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Implementation of Content based Image Retrieval and Comparison using Different Distance Measures

A R Sawant
M. E. EXTC
TCET, Kandivali
Mumbai-400 101

V A Bharadi, H B Kekre
Computer Department
MPSTME, NMIMS University
Mumbai-28

Bijith Markarkandy
Deputy HOD, IT Department,
TCET, Kandivali
Mumbai-400 101

ABSTRACT

Content Based Image Retrieval is an interesting topic of research since years. Specifically, it is on developing technologies for bridging the semantic gap that currently prevents wide-deployment of image content-based search engines. Image search engines currently in use are mostly rely on human generated data, such as text. Annotation of an image is totally depend on the person's perception who is going to store it into database. It is time-consuming as well as error prone. Therefore search engine using text input results in various non-relevant images. To overcome drawbacks of text based image retrieval, Content based image retrieval is introduced where retrieval of images is totally depend on the features of images.

Mostly, content-based methods are based on low-level descriptions, while high-level or semantic descriptions are beyond current capabilities. In this paper, we will try to implement the technique to fill this gap. This technique can eventually be extended to allow for content-based similarity type of search, such as find similar or "query-by- example". When it comes to image retrieval, we have taken into account a very primary feature of the signal namely content. This feature is used as parameter for comparison and retrieval from the previously stored image databases.

General Terms

Digital Image Signal Processing, Transforms

Keywords

Image retrieval, CBIR, MBTC, Kekre's pattern.

1. INTRODUCTION

Retrieval is the wide topic of research from the decades, because it is a challenge to reduce the semantic gap Basically retrieval of data means to get desired data from the database. It may image, text , audio or video as per requirement of user. The basic types of retrievals are mentioned in figure(1).

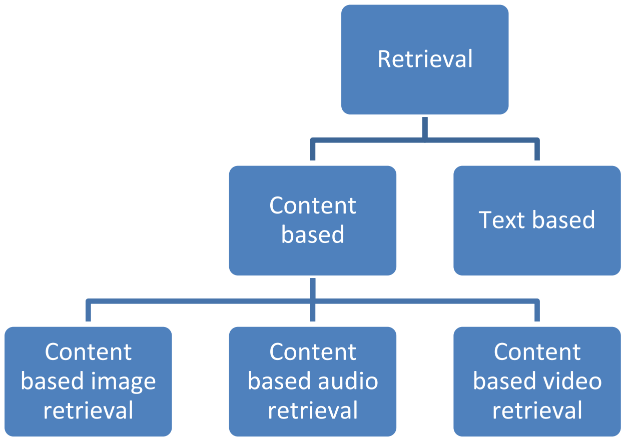

Figure 1. Types of retrieval

From ages images have been the mode of communication for human being. Today we are able to generate, store, transmit and share enormous amount of data because of the exhaustive growth of Information and Communication Technology. Much of this information is multimedia in nature, which consists of digital images, video, audio, graphics, and text data [1], [2]. But all that information is only useful if one can access it efficiently. This does not only mean fast access from a storage management point of view but also means that one should be able to find the desired information without scanning all information manually.

Previous method used for image retrieval is Text based image retrieval. The advantage of textual indexing of image is that it can provide user with key word searching, catalogue browsing and even with query interface. But the major drawback of text based image retrieval are, annotation depends on the person who adds it , the user of a Text Based Image Retrieval must describe an image using nearly the same keywords that were used by the annotator in order to retrieve that image [4]. Due to all these drawbacks, Content Based Image Retrieval is introduced.

