International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-6 Issue-3, February 2017

An Adequate Image Retrieval Technique Based on Global Level Feature Extraction

Sumaira M.Hayat Khan, Ayyaz Hussain, Imad Fakhri Taha Alshaikhli

Abstract: Efficient and effective methods are required for the retrieval of relevant data from data stores. The two main approaches for retrieving a required image from a database are known as the local approach and the global approach. This paper presents the technique based on global approach of image feature extraction and comparison. Image features are calculated by taking into account image as a whole. All the three rudimentary image features like; color, texture and shape are utilized in the process of feature vector calculation. Besides these basic image features, Edge Histogram and Fourier Descriptors are also computed to extract edge information and shapes of the objects in the image respectively. Similarity between two images is determined by calculating Euclidean distance between their feature vectors. The experiments in this study were performed on natural images of diverse semantics from a Corel image database, and showed obvious improvement in results compared to several noble systems in the literature.

Keywords: Content Based Image Retrieval, Feature Extraction, Feature Vector, Similarity Measure, Fourier descriptor, Edge Histogram Descriptor.

I. INTRODUCTION

Advancement in data storage and image acquirement phenomenon requires creation of large datasets. Digital images are now produced and applied in almost all fields of life like medicine, journalism, tourism etc . The need for a vigorous method for the retrieval of images from such systems has greatly increased research interest in the field of image retrieval [1]. Two different approaches used for image retrieval are: (1) text-based and (2) content-based. Text-based image retrieval is based on the keywords provided by users describing the required image. Content-based image retrieval (CBIR), on the other hand, depends on the content of the image, which includes visual features such as color, texture, and shape, and is of great importance in CBIR systems [2]. CBIR systems are an application of computer vision processes to the problem of image retrieval, i.e., searching for digital images in huge databases. CBIR is appropriate for image retrieval because image searches based on metadata are completely dependent on the quality, correctness, and completeness of the annotated text. Also, the process of annotating data manually by humans is time consuming and this might skip the keywords required for image description [3].

Manuscript published on 28 February 2017.
***** Correspondence Author (s)
Sumaira M.Hayat Khan, International Islamic University Islamabad, Pakistan. E-mail: sumaira@apu.edu.my
Ayyaz Hussain, Asia Pacific University, Malaysia. E-mail: ayyaz.hussain@iiu.edu.pk
Imad Fakhri Taha Alshaikhli, International Islamic University Malaysia, Selangor, Malaysia. E-mail: imadf@iium.edu.my

Visual feature of an image are used to describe image content in CBIR. These features can be either local or global. Typical global features include shape, color and texture while in local features extraction is done on local parts after segmentation. In medical and satellite images, segmentation is difficult as there is no clear boundary in such images [4]. To determine the similarity of two images in image retrieval process is the main problem. Color, shape and texture are the commonly used properties to measure parallelism among images

This paper proposes a global technique for CBIR extracting features based on color, texture and shape information. Along with these basic image features, edge features are also incorporated by calculating Edge Histogram Descriptors. One of the important shape features i.e. Fourier descriptors are also considered to extract as much of information as possible from the image. Similarity between the feature vectors of query and database images are then found by calculating Euclidean Distance. Images retrieved are then sorted according to the increased distance between their feature vectors. Manuscript is organized as: Section 2 elaborates related work and background of CBIR. Proposed technique is discussed in detail in Section 3. Section 4 presents experimentation and comparison of the proposed technique with other existing methods. Conclusion is made in Section 5 along with some future directions.

II. RELATED WORK

In CBIR, feature vector is generated for every image describing its content and is stored as an index in feature database. Hence, images are automatically indexed by this process. For retrieval of image from a database, resemblance between the feature vector of the query and database image is calculated. A threshold is specified and the distance is measured between the query image and the database image. This space must be less than the specified threshold [5]. Figure 1 shows an overview of content based image retrieval. QBIC system from IBM [6] is one of the image retrieval systems that were available in the beginning. It employs color histogram, a flash based shape and texture descriptor. Photo Book System from Massachusetts Institute of Technology (MIT) [7] is also one of such systems. This system utilizes appearance, texture and 2-D form characteristics. Face recognition technology was also added to this system for searching images of particular persons. Blob world is another image retrieval system [8] developed at UC Berkley. Images are symbolized section wise which are established in expectation-maximization (EM) like segmentation process.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

This system follows continuous approach using nearest neighbor approach for image retrieval. SIMBA, CIRES, SIMPLICITY city, Image Retrieval in Medical Applications (IRMA) and FIRE also uses the same approach for image retrieval. VIPER/GIFT Image retrieval system follows the discrete approach [9]. This system describes the local and global properties of the image by incorporating color and texture features. The structure of the system allows for extremely high dimensional feature spaces (> 80, 000 dimensions) but for each image 3, 000 to 5, 000 features are active only [10, 2]. Image recovery on the basis regions are extensively used among various local feature based approaches. To extract the features of region, image in Region Based Image retrieval divided into lesser regions. The parallelism of two figures is then measured depending on the analogous region based features. UCSB NeTra system is one of the region based retrieval systems to an edge flow model to divide the image by using triple user specific constraint [11].

