Comparative Evaluation of Transform and Cluster based CBIR

Seema Anand Chaurasia
Assistant Professor
Computer Department
Xavier Institute of Engineering,
Mahim, Mumbai, India

Omprakash Yadav
Assistant Professor
Computer Department
Xavier Institute of Engineering,
Mahim. Mumbai, India

Vaishali Suryawanshi
Assistant Professor
Computer Department
Thadomal Shahani Engineering College,
Bandra, Mumbai, India

ABSTRACT
In this paper, comparative evaluation is made on the result of CBIR system based on transform based Image retrieval and cluster based Image retrieval by taking Euclidean distance as similarity measure to calculate the deviation from query image. In transform based image retrieval discrete wavelet transform is used to decompose the image. The image is decomposed till sixth level and last level approximate component is saved as feature vector. For cluster based Image retrieval LBG algorithm is used. Comparisons are made between results of transform based Image retrieval and cluster based Image Retrieval. In this paper two experiments are carried out on COIL database images, first on 720 images having 10 different classes and second on 1440 images of 20 different classes.

General Terms
Average Precision, Average Recall, Query Image, Database, Similarity Measurement.

Keywords
CBIR, QBIC, Precision, Recall, Query Image, Precision, Recall, HAAR, LBG, Euclidean Distance.

1. INTRODUCTION
An image retrieval system is effective if it can retrieve an image or a collection of images from an operating database upon being inputted with a single image whose replicas or lookalikes need to be extracted. Database management and Computer vision are two major research communities, which study the subject of image retrieval from different perspectives. Text based image retrieval employs techniques of attaching text or data along with the image to describe it, often termed as 'metadata', while content based techniques use visual features to match images to the query image.

In CBIR, all the images from the database are taken and features of each are extracted and stored in a vector. These features are compared to the extracted features of the query image. A CBIR typically converts images in feature vector representations and uses them to match similar images [1].

IBM was the first research company to take initiative by proposing a system called QBIC (query by image content), which was developed, at the IBM Almaden Research Center. Unlike keyword based system, visual features are extracted from images itself. Content based image retrieval system uses contents and extracts features like color, shape and texture. All these are visual contents [2]. Feature extraction based on the color is done taking color histogram of each image. It is nothing but the portion of pixels within an image which has some specific value. This specific value people express as colors. One more benefit of using extraction based on colors is that it does not depend on the size of image. Eventually, color histograms will be taken and compared [3].Feature extraction based on shape does not refer to the shape of the whole image. Within an image we have certain area of interest. Shape denotes the shape that area of interest. To get the shape first image segmentation is performed or edge detection is done [3]. Feature extraction based on texture measurably concentrates on visual patterns and how they are organized. It is given by texels. Texels are kept into number of different sets, depending how many of textures detected. The sets determined like this will give complete information about which patterns and where in the image they got detected. The determination of specific texture can be made by molding texture as a 2D gray level variation. For determination of level of contrast, regularity, directionality and coarseness pixels relative brightness is considered. In this paper texture features are extracted using DWT transform in Transform based retrieval [3].

Figure shows a general description of a standard image retrieval system.

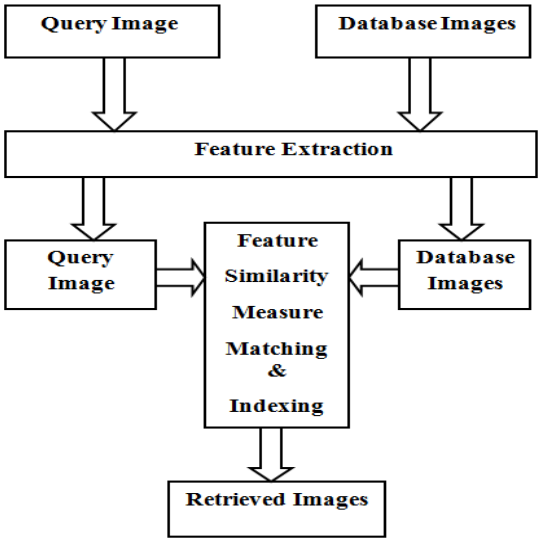

Fig 1: Basic block diagram of CBIR system

As shown in the above diagram, feature extraction is done for both query image as well as database images. First of all, all the databases images will be presented and there feature will be extracted and stored as feature database. Then query image is selected and its features will be extracted. This process will result into query features. After this process, query feature is taken and all the database feature is selected, and depending on criteria similarity measure will be calculated and the retrieved images will be displayed. In this paper, similarity measurement criteria is taken based on Euclidean distance [3].

