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SIMULATIVE COMPARATIVE ANALYSIS OF DIFFERENT CBIR TECHNIQUES

Supreet Sidhu[1], Jyoti Saxena[2], Sukhjinder Singh[3]

[1]M.Tech. Research Scholar, [2]Professor & Head, [3]Assistant Professor, ECE,
GianiZail Singh Campus College of Engineering and Technology, Bathinda (India)

ABSTRACT

Retrieval of images from large databases plays a major role in various domains such as medical diagnosis, biometrics, industry inspection, geographical information satellite systems, web searching, historicalresearch and so on. Content-Based Image Retrieval(CBIR)method is used to retrieve images efficiently by using low level image features mainly texture, shape and color. In this paper, three CBIR methods namely Support Vector Machine (SVM), Euclidean distance based Support Vector Machine (E-SVM) and Cluster-based Support Vector Machine (C-SVM)have been implemented using MATLAB platform. Performance of the same has been compared in terms of various parameters namely Precision, Recall and Accuracy taking a common database consisting of 100 images of five categories. The experimental results show that cluster based Support Vector Machine method is more accurate when compared with other two methods.

Keywords: Clustering, Content Based Image Retrieval, Euclidean Distance, Image Retrieval, Support Vector Machine.

I. INTRODUCTION

Image Retrieval is a process of browsing, searching and retrieving images from a large database of digital images. Advancement of technology and development of highly economical devices for capturing, storing and transmitting images have led to the creation of huge image libraries. This became more complex with the increased use of World Wide Web. Thus, it becomes inevitable problem to retrieve useful information from these databases, both efficiently and effectively. Thus, fast retrieval of images from large databases is an important problem that needs to be addressed.

There are two methods which are used for image retrieval namely Text-Based Image Retrieval and Content Based Image Retrieval. Text-based Image Retrieval employs text as primary means to represent and retrieve images from large databases. Images are stored along with keywords entered by a user. Text-based image retrieval systems are easy to implement and are relatively fast in computation. But there exist some drawbacks such as manual annotation is not always available in case of large volume of images and is also not much accurate. Another drawback is that there are no fixed set of words that would describe the image content according to the user. Thus the problems with text based image retrieval have led to the rise of interest in techniques for retrieving images on the basis of automatically-derived features such as color, texture [8] and shape – a technology now generally referred to as Content-Based Image Retrieval (CBIR). Content-Based Image Retrieval (CBIR), also known as query by image content (QBIC) is the process of retrieving images from

a database on the basis of features that are extracted automatically from the images themselves. 'Content-Based' means that the search will analyze the actual contents of the image. High retrieval efficiency and less computational complexity are the desired characteristics of CBIR systems

CBIR is the most important and effective image retrieval method and widely studied in both academic and industrial field. Thus, it has many applications in various fields such as military, medical diagnosis, web searching, industrial area, crime prevention etc. This has spurred the development of highly efficient system for retrieving images.

The rest of the paper is organized as follows: Section 2 describes the related work in the field of image retrieval. The different techniques have been discussed in section 3. In section 4, the results have been shown and analyzed followed by conclusion in section 5.