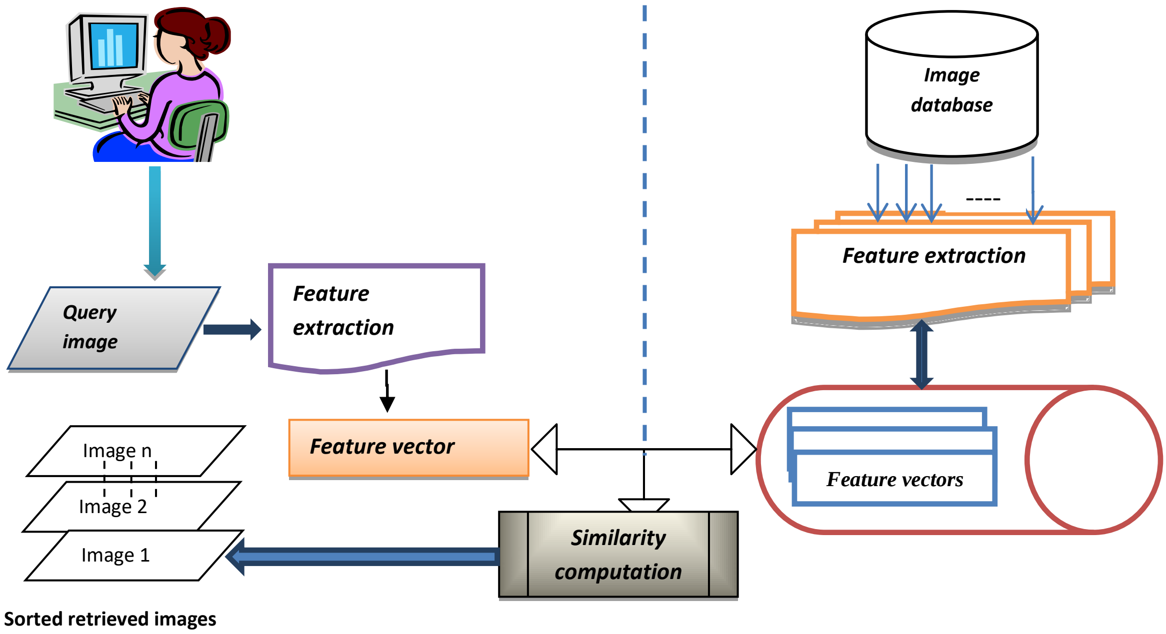


Figure 1: Flow Chart of Content-Based Image Retrieval

III. PROPOSED TECHNIQUE

The technique proposed here is based on the global approach where the image is considered as a whole when sent for the feature extraction process. The image features to be extracted for the calculation of the feature vector are color, texture, shape, FD, and EHD. After extraction, these feature vectors will be kept in a database in the form of Excel sheets. The query image given to the system also goes through the feature extraction process in the same way and comparison with all database images is made by calculating the difference between the characteristics of two images. Retrieved images would be sorted on the basis of the least Euclidean distance between two images. A diagrammatic representation of the proposed technique is given in Figure 2.

Algorithm:

Step 1: Color histogram Ḣ is constructed to extract color feature Î: ⨍ for each segment of image Î, where i=3.

Step 2: Construct a texture feature Î: ⨍ by calculating Co-occurrence matrix *C(i, j)*.

Step 3: Let $x|k|$ and $y|k|$ be the coordinates of the k^{th} pixel on the boundary of a given 2D shape containing n pixels, a complex number can be formed as

$z|k| = x|k| + py|k|$,

and the *Fourier Descriptor (FD)* of this shape is defined as the DFT of Z|k|

$$\mathrm{DFT}[\mathrm{Z}|\mathrm{k}|] = \sum_{k=0}^{n-1} z|k|e^{-\mathrm{p}\,2\ \mathrm{kN}}\ \ (N = 0,\ \ldots,\ n-1)$$

Step 4: Edge histogram descriptor EHD is calculated from four directional edges, namely vertical, horizontal, 45 degree, and 135 degree, and one non-directional edge.

Step 5: Euclidean distance is used to calculate the distance between the feature vector of the database images Vd and the feature vector of the query image Vq.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

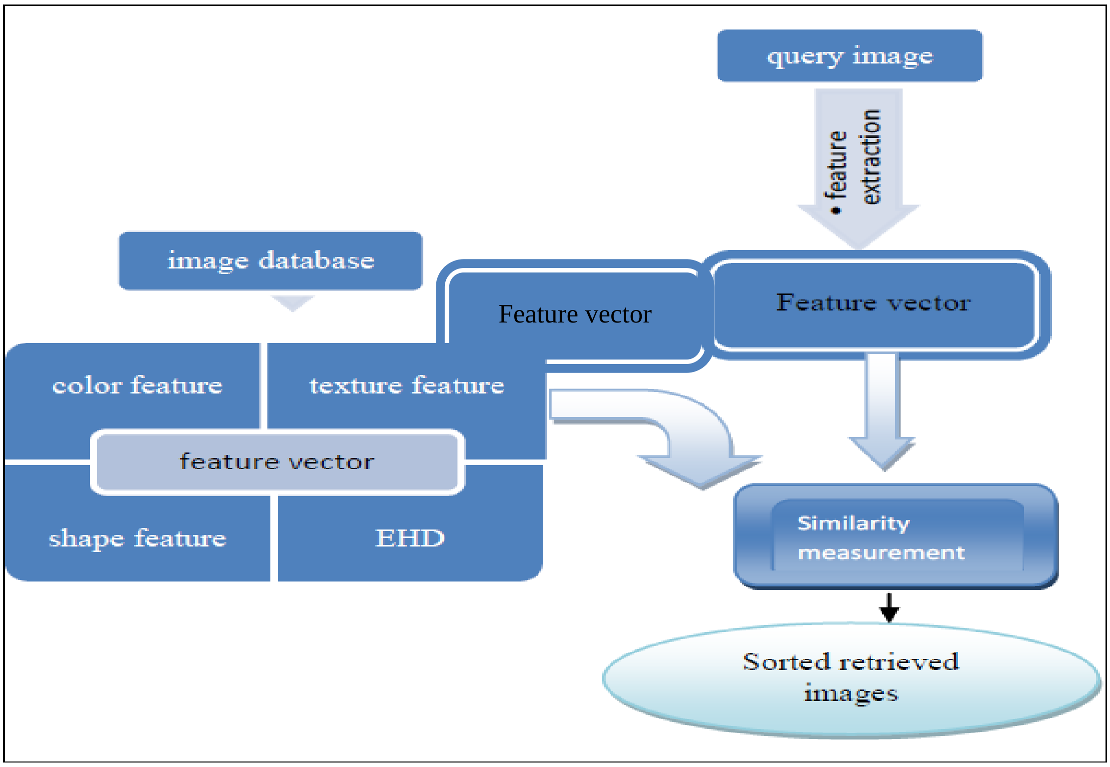


Figure 2: Block Diagram of Proposed Technique

3.1. Feature Extraction

All the key features of an image are extracted in the proposed technique. These features include color, texture, and shape features. EHD will also be calculated in addition to the core features to extract information at the edges.

