Content Based Image Retrieval System using SVM Technique

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Abstract— Multimedia applications are increasing rapidly and a large number of digital images are stored in database. For the effective retrieval of the desired images from a huge image database study of a content-based image retrieval (CBIR) technique has become an important research issue. In this proposed work, image retrieval is done through color and texture feature extraction. For feature extraction different algorithms are used like color auto correlogram, HSV (Hue Saturation Value) histogram and color moments. Also, texture features like mean square energy, mean amplitude of 2D wavelet component and standard deviation of wavelet coefficients. Features of query image and database images are classified and compared using support vector machine and similarity measures. Features are compared based on pair wise euclidean distance between query image and database image by various methods such as L1, cityblock, minkowski, chebychev, cosine, correlation and spearman.

Key words: CBIR; SVM; Color moment; Euclidean Distance; Feature Extraction.

I. INTRODUCTION

Image processing has wide range of applications almost in every area of science and technology such as agriculture, space program, industry and law enforcement and one of the key issues with any kind of image processing is image retrieval which helps to extract the useful information from the raw data such as recognizing the presence of textures or color. Image retrieval is technique which is concerned with browsing and searching digital images from database collection. There are different methods of image retrieval such as text-based method, content-based method and hybrid method [1].

In text based image retrieval, images are indexed using keywords, in this type of retrieval keywords or text are used as retrieval keys during search and retrieval. This is non-standardized because different users employ different keywords for annotation. Text descriptions are sometimes incomplete and subjective and because they cannot give complicated image features very well [2].

The Content Based Image Retrieval uses image content to retrieve the digital images from huge database of images. Content based image retrieval is a technique for retrieving semantically-relevant images from an image database based on automatically-derived image features. In CBIR system, image features are categorized in three main classes: color, texture and shape. Color is the most common visual feature used in CBIR as it is simple to extract the color information from images. To extract information about shape and texture feature is complex usually performed after the initial filtering provided by color features [2].

In this paper, robust CBIR system is implemented. Support Vector Machine is employed for classification of images based on the identification of features. Retrieval of the images is based on the euclidean distance comparison between the query image and database image.

II. METHODOLOGY

A. *Block diagram of proposed system:*

In this paper, content based image retrieval system is implemented. Block diagram of proposed CBIR system is shown in figure 1.

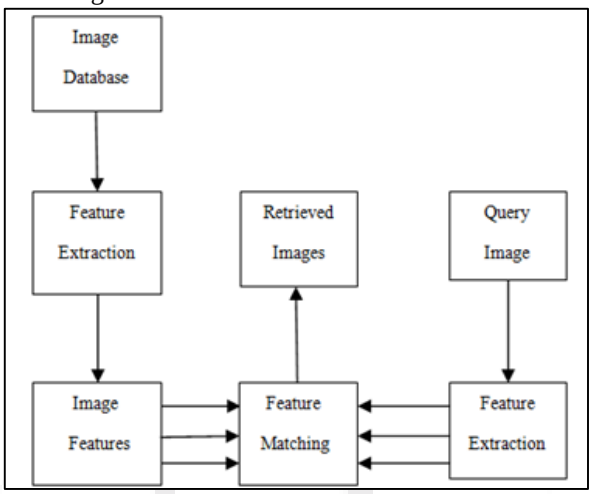

Fig.1: Block diagram of proposed scheme

Image Database:

Large numbers of digital images are stored to retrieve desired image or images on the basis of given query image. These images can be stored in the hard disk or database.

Query Image:

Desired image which is to be retrieved from database.

CBIR consists of two phases: Feature Extraction and Feature Matching.

1) Feature Extraction:

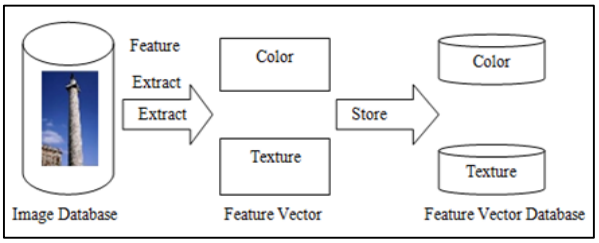

Fig. 2: Process of feature extraction

This phase involves extracting features of the query image and the database image. In proposed work, color based and texture based features are extracted. Color based feature extraction process is done by using three algorithms: Color auto-correlogram, HSV (Hue Saturation Value) histogram and Color moments. Texture based features are: Gabor features like mean square energy, mean amplitude of 2D wavelet components, mean and standard deviation of wavelet coefficients. From this phase, we get two feature vectors one for the query image and another for the database image.