II. RELATED WORK

XueFeng Wang et al. [1] presented a multiple support vector machine for image classification in the first stage. The features of each image were extracted using color indexing and Gabor wavelet transform. Next the multiple SVM classifiers were used to cluster the database images. Finally the relevance feedback based on Bayesian was applied to calculate the probabilities of images in the database. Then the images were ranked according to the probability and the images with higher probability were displayed as a result.Experimental results based on a set of Corel images demonstrated that the proposed system achieved high performance with less iterations. A novel approach for Content Based Image Retrieval which combined the color and shape features was proposed by Swati Aggarwal et al. [2]. The proposed approach extracted the edges from Y matrix of YCbCr using Canny edge detection technique and the RGB histogram was computed as global statistical descriptor that represented the distribution of colors in an image. Manhattan distance was used as a similarity measure to detect the final image rank. The experimental results show that the proposedmethod performed better in the case of query image alterations. Moreover, the computational steps were reduced with the use of simplest Haar Wavelet transformation which helped in improving the search speed.Yuhan Wang et al. [3] analyzed and compared the performance of two kinds of retrieval systems: Multimedia Video Indexing and Retrieval System (MUVIS) and Query-By-Semantic-Example (QBSE). The experiments were conducted on these two real typical content-based image retrieval systems: MUVIS (visual content based), and QBSE (semantic content based), and the performance was compared by using precision-recall measure. The experiments showed that QBSE has a better performance than MUVIS. The different feature extraction techniques with contribution based clustering algorithm were proposed by Snehal Mahajan et al. [4] to retrieve the similar images from database. Three techniques namely RGB color histogram, RGB color histogram with Canny edge detection and Local Binary Pattern (LBP) were discussed. The Local Binary Pattern (LBP) operator was used to calculate texture features. Experimental results were tested on the test dataset of about 771 images from the Washington University database. Euclidean distance method was used for the similarity measurement of query image and database images Experimental result showed that the CLBP method can obtain the high average precision, recall and f-measure value of image retrieval as compared to the feature extraction of color or color with edge used with contribution based clustering algorithm. Zhiyong Zeng et al. [5] proposed an SVM-based relevance feedback technique for region-based image retrieval including an image segmentation algorithm and devised a compact

and computationally effective representation for the color content of a region of an image using earth mover's distance and hybrid features including color, texture and shape as feature vector to match the images. A generalized SVM as a learning machines kernel for region-based image retrieval was also developed by the authors.Experimental results on a database of 1000 realimages demonstrated the efficacy and robustness of the proposed method. A.Bhagyalakshmi et al. [6] focused on different features descriptors for image retrieval and analyzed various retrieval operators like Local Binary Patterns (LBP), Local Ternary Patterns (LTP), Local Derivative Patterns (LDP) and Local Tetra Patterns (LTP) using high level features to improve the performance and accuracy in CBIR system. The authors also reviewed main CBIR components including low level descriptors for feature extraction such as color, texture, shape and various image retrieval methods using local binary operators.

III. CBIR TECHNIQUES

Content Based Image Retrieval (CBIR) uses the visual content of image such as color, texture, shape etc. CBIR system automatically extracts the features of the query image. Similarly, the features of images in the database are extracted by the system and are described by multi-dimensional feature vectors. The image that is selected as query by the user is known as the query image. The resultant images can be classified as relevant or irrelevant images according to the degree of matching between query image and the retrieved images.The feature vectors of images in the database form a feature database. After feature extraction process, distance between features of query image and images in the database is calculated by the system. Therefore, a typical CBIR system basically involves two processes, first is feature extraction and second is similarity measurement. In this section different methods of image retrieval: Euclidean Distance based SVM, SVM and Cluster based SVM have been discussed.

3.1 Euclidean- Distance Based SVM

Euclidean Distance based SVM (E-SVM) techniquehas been shown in Fig.1. The features of the query images and database images have been extracted using SVM and the distance between the features have been calculatedusing the Euclidean distance [7]. The images with least distance are displayed as a result.

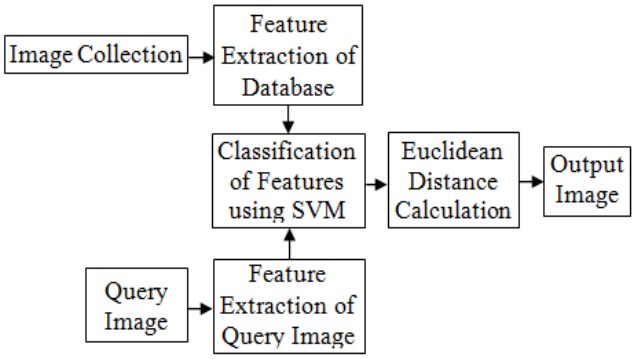

Figure 1: CBIR Using E-SVM Technique

3.2 SVM

The generalized block diagram of content based image retrieval using Support Vector Machine (SVM) [1] has been shown in Fig.2. The features of query image and database images are extracted and classified using SVM. SVM (Support Vector Machine) is a supervised learning method used for classification of images. It is a kernel

method and is thus crucial in determining the performance of the system. It interprets the image matching and relevant images are retrieved as a result. This technique thus matches features using a supervised learning method.