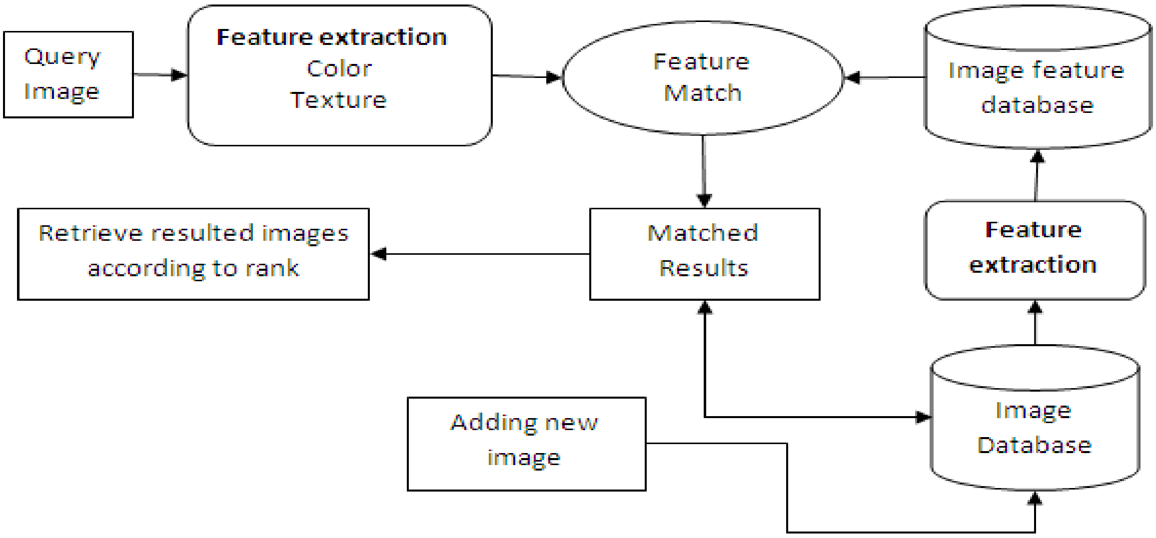

Figure 2.Basic block diagram for planned work

Here we will be dealing with three features of images shape, texture and color.

2. CBIR EXISTING TECHNIQUES

Dr H B Kekre, V A Bharadi et al. have introduced Content Based Image Retrieval using Fusion of Gabor Magnitude and Modified Block Truncation Coding[4]. Gabor filters are a group of wavelets, with each wavelet capturing energy at a specific frequency and a specific direction. Expanding a signal using this basis provides a localized frequency description, therefore capturing local features/energy of the signal. Texture features can then be extracted from this group of energy distributions. And modified block truncation is used to retrieve color feature from image. They proved that the proposed system is giving higher Precision and Recall as compared to only Gabor and Only MBTC based CBIR. Gabor feature gives good response to texture of the image and Modified BTC give good response to color content of image.

J. Zhang and W. Zou [5] have presented a novel technique that employs both the color and edge direction features for Content-Based Image Retrieval (CBIR). In this method, a given image is first divided into sub-block which has the same size and then the color and edge direction features of each sub block can be extracted. Next, it constructs a codebook of color feature using clustering algorithm and then each sub-block is mapped to the codebook. The color feature is used to retrieve images, and the edge direction feature is the weight of the similarity measure for the color feature.

Rose and Shah carried on a research project to improve the accuracy of CBIR Using Gradient Projections [6]; the image's structural properties were examined to distinguish one image from another. By examining the specific gray level of an image, a gradient can be computed at each pixel. Pixels with a magnitude larger than the thresholds are assigned a value of 1. These binary digits are added across the horizontal, vertical, and diagonal directions to compute three projections. These vectors are then compared with the vectors of the image to be matched using the Euclidean Distance Formula. These numbers are then stored in a bookmark so that the image needs only be examined once. A program has been developed for Matlab that performs this method of projecting gradients. Three databases were amassed for the testing of the proposed system's accuracy: 82 digital camera pictures, 1,000 photographic images, and a set of object orientated photos. The program was tested with 100% accuracy with all submitted images to the database, and was able to distinguish between pictures that fooled previous CBIR engines. The weakness of this project was its color-blindness.

A CBIR method based on color-spatial feature has been proposed by Lei, Fuzong & Zhang[7] . They proposed a fast algorithm which could include several spatial features of color in an image for retrieval because except for the color histogram information, the position information of each color plays an important role too. These features are area and position, which mean the zero-order and the first-order moments, respectively. By computing the moments of each color region the similarity of two images according to the weight of each factor can be computed. In fact, these features are a kind of representation for image in the scale of low resolution, and the sample image given by a user is usually a draft drawn by hand. Moreover, when a user judges the similarity between two pictures, he will firstly judge them in coarse scale. In this sense, this method is close to the vision model of our eyes. Because the features are simple and can be calculated in fast speed, better result can be made easily through training.