1.1.1. Color Feature

The color features used in the proposed technique are calculated from a color histogram. A color histogram defines the dissemination of colors in an image and is invariant to translation, rotation, and scaling of an object. However, color histograms do not contain any semantic information, hence two images can hold different contents having the same histogram. The color histogram H for an image is given as:

$$H = \{h[1], h[2], . . . h[i], . . . , h[N]\}$$

Where *i* denotes a certain color in the histogram, *h[i]* is the pixel count of colors *i*, and *N* defines the number of bins in the color histogram. The proposed method extracts color features by calculating the mean, mode, median, and standard deviation for every color channel. Thus, twelve color features will be extracted for the query image and every database image. Gray levels and pixel counts will be extracted from the histogram of gray images. Each time, one color channel is taken for calculation of the above-mentioned features. Table 1 shows a list of color features used by the proposed technique along with their equations [12]. Color is considered to be the most effective image feature in almost all CBIR systems because of the advantages of effectiveness, robustness, implementation easiness and low space requirements [13].

Table 1: Color Features Used In the Proposed Technique

Image Feature	Equation with Symbol Definition	
Mean	$\text{Mean} = m = \frac{\sum_{i=1}^{n} X_i}{n}$ where X= gray levels, i = index	(1)
Median	$\text{Median} = \frac{n+1}{2}$ where n = pixel count	(2)
Mode	$\text{Mode} = \max(X_i)$	(3)
Standard deviation	$\text{Standard deviation} = \sigma = \sqrt{\frac{\sum(X-m)^2}{n-1}}$	(4)

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

1.1.2. Texture Feature

Texture feature computation was done by constructing a co-occurrence variance matrix. A gray level image was used as input for computation of the co-occurrence variance matrix.

The co-occurrence matrix C(i, j) sums the number of pixels in a certain order having gray values I and j at a specific distance d which is given in polar coordinates (d, θ). These polar coordinates have distinct length and direction. The direction θ takes values from eight different angles: 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°.

The first and most widely used method for the extraction of texture features is constructing a grey level co-occurrence matrix. Six different features including mean (M), standard deviation (S), maximum probability (MAXP), uniformity (UNI), entropy (ENT), skewness (SK), difference moment and contrast (CONT) were extracted by using different formulae [12]. All these texture features are presented with their formula in Table 2.

Table 2: Texture Features Used in the Proposed Technique

Image feature	Equation with symbol definition	
Skewness	$SK = \frac{\sum\left(\frac{X-m}{\sigma}\right)^3}{n}$ where m = mean, σ = standard deviation	(5)
Maximum probability	$MAXP = \max\left(\frac{n(A)}{n}\right)$ where A = probability	(6)
Uniformity	$UNI = \left(1-\frac{\sigma}{m}\right)\times 100$ where σ = standard deviation, m = mean	(7)
Entropy	$ENT = -\sum_i \sum_j C(i,j)\log C(i,j)$ Where C(i,j) = gray level co-occurrence matrix	(8)
Contrast	$CONT = \sqrt{\frac{1}{MN}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(I_{ij}-I)^2}$ where M by N = size of 2 dimensional image, I = average intensity of all pixels in the image, $I_{i,j}$= i-th and j-th element of an image	(9)

1.1.3. Shape Features

In contour based shape feature abstraction procedures, a contour system was utilized. Three different features were extracted from the image's contour, which are presented in Table 3 with equations [12].

Table Error! No text of specified style in document.**: Shape Features Used in the Proposed Technique**

Image feature	Equation with Symbol Definition	
Circularity	$Cir = \frac{4_P A}{P^2}$ Where A = area of polygon enclosed by segment boundary, P = perimeter of polygon enclosed by segment boundary	(10)
Aspect Ratio	$\text{Aspect Ratio} = \frac{P1+P2}{C}$ P1,P2 = greatest perpendicular distances from longest chord to boundary, in each half-space either side of line through longest chord, C = length of longest boundary chord	(11)
Solidity	$\text{Solidity} = D = \frac{A_s}{H}$ where As = area of the shape region, H = convex hull area of the shape	(12)

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

1.1.4. Fourier Descriptor Method

Methods used for boundary-based recovery of shape characteristics include Fourier descriptors FD [14], Wavelet descriptors, Curvature scale space descriptors, Shape signatures, etc. Among all these methods, the FD method is the most fundamental one. The FD method computes shape signature functions by using shape boundary coordinates. These shape signatures utilize Fourier transform for computation of FD [15]. Shape is analyzed in the spectral domain by FD to surmount the consequences of sound and boundary differences on shape feature extraction. Also, the FD method for shape feature extraction is computationally inexpensive, easy to normalize, and has been proved to outperform many other boundary based techniques in terms of accurate and fast recovery [16]. FD is applied on each object separately after its identification through boundaries or edges.

Employment of the shape signature function, calculation of boundary pixels, and FD are the main constituents of the General FD method. Boundary pixel computation for boundary coordinates is performed through edge detector and boundary tracing techniques [17].

A pixel set is formed after the computation of boundary pixels and is represented by the following formula:

$$P = \{(x(t), y(t)) \mid t \in [1, N]\} \qquad (12)$$

In FD method, pixel coordinates of the shape boundary in a figure are used to measure shape signatures. Fourier transforms are employed for these shape signatures to evaluate Fourier transformed coefficients which are used as FDs [14].

1.1.4.1. Edge Histogram Descriptor (EHD)

Edge is also an important image feature that can be used to extract information present at the contrast. EHD signifies the spatial circulation of five types of edges. Among these, four are called directional edges, namely vertical, horizontal, 45 degree, and 135 degree, and one is a non-directional edge. Edge strength is detected by the application of filter coefficients as shown in Figure 3.4. Edge blocks bigger than a given verge were selected.

1	-1
1	-1

1	1
-1	-1

√2	0
0	√2

2	-2
-2	2

Figure Error! No text of specified style in document.**-2: Filter Coefficients**

MPEG-7 standards reveal that retrieval performance of images can be improved by calculation of EHD. This descriptor shows invariance to scale and rotation.