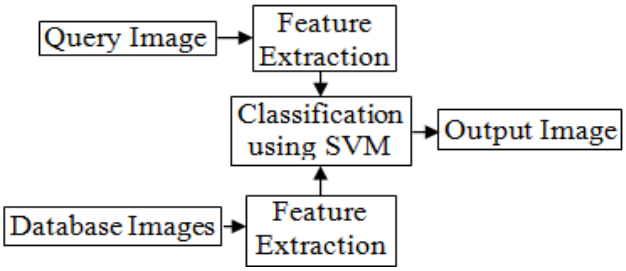

Figure 2: CBIR using SVM Technique

3.3 Cluster Based SVM

The cluster based Support Vector Machine (C-SVM) technique has been depicted in Fig.3. In this technique, clustering of query image and database images is done according to distance between the features. The features of the images are extracted and thus classified using SVM classifier. The distance between the features of query image and database images is calculated and the images with least distance are displayed as a result. The various operations which take place for this have been described next.

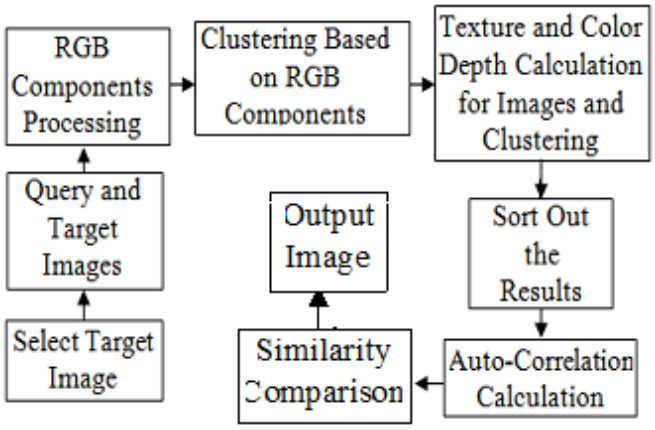

Figure 3: CBIR using C-SVM Technique

3.3.1 Pre-Processing

Pre- Processing block consists of query and target images selection. The main goal of the pre-processing is an improvement of the image that suppresses unwilling distortions or enhances some image features. Filtering is done in pre-processing for modifying, removing noise or enhancing an image. The image is filtered to highlight certain features or remove some other features which are not required. The noise in the image is filtered using linear and non-linear filtering techniques.

3.3.2 RGB Components Processing

An RGB color image is an M*N*3 array of colored pixels, where each color pixel is a triplet equivalent to the red, green, and blue components of an image. The mean values for the RGB components are calculated as described below for all images:

$$\text{Red Mean (rm)} = \frac{\text{sum of all the red pixels in the image R(y)}}{\text{No. of pixels in the image P(y)}}$$

$$\text{Green Mean (gm)} = \frac{\text{sum of all green pixels in the image G(y)}}{\text{No. of pixels in the image P(y)}}$$

$$\text{Blue Mean (bm)} = \frac{\text{sum of all the blue pixels in the image B(y)}}{\text{No. of pixels in the image P(y)}}$$

where R (y) = RED component pixels,

G(y) = GREEN component pixels,

B(y) = BLUE component pixels,

P(y) =No. of pixels in the image.

After calculating the mean value of Red, Blue and Green components, the values are compared with each other to find the apogee value of the components. Then these values are compared with the already stored values.

3.3.3 Clustering based on RGB Components

Image Clustering is an advantage for reducing the searching time of images in the database. Fuzzy C-Means (FCM) is a technique used for clustering which allows one piece of data to belong to two or more clusters.