Dr H B Kekre ,S D Thepade et al. introduced Image Retrieval with Shape Features Extracted using Gradient Operators and Slope Magnitude Technique with BTC [9] and tested on generic image database with 1000 images spread across 11 categories. The average precision and recall of all queries are computed and considered for performance analysis. Gradient operators used for shape extraction were Robert, Prewitt, Sobel and Canny which are known as 'Mask-Shape-BTC' CBIR techniques. The problem with these Mask-Shape-CBIR methods is the need of resizing the database images to match it with the size of query. This drawback is removed using proposed Mask-Shape-BTC-CBIR methods. In proposed image retrieval techniques the feature vectors are formed by applying the block truncation coding (BTC) on the shape image obtained using slope magnitude applied on gradient of the image in both horizontal and vertical direction.

Dr.H.B.Kekre, S. D. Thepade concentrated on more precise and faster retrieval techniques [10]. They had applied walsh transform of different sizes on all images in database to extract the features and the feature vector database is generated. Then walshlet feature vector of query image is compared with walshlet feature vectors calculated for database images. The proposed Gray- Walshlet and Color-Walshlet based CBIR techniques are tested using 55 queries fired on the image database with 1000 images spread over 11 categories. Among the different levels of walshlet transform, Walshlet level-5 had given best results.

3. PROPOSED TECHNIQUE

As we have discussed in previous section there are many techniques which are introduced to reduce semantic gap and to retrieve similar images. But still scope of improvement is possible. Non-relevant images get retrieved along with relevant images. It is difficult to implement technique which will provide zero non-relevant image retrieval. But we can try to reduce this possibility and may design a technique with maximum relevant images retrieval. To achieve this, here we are going to merge to techniques which are mentioned below. The overview of proposed technique is shown in figure(2).

3.1 Modified Block Truncation Coding

Block truncation coding (BTC) is a relatively simple image coding technique developed in the early years of digital imaging. This method first divides the image into small non-overlapping image blocks. The small blocks are coded one at a time. For each block, the original pixels within the block are coded using a binary bitmap the same size as the original block and two mean pixel values[4]. The method first computes the mean pixel value of the whole block and then each pixel in that block is compared to the block mean. If a pixel is greater than or equal to the block mean, the corresponding pixel position of the bitmap will have a value of 1, otherwise it will have a value of 0. The simplest extension was to view a color image as consisting of three independent grey scale images and apply BTC to each color plane independently. Most color images are recorded in RGB space, which is perhaps the most well known color space [11].

In modified BTC to create a binary bitmap in the RGB space, an inter-band average image (IBAI) is first created and a single scalar value is found as the threshold value.

First we will resize the image in 256*256pixels. Now let X={r(i,j),g(i,j),b(i,j) i =1,2,…..m. j=1,2,……n} be an m x n color block in RGB space where m=n=256.

$$i_b = \frac{1}{3} r\left(i, j\right) + g(i, j) + b(i, j)....(1)$$

The threshold is computed as the mean of each color and using this threshold binary of bitmap can be calculated[12] as shown in figure(3).

bm11 <16x16 double>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0	0	0	0	1	0	1	1	1	0	1	0	1	1	1
2	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1
3	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1
4	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1
5	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
6	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1
7	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1
8	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1
9	0	0	0	0	0	1	0	1	1	1	1	0	1	1	1	1
10	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1
11	1	0	0	0	0	1	1	0	1	0	0	0	0	1	0	1
12	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
13	1	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1
14	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1
15	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	1
16	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1

Figure 3. Bitmap of image

After the creation of the bitmap, two representative (mean) colors are then computed. The two mean colors are MC1 ={Cr1 ,Cg1 ,Cb1 } and MC2 ={Cr2 ,Cg2 ,Cb2}. Where MC1 represents uppermean components and MC2 represents lowermean components[12].

3.2 Pattern Generation for Texture

Patterns are generated for extracting texture feature of image. Each pattern defines different formats of textue. The idea is to map the image equivalent to patterns and then the different texture pattern '16-pattern' generated using Kekre's transform matrix.

Number of patterns can be generated using transform matrices namely 4 pattern, 16 pattern, 64 pattern. NxN matrix can be used to generate N2 patterns. For example, if we want to generate 16 pattern then 4x4 matrix need to be used. Element wise multiplication of each row of the transform matrix is taken with all possible rows of the same matrix.

The 16 Kekre texture patterns [13] is generated using Kekre transform matrices of size 4x4. Figure 4 gives 2x2 kekre matrix and generation of four Kekre texture patterns. 2x2 Kekre transform matrix is shown in figure, each row of this matrix is considered one at a time and is multiplied with all rows of the same matrix to generate Kekre texture patterns as shown in figure 5.