The edge histogram descriptor represents the spatial distribution of five types of edges - four directional edges and one non-directional edge and might improve the retrieval results. According to the MPEG-7 standard, if the edge histogram descriptor is joined with a color histogram descriptor, the recovery performance of an image is radically improved. The descriptor is scale invariant and supportive to rotation invariant and rotation sensitive matching operations [18].

IV. EXPERIMENTAL RESULTS

4.1. User Interface

Experiments were carried out on natural images to test the retrieval efficiency of the proposed method. An easy to use graphical user interface (GUI) was designed where the query image was browsed from the system and a threshold was chosen for the segmentation process. The system was then able to retrieve the top 10 similar images from the database. Figure 3 shows the main GUI of the proposed system.

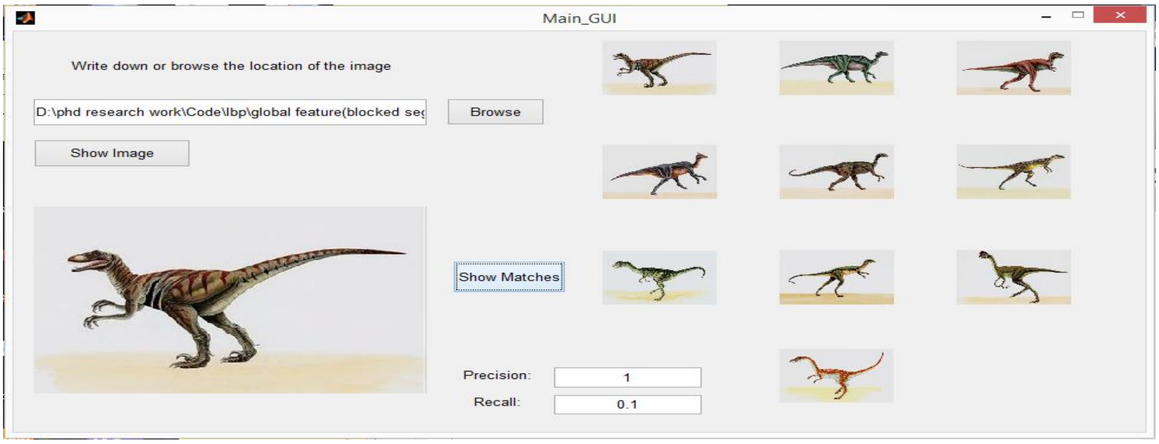


Figure Error! No text of specified style in document.**: Main GUI of the Proposed Technique**

4.2. Data Set

The proposed technique was tested on a database of 1,000 natural images from the Corel image database available free on the Internet. Corel images are stored in JPEG format with sizes 384 × 256 or 256 × 384. The entire database has 10 different image categories, where each category contains 100 images. All these images' categories contain diverse semantics including 'beach', 'vehicle', 'dinosaur', etc. Experiments were performed on 10 randomly chosen image queries, one from each category.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

The sample image from each category selected for experimentation is given in Figure 4. All these classes had different semantics and could therefore better evaluate the proposed method. The performance measures used to find the retrieval efficiency of the proposed system are precision and recall.

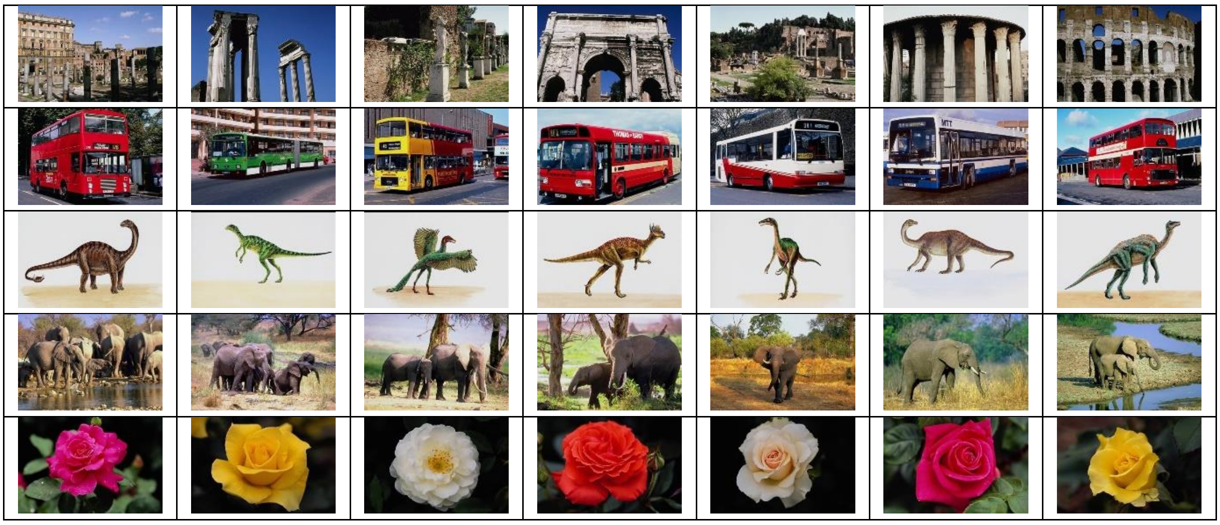


Figure 4: Sample Images from the 10 Different Image Categories of the Corel Image Database Used in the Experiments

4.3. Impact of FD and EHD on Image Retrieval

In addition to the three basic features (BF) color, texture, and shape, FDs and EHD were also combined to extract the maximum statistics of the image. FD is invariant to rotation, translation, and scaling. FDs relate to the low frequency components of the boundary to represent a 2D shape. The reinstated shape based on these descriptors estimate the shape without details corresponding to high frequency components vulnerable to noise. Figure 5 shows the comparison of retrieval results for two feature vectors. The retrieval results of the feature vector integrated with FD and EHD were better than the retrieval result of the feature vector with BF for five distinct image categories.