Texture Feature Extraction

In the texture-based approach, the parameters gathered are on the basis of statistical approach. There are various texture parameters such as entropy, contrast, dissimilarity, homogeneity, standard deviation, mean and variance, correlation, auto-correlation etc. However, in this paper, the texture parameter Auto-Correlation has been calculated for the query and target images. The Grey Level Co-occurrence Matrix (GLCM) have also been used for extracting second order statistics from an image. GLCMs have been used very successfully for texture calculations. The images are then sorted out to get relevant images.

3.3.4 Auto-Correlation Calculation

Auto-correlation introduces the correlation of a time series with its own past and future values. Positive auto-correlation is considered as a tendency of a system to remain in the same state from one observation to the next observation.

3.3.5 Similarity Comparison

After clustering, similarity comparison is performed. To compare images with query image we find difference between the values of their red, green and blue components as well as their auto-correlation. Then we perform indexing to sort the retrieved images. While performing indexing the image from database with least difference is ranked on the top and the image with large difference at bottom and so on. Then the top ranked images from the database are retrieved and given as result. The experimental setup has been shown in Fig. 4.

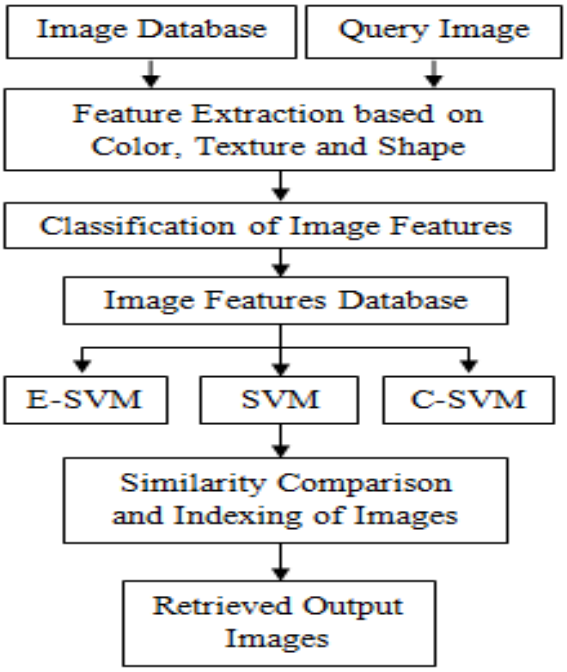

Figure 4: Experimental Set-up

The results have been calculated in terms of Precision, Recall and Accuracy as given below:

$$\text{Precision} = \frac{\text{No. of relevant images retrieved}}{\text{Total no. of images retrieved}}$$

$$\text{Recall} = \frac{\text{No . of relevant images retrieved}}{\text{Total no. of relevant images in database}}$$

$$\text{Accuracy} = \frac{\text{Precision} + \text{Recall}}{2}$$

IV. RESULTS ANDDISCUSSION

In this paper, three CBIR techniques namely Support Vector Machine (SVM), Euclidean based SVM (E-SVM) and Cluster based SVM (C-SVM), have been implemented using MATLAB platform taking a common database with 100 images of five categories (bird,mobile,tiger,flowerand building). Images in the database have been taken from different sources like internet and mobile with formats like *.jpeg, .png or .bmp*. Performances of these techniques have been evaluated in terms of precision, recall and accuracy.

The experimental results for SVM,E-SVM andC-SVM in terms ofprecision, recall and accuracy taking a common database consisting of 100 images of five categorieshave been presented in the Tables 1, 2 and 3 respectively.

