogram which represents the global feature and edge histogram as local descriptor to enhance the retrieval results. The proposed technique is proper for precisely retrieving images even in deformation cases such as geometric deformations and noise. It is tested on a standard image databases such as Wang and UCID databases. Experimental work shows that the proposed approach improves the precision and recall of retrieval results compared to other approaches reported in literature.**

***Index Terms*—CBIR, image retireval, EHD, FCTH, MPEG7, YCbCr**

I. Introduction

Content-based image retrieval measures the visual similarity between a query image and database images. The retrieval result is an images list ranked by their similarities with the query image. By extracting the feature vectors of the query image and the database images, there is need to develop similarity measures that will rank the database images by the actual distance between their vectors and the query image vector. Content Based Image Retrieval systems think that the best retrieving images are the most visually similar images to a given query image from a large collection of images. It is index visual characteristics of an image, such as its color, textures and shape to look for an explicit image in a large amount of images [1]. A similarity measure computed from the extracted features is used to rank the retrieved results. Several similarity measures have been introduced; such measures can be categorized as a vector-based that treats features as vectors, region-based and global-based or a combination of both, fuzzy or deterministic similarity measures, and the use of supervised, semi-supervised, or unsupervised learning. Sural, S. Gang Qian Pramanik, S. [2] analyzed the properties of the HSV (Hue, Saturation and Value) color space with emphasis on the visual perception of the variation in Hue, Saturation and Intensity values of an image pixel. HSV is a widely adopted space in image and video retrieval. The main advantages of this HSV color space was mentioned in [3-4]. A limitation of HSV color space was that dark colors were insensitive to saturation and hue changes. Therefore, the hue value was negligible for low saturation colors. MIRROR [5] image retrieval systems investigate MPEG7 visual descriptors. The MPEG-7 standard [6] provided Multimedia Description Schemes (DSs) for describing and annotating visual content. Qasim Iqbal and J. K. Aggarwal [7], combined the structure, color and texture for efficient image retrieval. Structure was extracted by the application of perceptual grouping principles. They stated that further research is needed to obtain a better performance in sub-classification. S. A. Chatzichristos and Y. S. Boutalis [8] proposed a composite feature descriptor that combined color and texture in a single quantized histogram. The proposed feature descriptor was named Fuzzy Color and Texture Histogram (FCTH). The fuzzy color and texture histogram was a combination of three fuzzy systems.

This paper proposes a new approach that combines the global descriptor with a local descriptor which improves the overall results.

II. The Proposed YC_BC_R Histograms

A histogram is a helpful tool in color image analysis. A histogram is a global statistical descriptor that represents the distribution of colors in an image. Histograms carry the statistical information of the three components of the used color space. A histogram-based retrieval system requires a suitable perceptually uniform color space such as RGB, HSV and $YCbC_r$. The histograms color in image retrieval has both merits and weakness. Such merits are, robust, fast, low storage requirements and straightforward to implement. In addition to the weakness are: there no spatial information of the color distribution and immune to lighting variations. In constructing such a histogram, the lake of the spatial distribution of colors can lead to erroneous similarity results between images.

This paper overcomes this problem by integrating with texture feature. The Immune to lighting variations solved by the proposed YC_bC_r histogram. Since the RGB color space is highly sensitive to intensity difference. HSV color space has a weakness that dark colors were insensitive to saturation and hue changes. According to these limitations, many color spaces have been presented to improve color consistency or segmentation. The YC_bC_r color space was chosen for this investigation after performing many tests in the RGB, HSI, and HSV color spaces. The Y in YC_bC_r denotes the

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luminance component, and C_b and C_r represent the chrominance factors. The difference between YC_bC_r and RGB is that the first represents color as brightness and two color difference signals, while the second represents color as red, green and blue.

The YC_bC_r space was chosen for the next reasons. The luminance component Y is independent of the color, so can be adopted to solve the illumination variation problem and it is easy to program. The skin color cluster is more compact in YC_bC_r than in other color spaces, as well as, it has the smallest overlap between skin and non-skin data in under various illumination conditions. YC_bC_r is a family of color spaces used in video systems which is broadly utilized in video compression standards. YC_bC_r is used for the ITU-R BT.601 standard-definition television. The YC_bC_r is one of two primary color spaces used to represent digital component video (the other is the RGB).