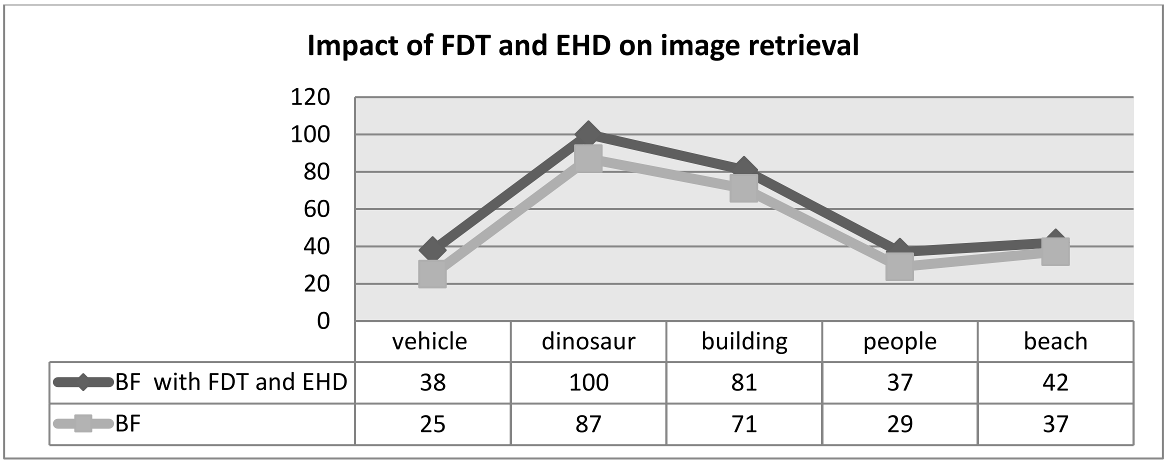


Figure 5: Comparison of Retrieval Results of Feature Vectors using FD and EHD with Basic Features

Greater improvement was observed in the results for ‘vehicle’ and ‘dinosaur’. These image categories had a lesser number of objects; therefore most of the edges and boundaries were detected by FD and EHD, which added to the information retrieved from these image categories. While the other three categories, having more objects, resulted in a less number of edges detected - hence showing little improvement in results as compared to ‘vehicle’ and ‘dinosaur’.

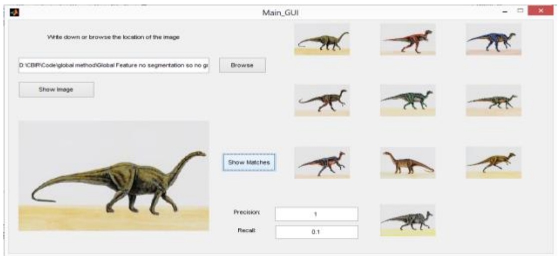
4.4. Qualitative Evaluation of Proposed Global Technique

Five different pictures with varied structures, namely: ‘beach’, ‘vehicle’, ‘horse’, ‘dinosaur’, and ‘people’ were randomly selected for a qualitative evaluation. All these selected image categories were totally different from. one another in their content.

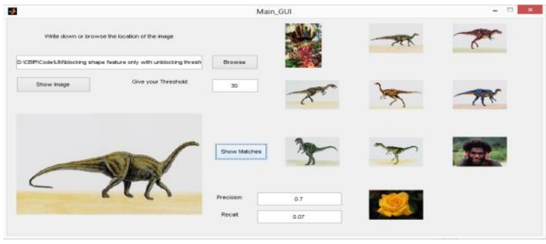
Here, the image retrieved was taken as a correct match if it fell in a category parallel to the query image. The results of the proposed global technique for CBIR compared to one of the local CBIR techniques, UM [19], which is one of the top region based retrieval methods we aware of, are shown side by side in Figure 6 For each member query image, the top 10 retrieved images are given for both methods.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

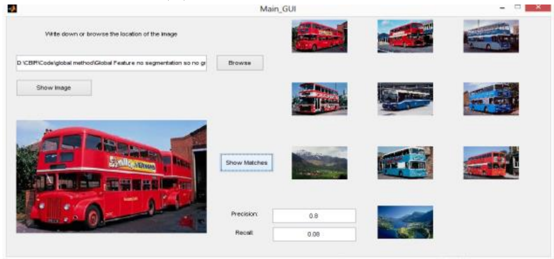
Retrieval results by using our proposed technique | **Retrieval results by using the UM method**