The 4x4 Kekre transform matrix is given in figure 6 and visualization of 16 Kekre transform patterns generated using it is shown in figure 8, where black and grey colour scaled between 1 to 256 in the pattern and 0 is represented by white colour.

$$\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$$

Figure 4. 2x2 Kekre Matrix

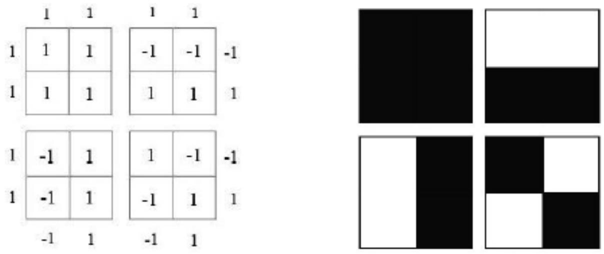

Figure 5. 4-Kekre Pattern Generation

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ -3 & 1 & 1 & 1 \\ 0 & -2 & 1 & 1 \\ 0 & 0 & -1 & 1 \end{bmatrix}$$

Figure 6. 4x4 Kekre Matrix

3.3 Fusion of MBTC & Patterns

1. We create a database containing images, the images are registered in the database. These images will be forwarded to Feature Vector Module i.e. fusion of MBTC and patterns generation. The resulted feature vector will be stored in feature vector database.

2.Feature vector generation:

(a) MBTC is applied on each image to calculate uppermean and lowemean.

(b) Uppermean and lowermean are 3-dimensional matrix i.e. it has three components red, green, blue. Three components are separated from uppermean and lowermean matrix.

(c) Each component is quantized to equivalent value of pattern matrix.

(d) Then occurrence of each pattern in six components i.e. uppermean(R,G,B) and lowermean (R,G,B) matrix is counted and arranged as (8x12) matrix for each image in database. This matrix is Feature Vector.

3.Using above procedure feature vector is also calculated for query image.

4.Now feature vector of query image is compared with feature vector of images in database using Euclidian distance concept.

5.Then Euclidian distance is arranged in ascending order and according to Euclidian distances images are retrieved as result.

6. Images are then retrieved according to different thresholds (thresholds for Euclidian distances) and precision, recall calculated for each threshold value.

Where,

$$\text{Precision}=\frac{\text{Total number of retrieve relevant images}}{\text{Total number of retrieve images}}$$

$$\text{Recall}=\frac{\text{Total number of retrieve relevant images}}{\text{Total number of relevant images in database}}$$

7. Images are retrieved using Euclidian distance and Absolute distance. Then precision and recall calculated for both techniques and compared to know which one is better.

4. RESULT AND DISCUSSION

For each image red, green and blue components are separated from uppermean and lowermean and quantized in pattern values as shown in figure 7,

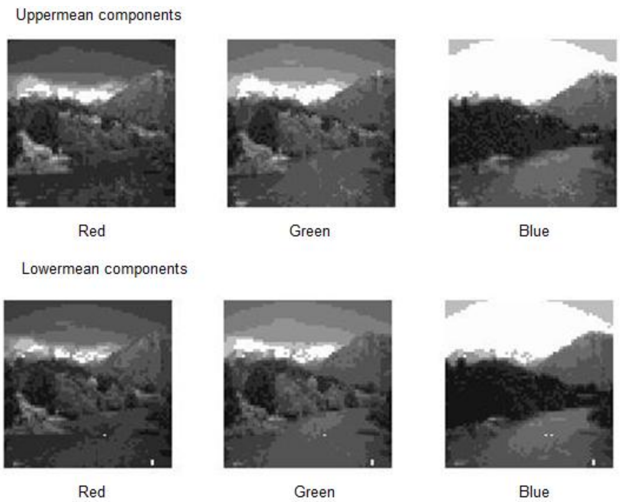

Figure 7. Quantized upperman and lowermean matrix

Using 4x4 Kekre matrix 16-pattern transform generated as shown in figure 7.