The histogram relays on an underlying color space and uses its components to determine the probability of a certain color being existed in an image. YC_bC_r histograms relay on the YC_bC_r color space components to build a histogram. In constructing an YC_bC_r histogram, each component of the YC_bC_r histogram is quantized into a certain number of regions. An implementation of YC_bC_r histogram divides the luminance (Y) into eight regions, whereas each of chromic components (C_b, C_r) is divided into four regions. The three color components then are linked, thus creating a (8x4x4) histogram of 128 bins

III. Similarity Measure of YC_BC_R Histogram

The Bhattacharyya distance [9] is used along with the YC_bC_r histogram to measure the distance between images; this distance is used as the global score of the image. The histogram comparison methods provide a similarity measure for matching images based on their extracted histogram. This distance measures the statistical reparability between spectral classes. It is a probabilistic distance measure that provides an estimate of the probability of correct classification. This distance overpasses zero histogram entries. This distance is given by:

$$B\left(H_Q,H_C\right)=-\ln\sum_i\sqrt{H_Q\left(i\right)*H_C\left(i\right)} \qquad (1)$$

where, H_Q represents the query histogram H_C represents the histogram to be compared, and (i) represents the number of bins, respectively.

IV. Edge Histogram Descriptor

The edge histogram descriptor (EHD) describes the spatial distribution of five types of edges. These edges were four directional edges (vertical, horizontal, 45°, and 135°) and one non-directional edge [6]. Edges may be used for retrieving images with similar semantic meaning. By combining edge histogram descriptor with other descriptors such as the YC_bC_r color histogram descriptor, retrieval precision and recall are enhanced. Spatial distribution of edges in an image is practical texture descriptor for similarity search and retrieval. The EHD represents local edge distribution in the image. The local-edge distribution for each sub-image can be represented by a histogram. This descriptor is demonstrated by figure (1). The first step is the partitioning of the image into 16 (4x4) blocks. The image partitioning always produces 16 equal-size sub-images regardless of the size of the original image. A 5-bin histogram for edge distribution is generated from each sub image that corresponded to the directional and non-directional edge types. Since there are 16 sub-images in the image, a total of 5*16=80 histogram bins is required as shown in figure (2).

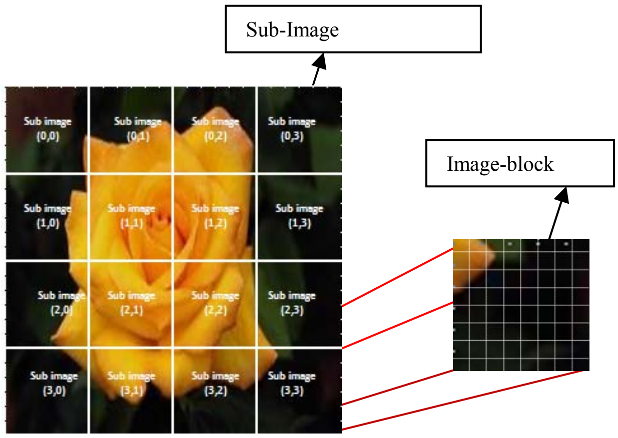
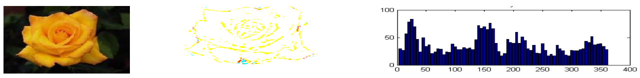


Fig. 1.description of sub-image and image-block



Query image | Edge of the query image | Edge histogram descriptor of the query image

Fig. 2.structure of 80 bins edge-histogram

V. Similarity Measures of EHD

The modified Euclidean distance is used along with the EHD to measure the distance between the images. This distance is used as the local score of the image. This paper employs new similarity measure as matching method of EHD as equation.

$$H(1,2)=\sqrt{\sum_{i=0}^{79}\left(h_1(i)-h_2(i)\right)^2}+\sqrt{\sum_{i=0}^{5}\left(h^g_1(i)-h^g_2(i)\right)^2}+\sqrt{\sum_{i=0}^{64}\left(h^s_1(i)-h^s_2(i)\right)^2} \qquad (2)$$

To normalize the value between 0 and 1

$$H(1,2)\Big/ = 8*(80+5*5+13*5)$$

where, $h_1(i)$ and $h_2(i)$ represent the normalized histogram bin values of image 1 and 2, respectively. $h_1^g(i)$ and $h^g{}_2(i)$ represent the normalized bin values for the global edge histograms which. $h_1^s(i)$ and $h_2^s(i)$ represent the histogram bin values for the semi global-edge histograms. Using the modified Euclidean distance as a similarity measure enhanced the retrieval performance with around 5%, and 3% for average precision and average recall, respectively.