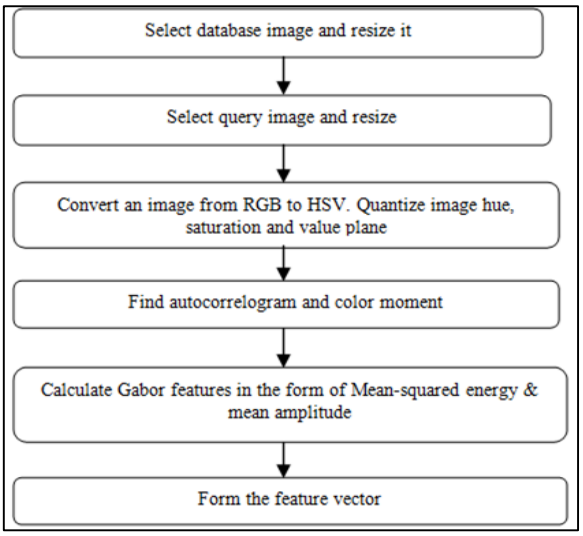

Fig. 3: Flowchart for feature extraction process

2) Feature Matching:

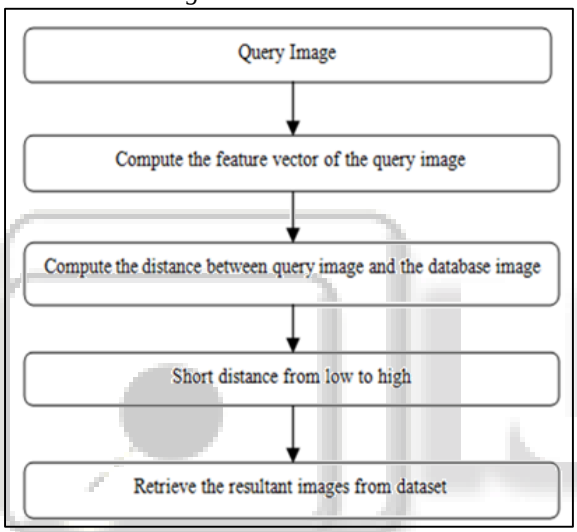

Fig. 3: Flowchart for feature matching process

In this phase, features of each image stored in the database are compared to the features of the query image. SVM (Support Vector Machine) is employed for classification of images based on their features. Also, similarity between the two images is measured by using euclidean distance by various methods like cityblock, minkowski, chebychev, cosine, correlation and spearman. If the distance between feature vector of the database image and the query image is small, then that image in the database is considered as a matched image to the query image. Then, the matched images are ranked accordingly to a similarity index. Finally, images with high similarity are retrieved.

B. Support Vector Machine:

In machine learning, support vector machines are supervised learning models which are associated learning algorithm. It analyzes data which is used for classification and regression analysis. Given a set of training examples, each data marked to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, which is not present in any one of the two classes making it a non-probabilistic binary linear classifier.SVM classification involves identification of features which are related to the known classes. This is known as feature extraction. [10].

Confusion Matrix: A confusion matrix contains information about classifications such as actual and predicted classifications. Each column of the matrix represents the instances in a predicted class, while each row represents the instances in an actual class. It is a table with n rows and an n column that gives the number of false positives, false negatives, true positives, and true negatives where n is number of classes. Performance of systems is evaluated from the data in the matrix. [10].

III. STATISTICAL CONSIDERATIONS

In proposed approach, various statistical features are considered for the similarity matching between query image database images. Following are the pair wise distance calculation method which calculates the distance between the two images.

Mean: The first color moment can be interpreted as the average color in the image, and it can be calculated by using the following formula,

$$E_i = \sum_{j=1}^{N} \frac{1}{N} P_{ij}$$

Where N is the number of pixels in the image and Pij is the value of the j-th pixel of the image at the i-th color channel.

Standard Deviation: The second color moment is the standard deviation, which is obtained by taking the square root of the variance of the color distribution.

$$\sigma_i = \sqrt{(\frac{1}{N} \sum_{j=1}^{N} (P_{ij} - E_i)^2)}$$

Where Ei is the mean value, or first color moment, for the i-th color channel of the image.

Given an mx-by-n data matrix X, which is treated as mx (1-by-n) row vectors x1, x2... xmx, and my-by-n data matrix Y, which is treated as my (1-by-n) row vectors y1, y2... ymy, the various distances between the vector xs and yt are defined as follows:

1) Euclidean distance

$$d_{st}^2 = (x_s - y_t)(x_s - y_t)' \quad \text{..... (1)}$$

Euclidean distance is a special case of the Minkowski metric, where p=2.