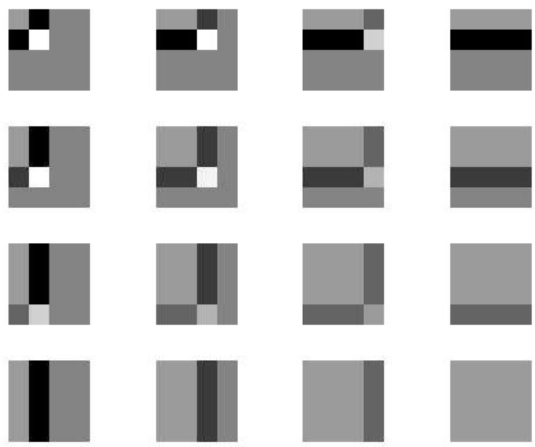

Figure 8. 16-Kekre Pattern Generation

Find co-occurrence of each pattern shown in figure 8 is checked with components in figure 7. This co-occurrence matrix is nothing but feature vector as show in figure 8,

1888	1651	1262	999	740	514	337	234	1191	1063	957	879
1651	1651	1651	1651	514	514	514	514	1063	1063	1063	1063
1262	1651	1888	2118	337	514	740	944	957	1063	1191	1291
999	1651	2118	2717	234	514	944	1759	879	1063	1291	1573
2062	1831	1270	980	946	704	467	319	1363	1255	1132	1053
1831	1831	1831	1831	704	704	704	704	1255	1255	1255	1255
1270	1831	2062	2277	467	704	946	1160	1132	1255	1363	1451
980	1831	2277	2827	319	704	1160	1998	1053	1255	1451	1787

Figure 9. (8x12) feature vector

Now according to Euclidian distances and absolute distances, images are retrieved for different threshold levels. Precision & recall is calculated for three query images from different classes as shown in figure 10,11 and 12. These figures also shows comparison between retrieving measures using Euclidian distance and Absolulte distance.

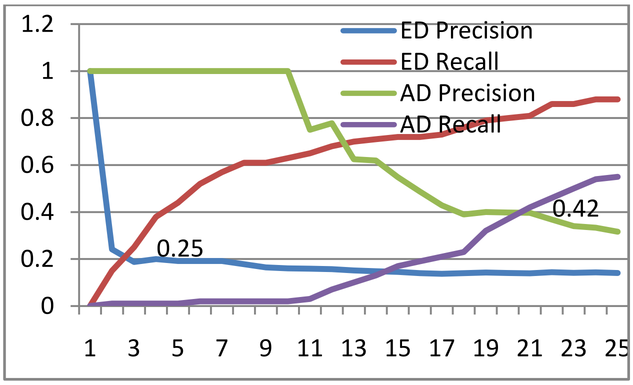

Figure 10. Comparison of Precision-recall for class 1 using Euclidian distance and Absolute distance (*ED-Euclidian distance and AD-Absolute distance)

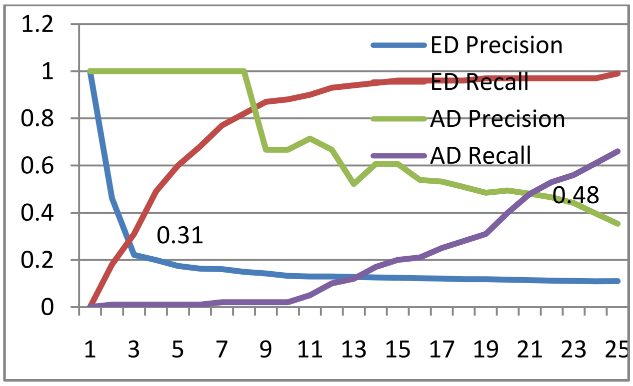

Figure 11. Comparison of Precision-recall for class 2 using Euclidian distance and Absolute distance

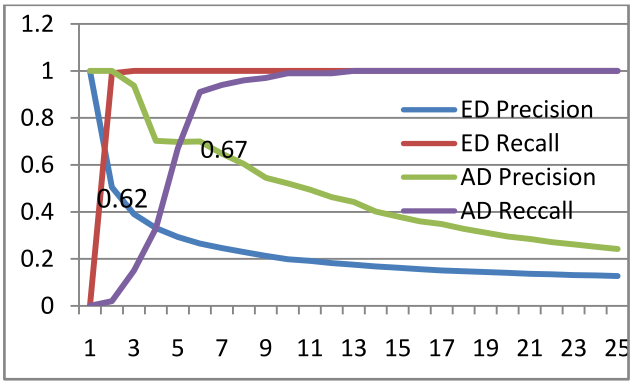

Figure 12. Comparison of Precision-recall for class 1 using Euclidian distance and Absolute distance

5. CONCLUSION

From above results we can conclude that precision-recall calculated using Absolute distance are better than precision-recall calculated using Euclidian distance. Optimum point of precision and recall where we can get best retrieval results for implemented technique. Figure (13) shows comparison optimum point for different images using two Euclidian distance and Absolute distance.