VI. Performance Evaluation

Precision and Recall are metrics to calculate the ranking of the images returned by the retrieval system [10]. For a query q having a defined ground truth images over a database R(q), and let Q(q) be the retrieved result of images for that query. The precision of the retrieval is defined as the fraction of the retrieved images that are indeed relevant to the query [11].

$$Precision = \frac{|Q(q) \cap R(q)|}{|Q(q)|} \quad (3)$$

The recall is the fraction of the relevant images that is returned by the query [11].

$$Recall = \frac{|Q(q) \cap R(q)|}{|R(q)|} \quad (4)$$

To evaluate a system over all the categories, Top N performance measurements [12] can be used. When submitting a query q to a CBIR system, the system returns N resulted list of images sorted based on similarity to the query image, where N is the number of top similar images. We denote $PR_N(q_i)$ as the precision of the top N returned sorted results. The aim of the user after submitting a query is to search for the most relevant images R(q). The precision PR_j, j=1, 2, … of the top N results of a query q is defined as:

$$PR_N(q_i) = \sum_{i=1}^{N} \frac{\psi(p_k, R(q))}{N} \quad , \psi(x,y) = \begin{cases} 1; if\ x \in y \\ 0; if\ x \notin y \end{cases} \quad (5)$$

So the average precision for all queries performed on a CBIR system for a certain N number of returned results is defined as:

$$PR_N = \sum_{i=1}^{Total\_Query\_count} \frac{PR_N(q_i)}{Total\_Query\_count} \quad (6)$$

Similarly, the recall RE_j, j=1, 2, … N of the top N results of a query q is defined as:

$$RE_N(qi) = \sum_{i=1}^{N} \frac{\psi(p_k, R(q))}{\|R(q)\|} \quad (7)$$

And the average Recall for all queries is defined as:

$$RE_N = \sum_{i=1}^{N} \frac{RE_N(qi)}{\|R(q)\|} \quad (8)$$

VII. Average Normalized Modified Retrieval Rank (ANMRR)

It is simple ranking method than the precision and recall. This frame work utilize the normalized ranking measure: average normalized modified retrieval rank (ANMRR) that was defined by the MPEG-7 research group [6].

Let the number of ground truth images for a query q be NG (q)

Compute NR(q), number of found items in first K(q) retrievals, where

K (q) =min (4*NG (q), 2*GTM)

where, GTM is max {NG (q)} for all q's of a data set.

Rank (k) is defined as follows:

$$Rank(k) = \begin{cases} R(k) & if\ R(k) \le k(q) \\ (k+1) & if\ R(k) > k(q) \end{cases} \quad (9)$$

where, R (k) is the rank of an image k.

The average rank (AVR) for query q is defined as follows:

$$AVR(q) = \sum_{k=1}^{NG(q)} \frac{Rank(k)}{NG(q)} \quad (10)$$

However, with ground truth sets of different size, the AVR value depends on NG (q). To minimize the influence of variations in NG(q), modified retrieval rank (MRR) is defined as follows:

$$MRR(q) = AVR(q) - 0.5(1 + NG(q)) \quad (11)$$

The upper bound of MRR depends on NG (q). To normalize this value, normalized modified retrieval rank (NMRR) is defined as follows:

$$NMRR(q) = \frac{MRR(q)}{k + 0.5 - 0.5 * NG(q)} \quad (12)$$

NMRR (q) has values between 0 (perfect retrieval) and 1 (nothing found). Finally, for the whole query sets, ANMRR is defined as follows:

$$ANMRR = \frac{1}{Q} \sum_{q=1}^{Q} NMRR(q) \quad (13)$$

VIII. The Proposed Image Retrieval System

The proposed approach combines a local descriptor (edge histogram descriptor) with a global descriptor (YC_bC_r histogram). The YC_bC_r histogram descriptor is applied globally on the whole image to capture the color information from all the pixels of the image. The Bhattacharyya distance is used along with the YC_bC_r histogram to measure the distance between images; this distance is used as the global score of the image. Another local score is defined by applying the local description technique to extract the texture information. The final score between two images is given by

$$\Delta_{finalScore} = w_1 \times \Delta_{Global\ Score} + w_2 \times \Delta_{local\ Score}$$

where w_1 and w_2 are the weights for global YC_bC_r histogram and the edge histogram descriptor. This score increases with the increase of similarity to the query image. In our experiments, w_1 and w_2 are equal to one each; giving an equal importance to both global and local description of an image.

IX. EXPERIMENTS RESULTS

The experiments were executed on the 1000 image Wang database [13] and the Uncompressed Color Image Database (UCID) [14]. The Wang database includes 10 categories; each category contains 100 images. For each query, a set of ground truth images that are relevant to the query were identified. Wang database have 20 queries each with a proposed ground truth. The UCID consists of 1338 uncompressed TIFF images of different topics related to indoors, outdoors and natural scenes, and man-made objects. UCID database have 162 queries each with a proposed ground truth. The results of the proposed approach have been compared with the results of the following MPEG7 descriptors: Scalable Color Descriptor (SCD), Color Layout Descriptor (CLD), and Texture Descriptor: Tamura Descriptor. Moreover, the results have been compared to HSV histogram. Also the results have been compared to the fuzzy color and texture histogram (FCTH) composite descriptor.

The evaluation of the top N precision results for the proposed approach compared to other approaches over the Wang database is shown in figure (3). The evaluation of the top N recall results for the proposed approach compared to other approaches over the Wang database as shown in figure (4). Figure (5) shows the experimental results of the mean precision for each category in the Wang database. Figure (6) shows the experimental results of the mean recall for each category in the Wang database. It is shown that proposed technique is better accurate than the previous approaches for categories.

Figure (7) shows the evaluation of the top N recall results and the top N precision evaluated over the UCID. Consistent with the results the proposed technique is better accurate than the previous approaches. Figure (8) shows the evaluation of Average Normalized Modified Retrieval Rank evaluated over the UCID and Wang databases. The proposed technique is compared with the HSV histogram, FCTH and the MPEG7 descriptors. The results prove that the proposed technique is better than the previous approaches

X. CONCLUSION

This paper proposed an image retrieval approach which integrates the proposed YC_bC_r color histogram and texture extraction technique. The proposed approach extracts the YC_bC_r histogram as global statistical descriptor that represents the distribution of colors in an image. A Bhattacharyya distance is used as a similarity measure to detect the final image rank. The integration between global and local features has been explored by combining our approach with another local feature technique (EHD). The experimental results showed that this combination provided more accurate results than MPEG7 color and texture descriptors and fuzzy color and texture histogram composite descriptor. The proposed approach is accurate in retrieving images even in the presence of geometric deformations or large occlusion and noise.

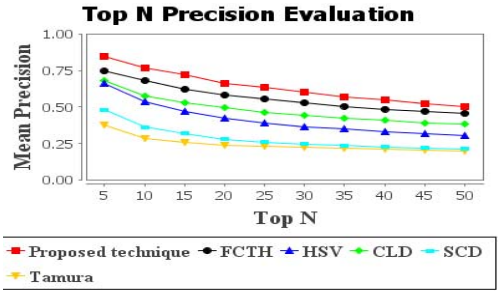


Fig. 3. Evaluation of the top N precision results for proposed approach compared to other approaches over Wang database

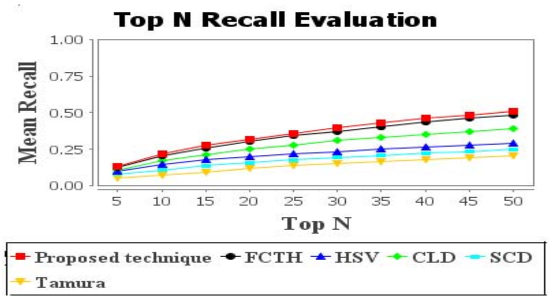


Fig. 4. Evaluation of the top N recall results for proposed approach compared to other approaches over Wang database