2. PERFORMANCE MEASUREMENT USING EUCLIDEAN DISTANCE

The parameters being used for calculation of efficiency of the CBIR system designed, namely Average Precision and Average Recall are the ones being used to compare the results of different Distance Types being employed to retrieve images in the proposed system. Precision and recall can be calculated as follows:

$$\text{Precision} = \frac{Number\ of\ relevent\ images\ retrieved}{Total\ number\ of\ images\ retrieved}$$

$$\text{Recall} = \frac{Number\ of\ relevent\ images\ retrieved}{Total\ number\ of\ relevent\ images\ in\ the\ database}$$

2.1 Euclidean Distance

Euclidean distance metric was initially used by CANDID. He used this for the comparison of global signatures. Euclidean distance can be calculate as follows: If A(x,y) and B(p,q) are two pixels then euclidean distance can be given as,

$$Distance = \sqrt{\left(|x-p|^2 \oplus |y-q|^2\right)}.$$

3. LITERATURE REVIEW

3.1 Transform Based Image Retrieval

3.1.1 DWT

DWT is an mathematical tool, it decomposes the image into various parts and decomposition is performed hierarchically. It is very much useful in the processing of non-stationary signals. It uses wavelets. Wavelets are small waves and of limited duration. In Fourier transform we loose the time information after transform is performed. But, I n wavelet transform we get both time and frequency information. Different wavelets can be generated by translation and dilations performed on mother wavelet.

DWT decomposes the image into components like horizontal denoted by cH, vertical component denoted by cV and diagonal component denoted by cD. Figure below shows the decomposition upto three level. In our project we have used decomposition till sixth level. Major benefit we get by decomposing till sixth level is that feature vector size gets reduced too much [4].

Wavelet transform is very efficient. It can also be implemented using filter banks using convolution. Image processed with wavelet transform gives multi resolution description of image. Image can be viewed at different levels of resolution. In the lowest band LL magnitude is largest level wise. Significantly its good to have more magnitude. Larger the magnitude of wavelet coefficient , it will become more significant [5][6].

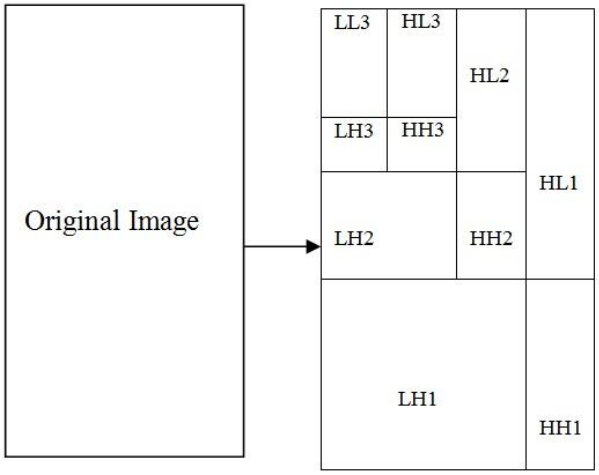

Fig 2: DWT decomposition of image till 3rd level

3.2 Cluster Based Image Retrieval

Search time can be reduced considerably by using clustering [9, 10]. LBG algorithm is one of the clustering methods which is most widely used. In these section LBG algorithms is explained.

3.2.1 LBG Algorithm

Consider two-dimensional vector space as shown in figure 1.In this algorithm centroid is computed as the first codevector C1 for the training set. Two codevector v1 and v2 are generated as shown in figure 1 by adding constant error to the codevector [8].

Two clusters are formed by Euclidean distance of all training vectors with vectors v1 and v2 based on nearest of v1 and v2. Four clusters are generated by repeating the same procedure for these two clusters and similarly eight clusters are generated by repeating the same procedure for these four clusters. This procedure is repeated for every new cluster until the required size of codebook is reached.