Query image from ⇨	**Class 1**	**Class 2**	**Class 3**
Precision-recall optimum point using Euclidian dist.	0.25	0.31	0.57
Precision-recall optimum point using Absolute dist.	0.42	0.48	0.67

Figure 13. Comparision between Precision-recall calculated using Euclidian dist. and Absolute dist.

Table shows that precision-recall by Absolute distance is better than by Euclidian distance. Therefore, Content based image retrieval by fusion of MBTC and pattern generation using Absolute distance is best technique to retrieve the images. Overview of comparison between these two distance meausure is shown in figure (14). Some results related to retrieval are shown below in figure (15) and (16).

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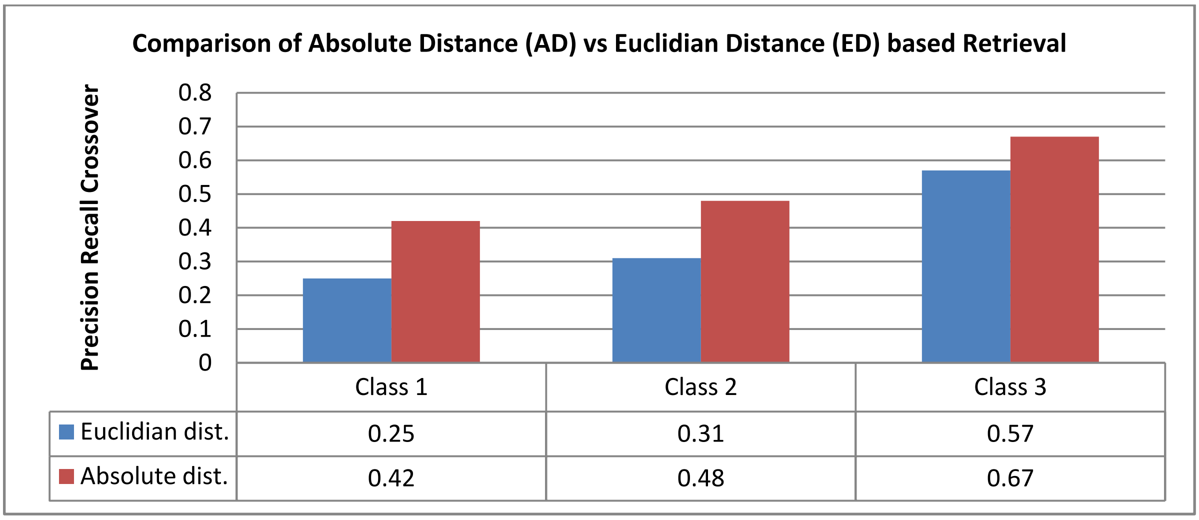

Figure 14. Comparison of retrieval techniques using absolute distance and Euclidian distance