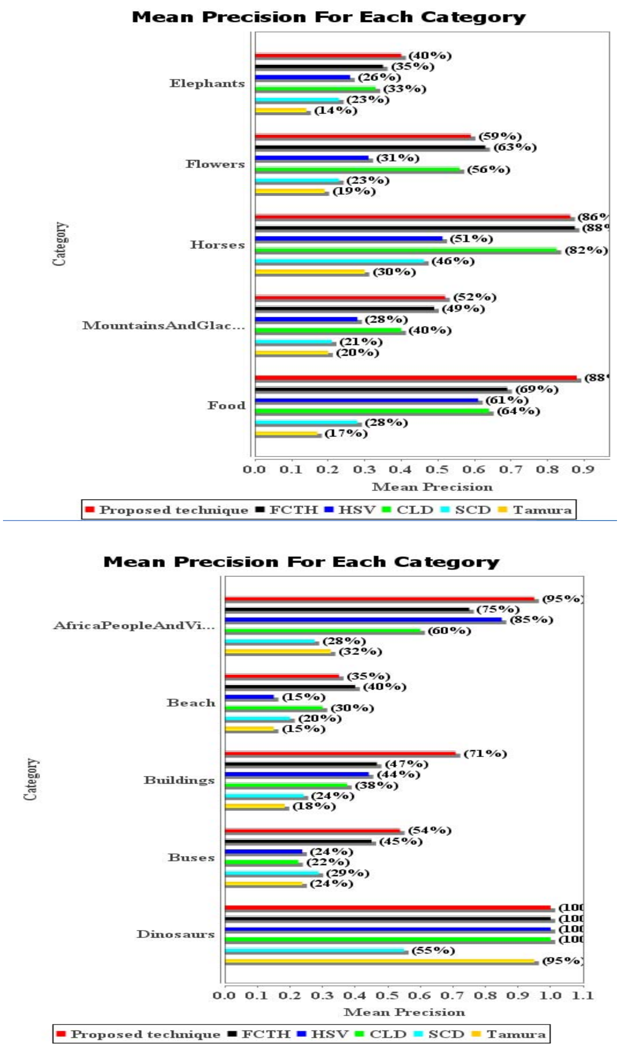


Fig. 5. The mean precision for each category in the Wang database

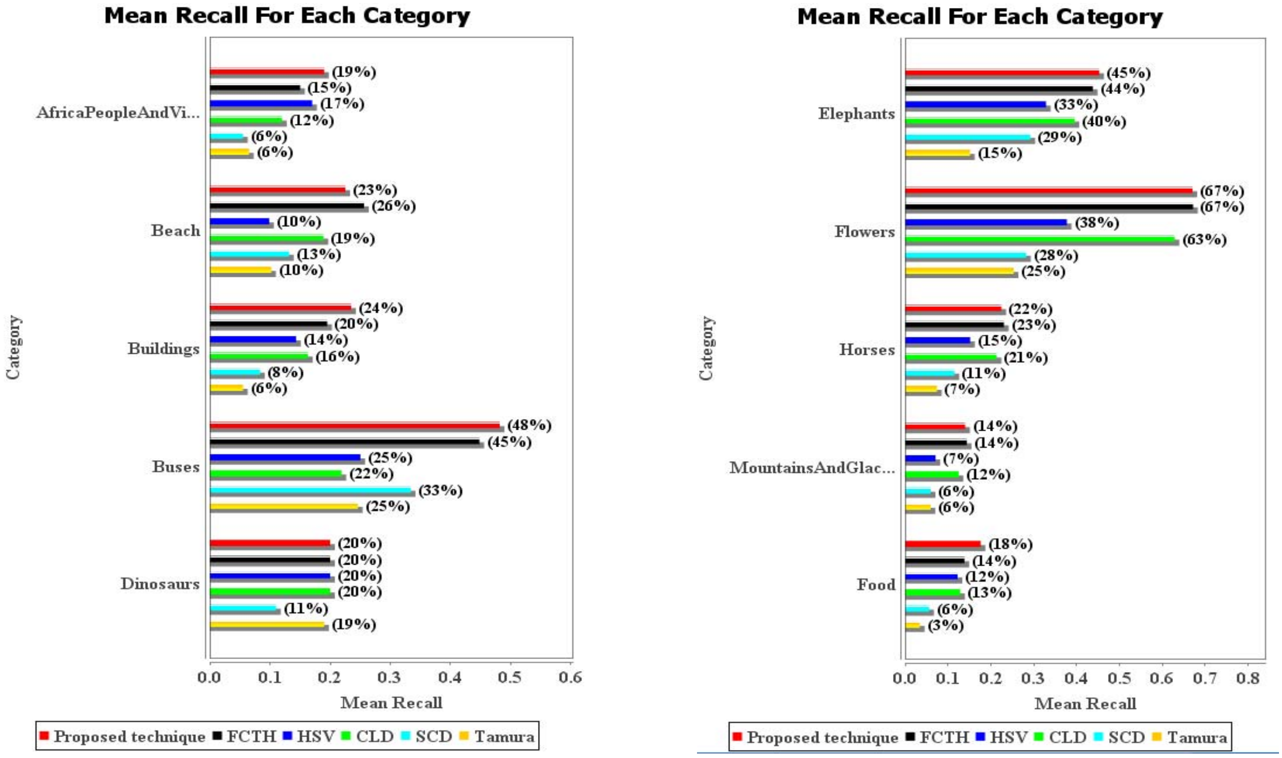