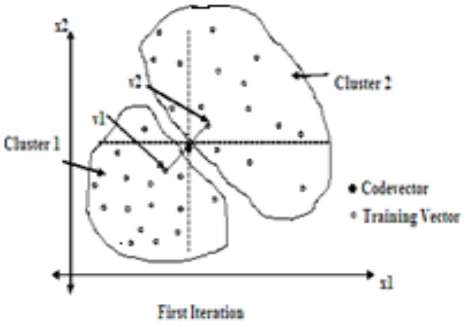

Fig 3: LBG algorithm for 2-dimensionl case

4. FIGURES/CAPTIONS

Figure 4 and figure 5 shows Precision/Recall graph for 720 and 1440 images respectively using HAAR . Figure 6 and 7 shows Precision/Recall graph for 720 and 1440 images using LBG algorithm.

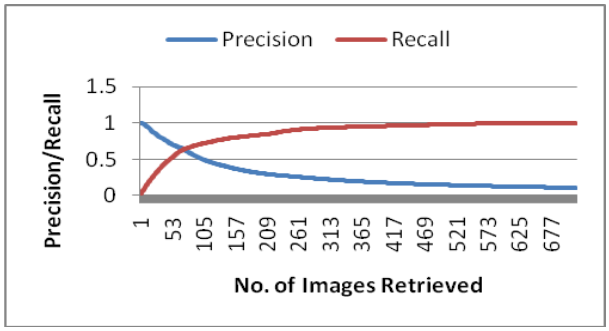

Fig 4.: Plot of Precision/ Recall Vs. number of Images Retrieved based on Haar (On 720 images(COIL-100),Crossover Point=68.84%)

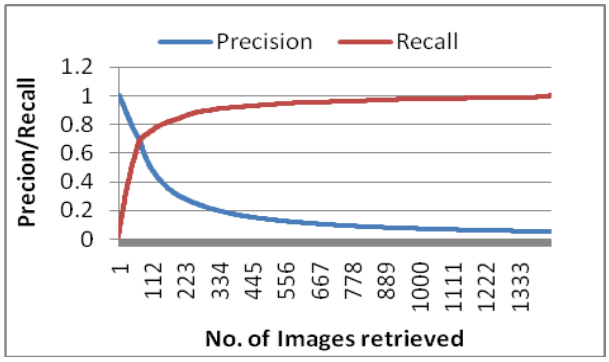

Fig 5: Plot of Precision/Recall Vs. Number of Images Retrieved based on Haar (On 1440 Images(COIL-100),Crossover Point=63.94%)

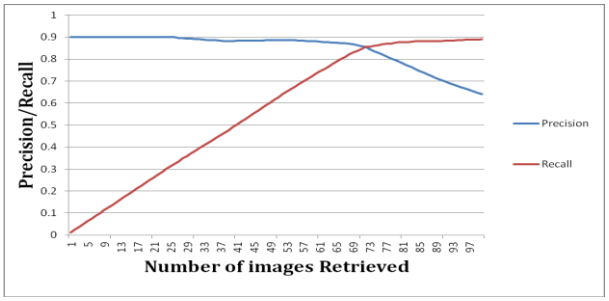

Fig 6:.Plot of Precision/Recall Vs. Number of Images Retrieved based on LBG algorithm (On 720 Images (COIL-100), Crossover Point=85.55 %)

Fig7:Plot of Precision/Recall Vs. Number of Images Retrieved based on LBG algorithm (On 1440 Images (COIL-100), Crossover Point=79.25 %)

5. SCHEME OF IMPLEMENTATION

We aim to extract texture from an image. Texture is a pattern on image which can be smooth, rough, etc. The wavelet transformations transform the images into a multi-scale representation with both spatial and frequency characteristics. In transform based retrieval feature extraction is done using wavelet transform [5].

5.1 Feature extraction of database images

For this project discrete wavelet transform is used to decompose the images. DWT decomposes the image into four parts. Here, decomposition is performed till sixth level.

Step1: Apply first level decomposition and decompose image into 4 subparts i.e. cA1, cH1, cV1 and cD1.

Step2: Apply second level decomposition and again decompose cA1 into four subparts i.e. cA2, cH2, cV2 and cD2.