2) Standardized Euclidean distance

$$d_{st}^2 = (x_s - y_t)V^{-1}(x_s - y_t)' \quad \text{..... (2)}$$

Where, V is the n-by-n diagonal matrix whose jth diagonal element is S (j) 2, where S is the vector of standard deviations.

3) Mahalanobis distance

$$d_{st}^2 = (x_s - y_t)C^{-1}(x_s - y_t)' \quad \text{..... .(3)}$$

Where C is the covariance matrix.

4) City block metric

$$d_{st} = \sum_{j=1}^{n} |x_{sj} - y_{tj}| \quad \text{..... (4)}$$

City block distance is a special case of the Minkowski metric, where p=1.

5) Minkowski metric

$$d_{st} = p\sqrt{\sum_{j=1}^{n} |x_{sj} - y_{tj}|^p} \quad \text{..... (5)}$$

For the special case of p = 1, the Minkowski metric gives the City Block metric, for the special case of p = 2, the Minkowski metric gives the Euclidean distance, and for the special case of p=∞, the Minkowski metric gives the Chebychev distance.

6) Chebychev distance

$$d_{st} = \max_j \left\{ |x_{sj} - y_{tj}| \right\} \quad \text{..... (6)}$$

Chebychev distance is a special case of the Minkowski metric, where p=∞.

7) Cosine distance

$$d_{st} = \left(1 - \frac{x_s y_t'}{\sqrt{(x_s x_s')(y_t y_t')}} \right) \quad \text{..... (7)}$$

8) Correlation distance

$$d_{st} = 1 - \frac{(x_s - \bar{x}_s)(y_t - \bar{y}_t)'}{\sqrt{(x_s - \bar{x}_s)(x_s - \bar{x}_s)'}\sqrt{(y_t - \bar{y}_t)(y_t - \bar{y}_t)'}} \quad \text{.... (8)}$$

Where

$$\bar{x}_s = \frac{1}{n}\sum_j x_{sj}$$

and

$$\bar{y}_t = \frac{1}{n}\sum_j y_{tj}$$

IV. RESULTS AND DISCUSSIONS

A. GUI of the Image Retrieval System:

The feature extraction algorithms and similarity matching methods are coded using MATLAB on Intel(R) Core(TM) i5 CPU with 4GB RAM running on Windows 7. The database consists of 500 images which have been manually selected to be a database of 5 categories of 100 images each. The images are subdivided into 5 categories (Africa, Beach, Monuments, Buses, Dinosaurs) such that that a user wants to find the other images from a category if the query is from one of these 5 categories. Figure 5 shows the GUI of the Image Retrieval Systems.First database is trained and then images are retrived by applying any one of the comparison method.Here,GUI shows retrieved images based on L1 method of comparison.It also shows expected and actual retrieved images.