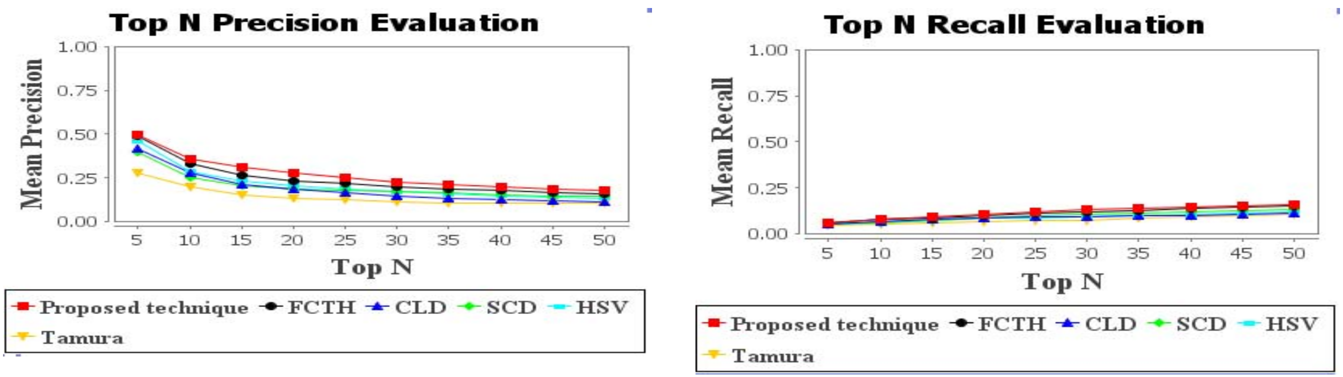


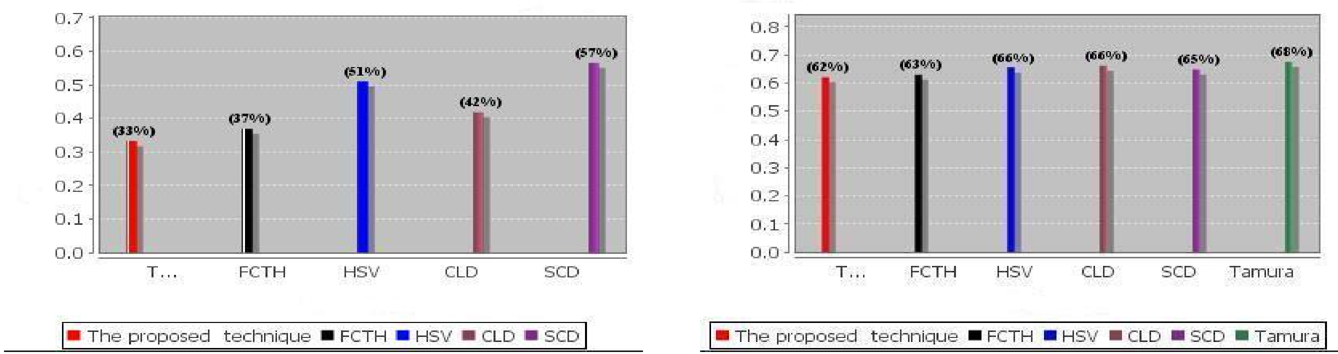
Fig. 6. The mean recall for each category in the Wang database