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Table 1: Results of E- SVM Technique

Class of query image	No. of relevant images retrieved (A)	Total no. of images retrieved (B)	No. of relevant images retrieved (C)	Total no. of relevant images in database (D)	Precision (%) (P)=(A/B)	Recall (%) (R)=(C/D)	Accuracy (%) (A)=(P+R)/2
Bird	5	9	6	20	55.55	30	42.77
Mobile	4	9	10	20	44.44	50	47.22
Tiger	6	9	12	20	66.66	60	63.33
Flower	5	9	8	20	55.55	40	47.77
Building	5	9	8	20	55.55	40	47.77
						Average accuracy =	47.16

Table 2: Results of SVM Technique

Class of query image	No. of relevant images retrieved (A)	Total no. of images retrieved (B)	No. of relevant images retrieved (C)	Total no. of relevant images in database (D)	Precision (%) (P)=(A/B)	Recall (%) (R)=(C/D)	Accuracy (%) (A)=(P+R)/2
Bird	6	9	11	20	66.66	55	60.83
Mobile	7	9	17	20	77.77	55	66.38
Tiger	5	9	13	20	55.55	65	60.27
Flower	5	9	10	20	55.55	50	52.77
Building	8	9	11	20	88.88	55	71.94
						Average accuracy =	62.43

Table 3: Results of C-SVM Technique

Class of query image	No. of relevant images retrieved (A)	Total no. of images retrieved (B)	No. of relevant images retrieved (C)	Total no. of relevant images in database (D)	Precision (%) (P)=(A/B)	Recall (%) (R)=(C/D)	Accuracy (%) (A)=(P+R)/2
Bird	7	9	13	20	77.77	65	71.38
Mobile	7	9	17	20	77.77	85	81.38
Tiger	8	9	14	20	88.88	70	79.44
Flower	6	9	11	20	66.66	55	60.83
Building	8	9	14	20	88.88	70	79.44
						Average accuracy =	74.49

Furthermore the comparison of SVM,E-SVM andC-SVM has been represented graphically in terms of accuracy in Fig. 5.

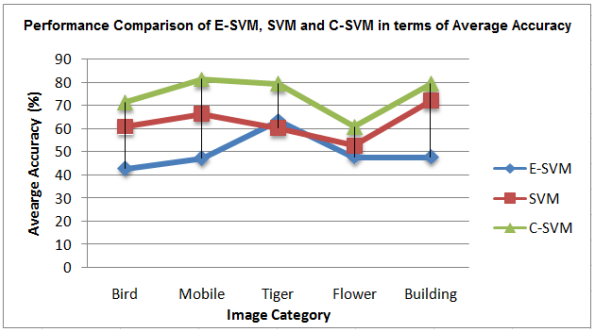

Figure 5: Comparison of E-SVM, SVM and C-SVM

The experimental results indicate that average accuracy of CBIR techniques namely E-SVM, SVM and C-SVM are 47.16%, 62.43% and 74.49% respectively for database of 100 images of five categories. It indicates poor performance of E-SVM and moderate performance of SVM in terms of average accuracy. However, C-SVM gives better performance for the same and hence it is more suitablefor retrieving images relevant to the query image.

V. CONCLUSION AND FUTURE SCOPE

ContentBased Image Retrieval (CBIR), also known as Query ByImage Content (QBIC) and ContentBased Visual Information Retrieval (CBVIR) is the application of computer vision techniques and is active research area in image processing.CBIRtechnique is used to solve the image retrieval problem*i.e.* problem of searching digital images in large databases of the same category. In this paper three CBIR techniquesnamely Euclidean distance based SVM (E-SVM), SVM and Cluster based SVM (C-SVM) have been implemented using MATLAB platform and results have been calculated for the same in terms of accuracy, recall and precision.

Euclidean distance based techniqueshave considerably reduced the semantic gap between the information (one can extract from the visual data) and interpretation of the same visual data by the system. However these techniques such as E-SVM could not work efficiently for large volume of images in database. SVM is computationally more efficient as compared with E-SVM, works-well even with high dimensional data and presents moderate average precision, recall and accuracy. HoweverSVM is not a good option specially if there are multiple classes and is not efficient, if the number of features is very huge in number as compared to the training samplesof SVM classifier. However, C-SVM technique extracts features of an imagemoreefficiently and represents them in a particular form that can be used effectively for the matching of images.From the simulation results, it is gathered that C-SVM gives better performance as compared with E-SVM and SVM in terms of average accuracy for a given dataset. The retrieval of images can be further extended to more number of images of different categories along with other combination of features.

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