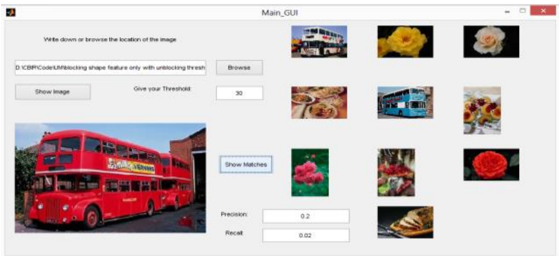
(a) 10 matches out of 10



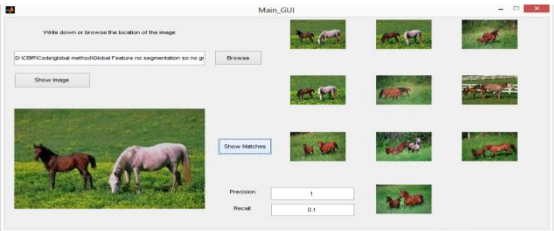
7 matches out of 10



(b) 8 matches out of 10

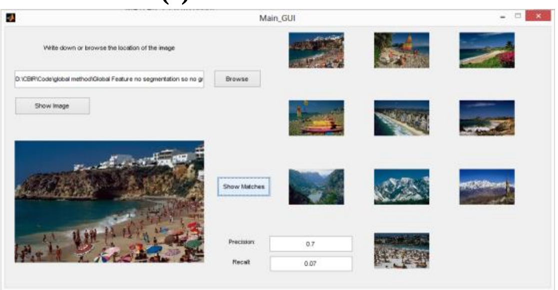


2 matches out of 10

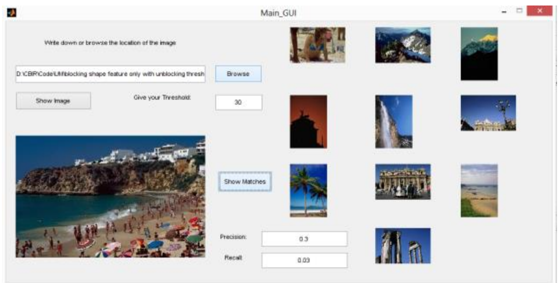


(c) 10 matches out of 10

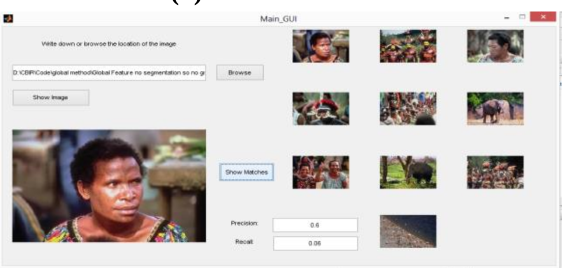
8 matches out of 10



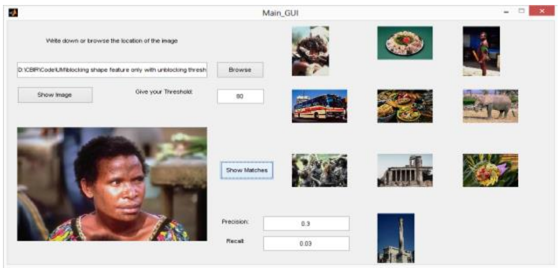
(d) 7 matches out of 10



3 matches out of 10



(e) 6 matches out of 10



3 matches out of 10

Figure 6: Retrieval Results of Five Query Images by using the Proposed Technique and the UM Method

Our method produced expected outcomes for 'dinosaur' and 'horse' queries while the results of the UM method showed some extraneous images. This is because of the elimination of segmentation from our proposed system, resulting in less information loss and better construction of the feature vector. Our proposed method also generated much better outcomes of 'vehicle', 'beach' and 'people' than the UM method.

4.5. Quantitative Evaluation of Proposed Global Technique

For quantitative evaluation, the proposed technique was tested on 10 different images selected randomly from five distinct image categories. The average retrieval accuracy of each category was calculated by finding the top 10, 20, 30, 40, and 50 retrieved images and is given in Table 4. It was found that the results for 'dinosaur' were more consistent compared to other image categories.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

All the image categories produced the best results when the top 10 images were returned as an output. However, precision decreased by increasing the number of returned images.

Table 4: Average Precision at Different Number of Images Retrieved

Image Category	Retrieval Precision @ 10	Retrieval Precision @ 20	Retrieval Precision @ 30	Retrieval Precision @ 40	Retrieval Precision @ 50
Beach	44.05	37.15	39.16	36.37	35.46
Vehicle	57.00	51.08	43.00	39.71	32.30
Horse	94.45	85.03	80.30	78.03	71.04
Dinosaur	100.00	98.35	99.09	98.28	98.28
People	57.21	48.24	39.72	35.05	31.80

4.6. Comparison of Proposed Global Technique with ACT

Our proposed global technique was also compared with a prominent global technique from the literature called ACT [20]. The average retrieval precision of the proposed technique was compared with the retrieval values of ACT for six different image categories. Results showed that the retrieval precision of the proposed technique was better than ACT for all image categories. Comparison of the two methods is shown in Figure 7.

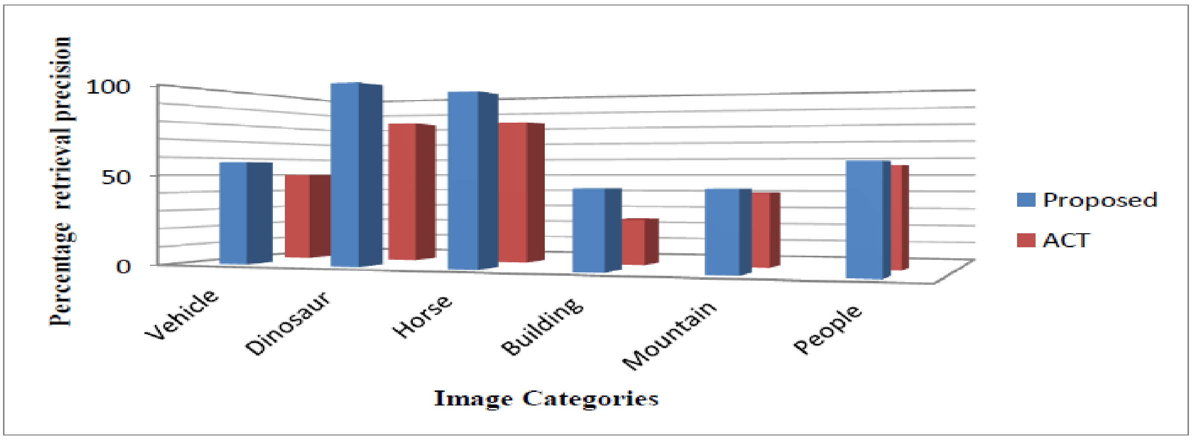


Figure 7: Comparison of the Average Retrieval Precision of the Proposed Global Technique with ACT

The proposed technique makes use of all the basic features, thereby extracting greater information in constructing a feature vector. Considerable improvement was shown for 'building' image types because of the shape features and EHD in the proposed method that detected and extracted most of the edges in these images.

4.7. Comparison of Proposed Global Method (GM) with UM

Comparison of the proposed global technique was also made with a prominent local technique called UM. Results showed that the retrieval precision of the proposed global technique was high compared to UM. UM is a local technique where segmentation is done before feature vector calculation. Segmentation might result in data loss, consequently affecting retrieval of required images from the database. Figure 8 reports a comparison of percentage retrieval precision of the two methods for six distinct image categories.