(a) shows evaluation of the top N recall results for proposed approach compared to other approaches

(b) shows evaluation of the top N recall results for proposed approach compared to other approaches

Fig. 7. The evaluation of the top N recall results and the top N precision over UCID database



(a) Average Normalized Modified Retrieval Rank evaluated over the UCID and Wang

(b) Average Normalized Modified Retrieval Rank evaluated over the UCID and Wang

Fig. 8.Average Normalized Modified Retrieval Rank evaluated over the UCID and Wang

REFERENCE

[1] Mohamed Ahmed Ebrahim Helala, Mazen Mohamed Selim, Hala Helmy Zayed, "An Image Retrieval Approach Based on Composite Features and Graph Matching," iccee, vol. 1, pp.466-473, 2009 Second International Conference on Computer and Electrical Engineering, 2009.

[2] Shamik Sural, Gang Qian, and Sakti Pramanik. Segmentation and histogram generation using the hsv color space for image retrieval. Proceedings of the 6th ACM international conference on Image and video retrieval, Amsterdam, The Netherlands, 2:II–589– II–592, 2002.

[3] Barcellos, R; Oliani , R. S.; Lorenzi, L. T.; Gonzaga, A. "Content Based Image Retrieval Using Color Autocorrelograms in HSV Color Space", In Proceedings Of Xviii Brazilian Symposium on Computer Graphics and Image Processing - Sibgrapi 2005, ISBN: 85-7669-036-5.

[4] Ji-quan Ma, "Content-Based Image Retrieval with HSV Color Space and Texture Features," wism, pp.61-63, 2009 International Conference on Web Information Systems and Mining, 2009

[5] Ka-Man Wong, Kwok-Wai Cheung and Lai-Man Po, "MIRROR: an interactive content based image retrieval system", Proceedings of IEEE International Symposium on Circuit and Systems, vol. 2, Japan, May 2005, pp. 1541-1544, 23-26.

[6] Jose M. Martinez, Mpeg-7 overview (http://www.chiariglione.org/mpeg/standards/mpeg-7/mpeg-7.htm).

[7] Qasim Iqbal and J.K. Aggarwal. Combining structure, color and texture for image retrieval: A performance evaluation. 16th International Conference on Pattern Recognition (ICPR), 2:438–443, 2002.

[8] S. A. Chatzichristo_s and Y. S. Boutalis, "FCTH - Fuzzy Color and Texture Histogram - A low level Feature for Accurate Image Retrieval", 9th International Workshop on Image Analysis for Multimedia Interactive Services, IEEE Computer Society, Klagenfurt, Austria, 2008, pp. 191-196.

[9] Keinosuke Fukunaga. Introduction to statistical pattern recognition (2nd ed.) Academic Press., 1990.

[10] Sylvie Philipp-Foliguet, Julien Gony, and Philippe-Henri Gosselin. Frebir: An image retrieval system based on fuzzy region matching. Comput. Vis. Image Underst., 113(6):693–707, 2009.

[11] Zhang H. LongF. and Dagan Feng D. Fundamentals of content-based image retrieval,in multimedia information retrieval and management – technological fundamentals and applications. Springer-Verlag, pages 1–26, 2003.

[12] J. Stottinger, N. Sebe, T. Gevers, and A. Hanbury. Colour interest points for image retrieval. Vision Winter Workshop, 2007.

[13] James Z. Wang, Jia Li and Gio Wiederhold, "SIMPLIcity: Semantics-Sensitive Integrate, Matching for Picture Libraries", IEEE transactions on pattern analysis and machine intelligence, Volume 23, no. 9, September 2001.

[14] G. Schaefer and M. Stich, "UCID -An Uncompressed Colour Image Database", Proc. SPIE, Storage and Retrieval Methods and Applications for Multimedia, pp. 472-480, San Jose, USA 2004.