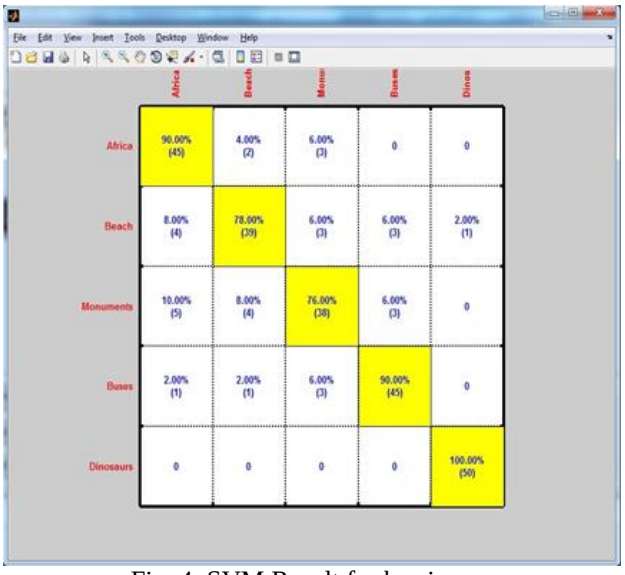

Fig. 4: SVM Result for bus image

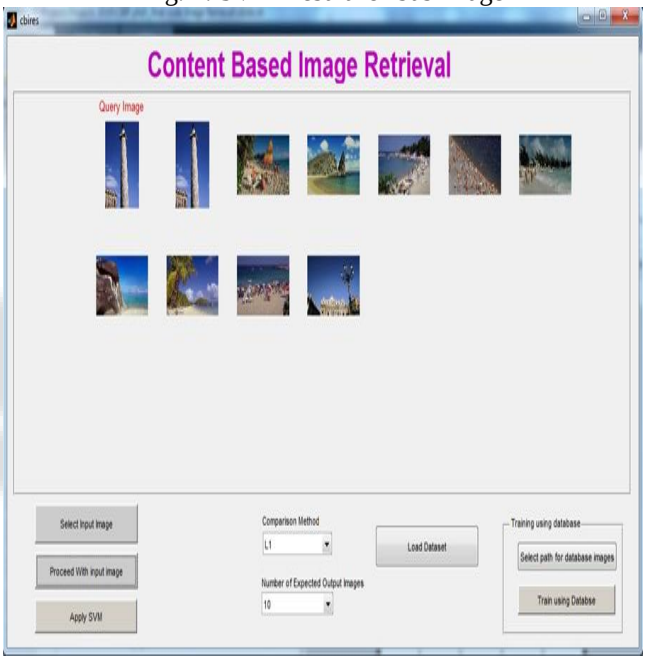

Fig. 5: Retrieval of monument image using L1 method

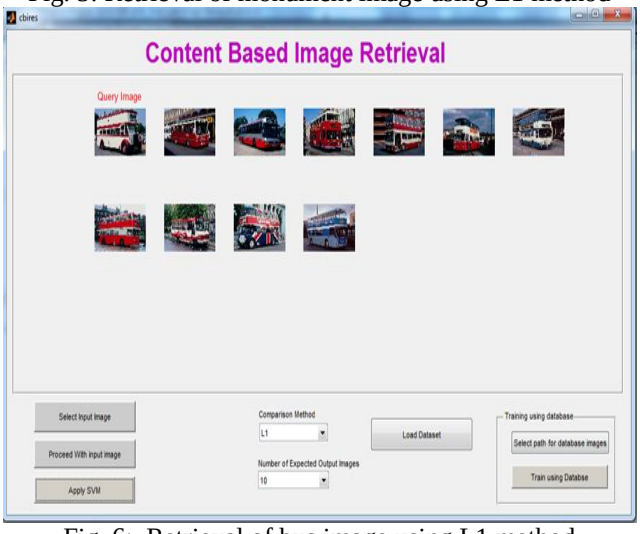

Fig. 6: Retrieval of bus image using L1 method

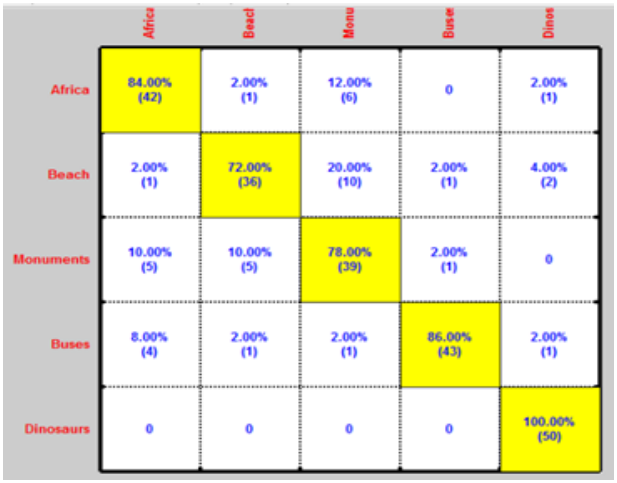

Fig. 7: SVM Result for monument image

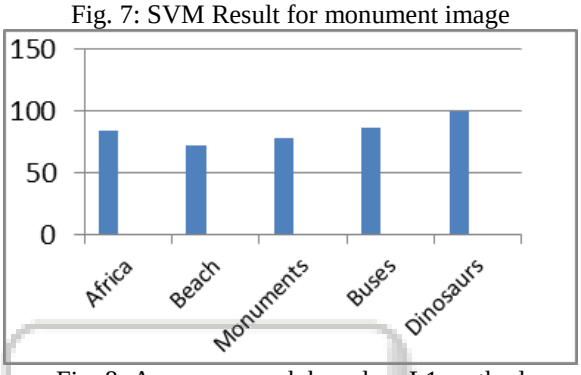

Fig. 8: Accuracy graph based on L1 method

V. CONCLUSION

In this research, we presented a content based image retrieval system based on feature extraction. We use Gabor filter, which is a powerful texture extraction technique either in describing the content of image regions or the global content of an image. For feature extraction, various color based and texture features are used. Also, for classification of images Support Vector Machine is employed. SVM confusion matrix shows the accuracy of retrieving the desired image from the database images. Results show GUI for the image retrieval system for monument and bus image. It shows number of expected and actual retrieved images are same. Similarity matching between the images is done by measuring euclidean distance between them with different methods like L1, cityblock, minkowski, chebychev, cosine, correlation and spearman.

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