Step3: Apply third level decomposition and again decompose cA2 into its 4 subparts cA3, cH3, cV3 and cD3.

Step4: Apply fourth level decomposition and again decompose cA3 into its 4 subparts cA4, cH4, cV4 and cD4.

Step5: Apply fifth level decomposition and again decompose cA4 into its 4 subparts cA5, cH5, cV5 and cD5.

Step6: Apply sixth level decomposition and again decompose cA5 into its 4 subparts cA6, cH6, cV6 and cD6.

Step7: Save the cA6 as a feature vector.

Where,

cA = Approximate coefficient matrix
cH = Horizontal component
cV = Vertical component
cD = Diagonal component

Final feature vector size is 2*2*3 after the sixth level decomposition. Do this (step1 to step7) for all the image in the database and store the feature vector of all the images. Here, COIL database is used, of that 720 images is selected of 10 different classes for the first experiment and for second experiment 1440 images of 20 different classes is selected.

5.1.1 Feature extraction of query image

After the all images of database is converted into feature vector, query image is taken for retrieval purpose. In this scheme five different query images are taken from each different classes.

Step1: Five query images selected from one type of class

Step2: Each query image is taken one by one and decomposed using dwt till sixth level and query image feature vector extracted.

Step3: Similarity measurement is done.

Step4: Step 1 to 3 is repeated till all the classes are covered.

Step5: Precision and recall calculated for each query image class wise.

Step 6: Average precision and recall calculated for all the classes [6][7].

5.2 Cluster based Image Retrieval using LBG algorithm

For efficient image indexing and retrieval we are using the LBG algorithm as follows [8]:

1. To obtain LBG codebook image is first divided into the non-overlapping windows of size 2x2 pixels.

(Each pixel consisting of red, green and blue components).

2. These are put in a row to get 12 coordinates per vector. A training set is collection of these vectors. (initial cluster).
3. Compute centroid (codevector) of the cluster.
4. Split the cluster using LBG.
5. Repeat the 3,4 till we obtain codebook of required size.
6. The codebook is stored as the feature vector for the image. Squared Euclidian distance is used as similarity measure.

6. RESULTS

First experiment is carried out on 720 images of 10 different classes of COIL database. In this first experiment Euclidean distance as a similarity matching, it gives 68.84% average precision and recall for transform based image retrieval and 85.55% average precision and recall for cluster based Image Retrieval using LBG algorithm.

The results of first experiment is tabulated below:

Table 1.Using 720 Images of 10 different classes

Distance Type	Average Precision	Average recall
Transform based Haar	68.84%	68.84%
Cluster based using LBG Algorithm	85.55%	85.55%

Second experiment is carried out on 1440 images of 20 different classes of COIL database using Euclidean distance.. distance as a similarity matching, it gives 63.94% approximately 64% average precision and recall for transform based image retrieval and 79.25% average precision and recall for cluster based Image Retrieval using LBG algorithm.

The results of second experiment are tabulated below:

Table 2.Using 1440 Images of 20 different classes

Distance Type	Average Precision	Average recall
Transform based using Haar	63.94%	63.94%
Cluster based using LBG Algorithm	79.25%	79.25%

7. CONCLUSION

In this paper experiments are carried out on 10 different classes i.e. 720 images and 20 different classes i.e. on 1440 images of COIL-100 database based on transform based image retrieval using Haar and cluster based image retrieval using LBG algorithm by taking Euclidean distance as similarity measure. Transform based Image retrieval based on Haar gives 68.84%and 63.94% average Precision and Recall for 720 and 1440 images respectively. Cluster based Image Retrieval using LBG algorithm gives 85.55% and 79.25% average Precision and Recall for 720 and 1440 images respectively.

The comparison is carried out between transform based Image Retrieval using Haar and Cluster based Image retrieval using LBG algorithm based on performance measures i.e. Precision and recall values. Results clearly indicates that cluster based Image retrieval using LBG algorithm gives better precision an recall values as compared to transform based Image retrieval using haar by taking Euclidean Distance as similarity measure. In this paper experiment is carried out on the same database i.e. COIL. In future scope, this experiment can be carried out on different and more natural databases and with t different types of distances.

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