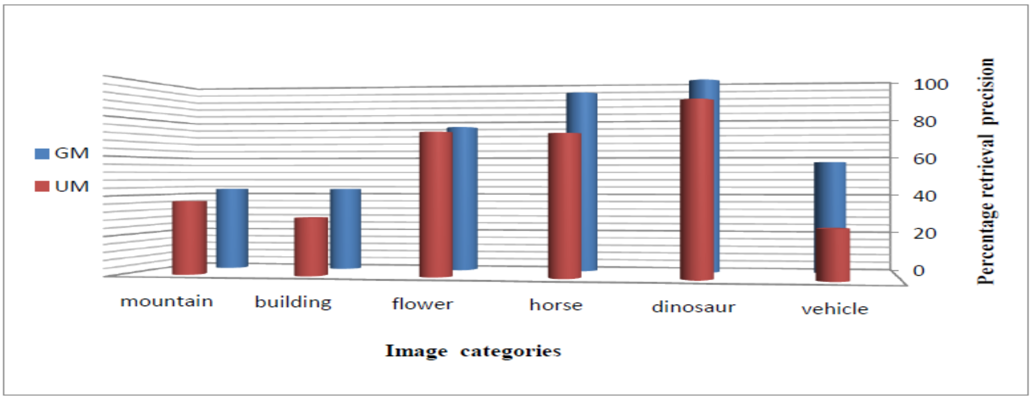


Figure 8: Comparison of Percentage Retrieval Precision of Proposed Global Technique with UM for Five Distinct Image Categories

*Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)*

The above figure illustrates remarkable improvement in results for images from the 'vehicle' group because of the incorporation of FD and shape features in the system. This particular image category has more edges and boundaries, which were extracted through FD. Also, for 'building' type images, FD and shape features finely perceived edges, resulting in greater retrieval precision.

4.8. Comparison with recent local level CBIR techniques

The technique proposed is compared with FRCE [21] and PRIR [22]. These are the CBIR techniques based on the local approach where segmentation is performed before feature extraction. Average precision for different categories of images is calculated. The top number of images considered was 10, 20, 30, 40 and 50.retrieved. It is shown the proposed method outperforms the other two methods in the literature.

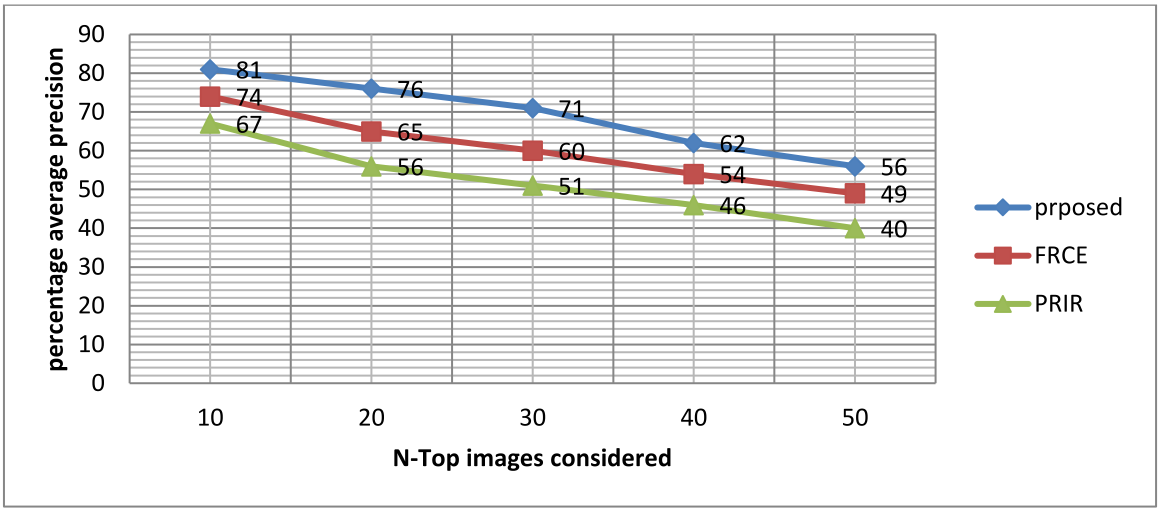


Figure 3-9: Comparison of Percentage Average Precision of the Proposed Methods with FRCE and PRIR at N Images Retrieved

4.9. Comparison of Overall Retrieval Performance

Fair comparisons were ensured by using the same image database as a tester and similar 50 images as queries for comparison with eight different techniques. Average exact retrieval of the selected five image groups from the top 10, 20, 30, 40, and 50 was calculated. It is obvious from the results that our proposed method outperforms all eight techniques in approximately all image categories. Specifically, our proposed method showed better results compared to the UM method for all image categories except for 'beach' and 'dinosaur' images. NFA's results for 'vehicle' and 'horse' were better compared to our proposed technique, but the overall retrieval results of our proposed technique were greater than NFA [23]. For all the other six methods – UFM method [24], IRM method [25], HSV color histogram technique with two different types of bins (i.e., 32 and 64 bins) [26], EHD method [26] and the color indexing method [27] - our proposed method achieved improved results and better precision values for all types of pictures. Figure 9 shows a comparison of whole retrieval precision at 10 returned images for five different image categories using nine different methods. UM did achieve highest precision for two image categories ('beach' and 'dinosaur'), but for all other image categories, the proposed technique had the highest precision.

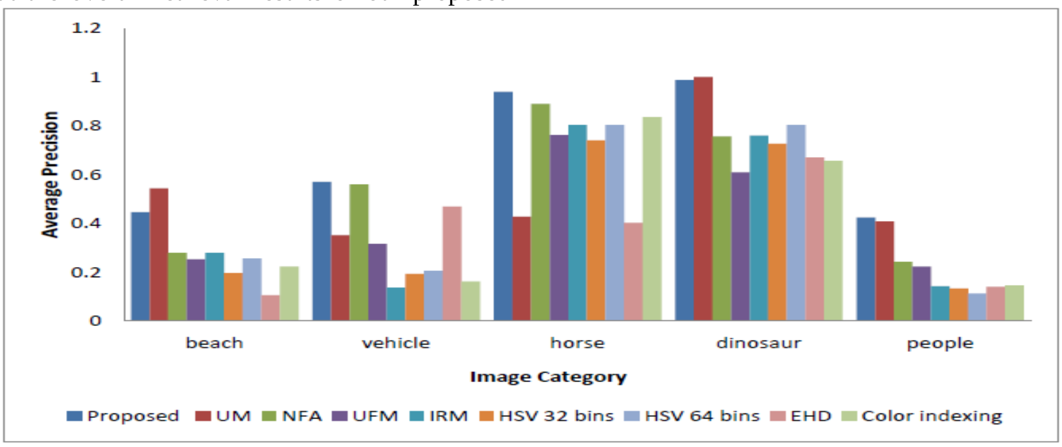


Figure 9: Comparison of Overall Retrieval Precision of Different Image Categories by using Nine Different Methods.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