7. Retrieval results

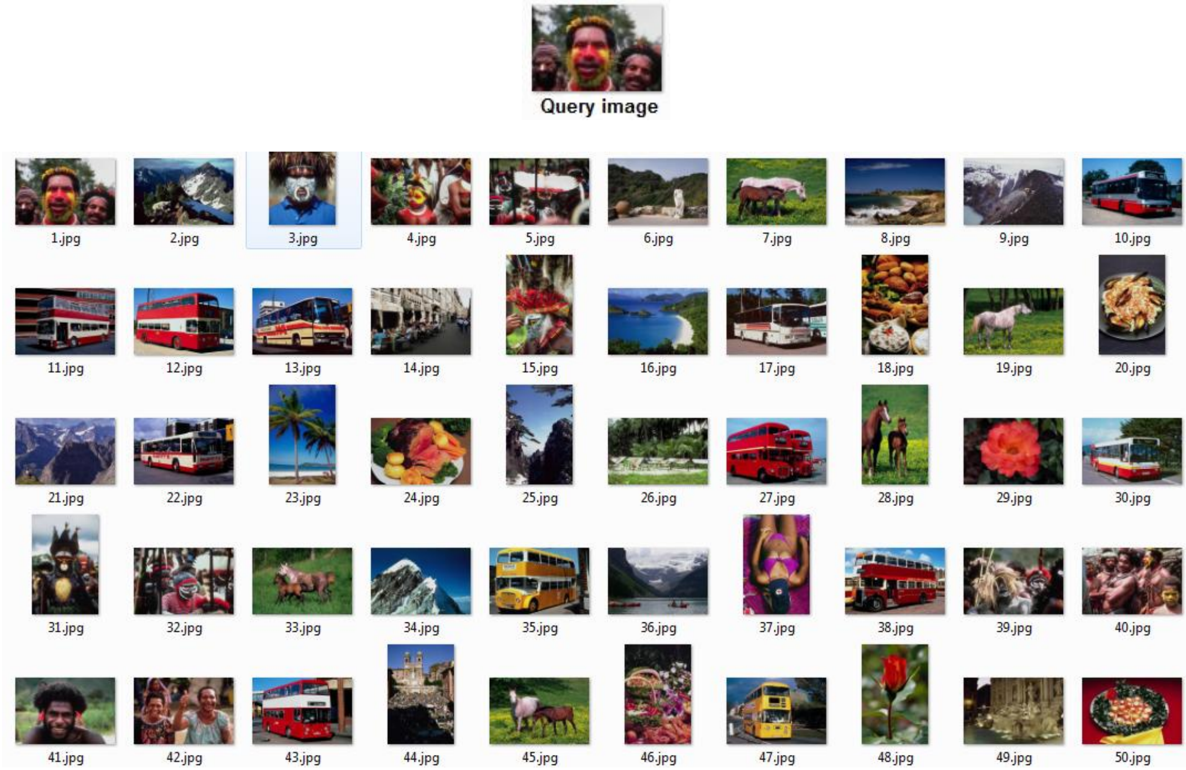

Figure 15. Retrieval results by fusion of MBTC and pattern generation using Euclidian distance

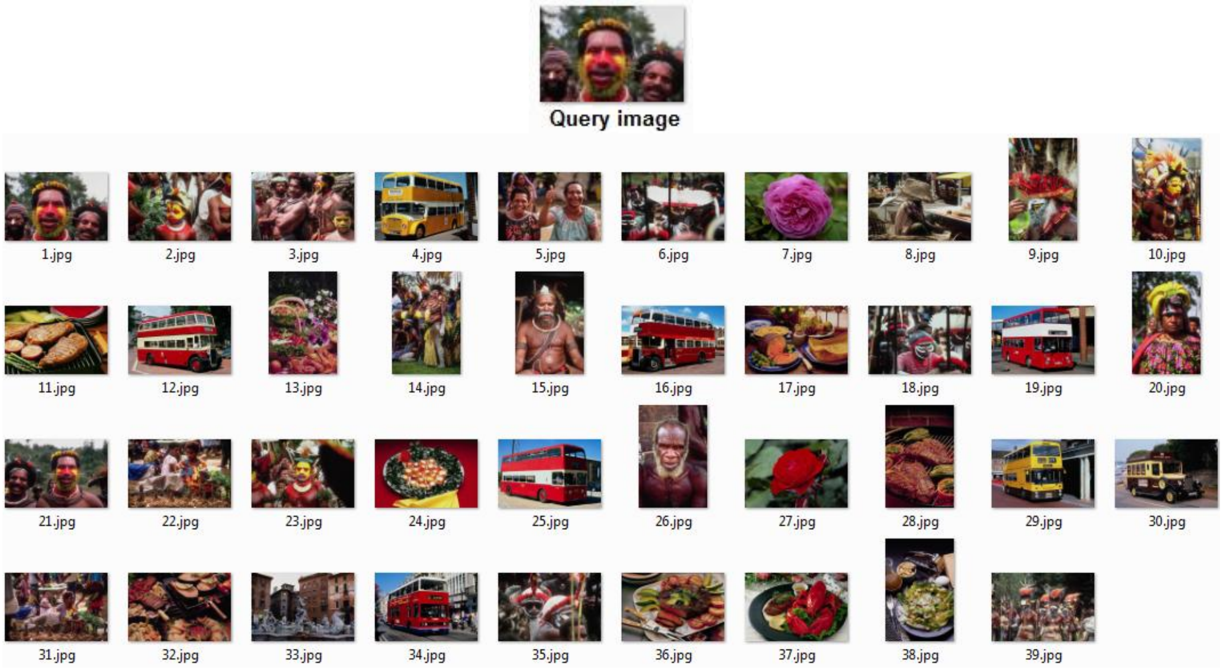

Figure 16. Retrieval results by fusion of MBTC and pattern generation using Absolute distance