V. CONCLUSION

The global method extracts image features by taking the whole image into account. In the proposed global technique, extraction of image features was done at a global level and the feature vector was calculated for all the main image features such as color, texture, shape, FD, and EHD. The distance between two feature vectors or two different images was measured through Euclidean distance. Precision and recall were used as performance measures to evaluate the retrieval efficiency of the proposed system. The proposed system was compared with eight different techniques from the literature. Some of these techniques were based on the local approach, some on global, and some, however, were hybrids utilizing both approaches to CBIR. Five different image categories were selected and all the techniques were tested on the same query image. Results showed that the proposed system was better in retrieving the desired image from the database compared to all other eight methods. Further improvements to our system could be added by incorporating other important features, such as local binary patterns that are significant texture features and that can extract useful information about the structural arrangement of pixels.

REFERENCES

1. Y. Rui, T.S. Huang, S.F. Chang, “Image retrieval: current techniques, promising directions and open issues”, J. Visual Communication, Image Representation 1999.
2. A.W.M. Smeulders, M. Worring, et al., “Content-based image retrieval at the end of the years”, IEEE TPAMI 2000.
3. I.K. Sethi, I.L. Coman, “Mining association rules between low-level image features and high-level concepts”, Proceedings of the SPIE Data Mining and Knowledge Discovery, vol. III, (279–290) 2001.
4. H. Armitage and P. G. Enser, “Analysis of user need in image archives,” Journal of Information Science, vol 23, no. 4, pp. 287–299, Apr. 1997.
5. R.S. Torres, A.X. Falco, “Content-based image retrieval, theory and applications, Rev”. April, 2006.
6. Fallouts, R. Barberet al., “Efficient and effective querying by image content”. Journal of Intelligent Information Systems, July 1994.
7. Pentland, R. Picard, and S. Sclaro. Photo book, “Content-based manipulation of image databases”, International Journal of Computer Vision, 1996.
8. Carson, S. Belongie etal, “Image segmentation using expectation maximization and its application to image querying”, IEEE Transaction on Pattern Analysis and Machine Intelligence, August. 2002.
9. M. Squire, W. Mulleretal, “Content-based query of image databases, inspirations from text retrieval: Inverted les, frequency-based weights and relevance feedback”, In Scandinavian Conference on Image Analysis, June 1999.
10. A.W.M. Smeulders, M. Worring, et al., “Content-based image retrieval at the end of the early years”, IEEE Trans. Pattern Anal. Mach. Intel, 2000.
11. W.Y. Ma, B.S. Manjunath, “NeTra: a toolbox for navigating large image databases”, Multimedia Systems 7 (184–198) 1999.
12. R. S. Choras, “Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems,” International Journal of Biology and Biomedical Engineering, vol. 1, no. 1, 2007.
13. H.A, Jalab, “Image retrieval system based on color layout descriptor and Gabor filters”, IEEE Conference on Open Systems, 25-28 Sept. 2011, pp. 32 – 36.
14. G. Zhang et al., “Shape feature extraction using fourier descriptors with brightness in content-based medical image retrieval,” in IEEE Int. Conf. on Intelligent Information Hiding and Multimedia Signal Processing, 2008, pp. 71 – 74.
15. H. Kauppinen et al., “An experimental comparison of autoregressive and Fourier based descriptors in 2D shape classification,” IEEE Transactions on Pattern Analysis and Machine Intelligence, pp. 201–207, 1995.
16. D. S. Zhang and G. Lu, “Evaluation of MPEG-7 shape descriptors against other shape descriptors,” Multimedia Systems, vol. 9, no. 1, pp. 15–30, 2003.
17. J. Canny, “A computational approach to edge detection,” IEEE Transactions on Pattern Analysis and Machine Intelligence, pp. 679–698, 1986.
18. Pentland et al., “Photobook: Content-based manipulation of image databases,” International Journal of Computer Vision, vol. 18, no. 3, pp. 233-254, 1996.
19. S. Nandagopalan et al., “A universal model for content based image retrieval,” International Journal of Computer Science, vol. 4, no. 4, pp. 242, 2009.
20. S. Soman et al., “Content Based Image Retrieval Using Advanced Color and Texture Features”, International Journal of Computer Applications, 2012.
21. C.M.Pun and C.F.Wong, “Fast and robust color feature extraction for content based image retrieval”, Internation journal of advancments in computing technolog, vol 3, no 6, July 2011.
22. M.A.Helala, “A content based image retrieval approach based on principal region detection”, IJCSI, International journal of computer science issues, vol 9, issue 4, no 1, July 2012
23. X. Qi and Y. Han, “A novel fusion approach to content-based image retrieval,” Pattern Recognition, vol. 38 pp. 2449–2465, 2005.
24. Y. Chen and J. Wang, “A region-based fuzzy feature matching approach to content-based image retrieval,” IEEE Transaction on Pattern Analysis and Machine Intelligence, vol. 24, no. 9, pp. 1252–1267, 2002.
25. J. Li et al., “SIMPLIcity: semantics sensitive integrated matching for picture libraries,” IEEE Transaction on Pattern Analysis and Machine Intelligence, vol. 23, pp. 947 – 963, 2001.
26. B. S. Manjunath et al., Introduction to MPEG-7 multimedia content description interface. New York: Wiley, 2002.
27. M. Swain and D. Ballard, “Color indexing,” International Journal of Computer Vision, vol. 7, no. 1, pp. 11–32, 1991.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)