A novel approach for image classification in Content based image retrieval using support vector machine

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Abstract- Image is a collection of row and column that is called pixel values. Extracting best matched image from large collection of database is emerging task. Image retrieval is mainly used in image processing, pattern recognition and computer vision. CBIR technique used in many areas such as medical, academic, art, fashion, entertainment. Generally image have colour, texture, shape and size are relevant feature so extract all the relevant and irrelevant features of image. Colour histogram of image formed by divided graph into levels and mean and standard deviation are calculated by pixel value of each level. After extracting all the feature of image applies SVM i.e. supervised learning algorithm get optimal result for image classification.

Keywords*:* CBIR, Image Retrieval, SVM, Image classification, image processing, pattern recognition, computer vision.

I. INTRODUCTION

A digital image is derived by analog image signal by sampling process that means 2D continuous signal converted into 2D discrete signal. Here 2D continuous signal is divided into row and column. The intersection of row and column is called pixel values. The need of digital images in area such medical, journalism, home user, art, fashion, advertising [13].

The main goal of CBIR to build new technique for extracting similar image from large collection of image i.e. database based on their content or features [6].Image retrieval system is used to find out similar image to query image. There are different methods to search image from large database [2].

- Based on Text (Query by Text): Here user gives a keyword or textual description for searching an image.
- Based on Draw (Query by sketch): Here user provides drawing or sketch of an image.
- Based on Example image (Query by Example): Here user gives similar image to the query image [2].

Text and Sketch based approach has two drawback, first is there is large no. of similar images in the database so it require lots of work load and it is very time consuming process. Second is different textual description of image by different people [5]. So, in 1980's Content based image retrieval system used. Because this system overcome the problem of textual description and provide fast searching [9]. In this user match similar image to query image (Query by Example) [1].

In CBIR, image retrieved low level feature of image like colour, shape, texture and high level feature entropy, mean, standard deviation. Colour feature use image histogram technique, entropy gives statistical representation of image and text feature gives polite and regularity of histogram [5].

It is most widely used technique for managing, searching, browsing and extracting visual content of image from large collection of images [9]. These feature are stored in database for further use, when we need to find out an image, give a query image for matching, the feature of query image are extracted and matched by stored database image, so that a group of same image comes from the query image as a result [12].

To reduce complexity of CBIR system and to increase precision a feature reduction or feature selection algorithm is used. It uses an automatic indexing scheme, to reduce search time of retrieval system from the database. At searching time, user select best matched image from resultant image and then repeat the process again new matched image found. Repeat the step until an image matches to query image [9].

In this paper we show image retrieval technique for different feature of image. Colour, shape texture features are most prominent to compare image automatically [9]. Colour histogram used to reduce the noise, mean and standard deviation used for calculating pixel for each level for image retrieval.

Here Support Vector Machine used to find out optimal result of all the feature of image. It improves efficiency as well as accuracy of all the process of CBIR.

II. CONTENT BASED IMAGE RETRIEVAL

The block diagram shows the pertinence between a query image and resultant image. It applies feature extraction method to all the images and matches the features of query image and resultant image. An image that has best similar feature is extracted from database [9].

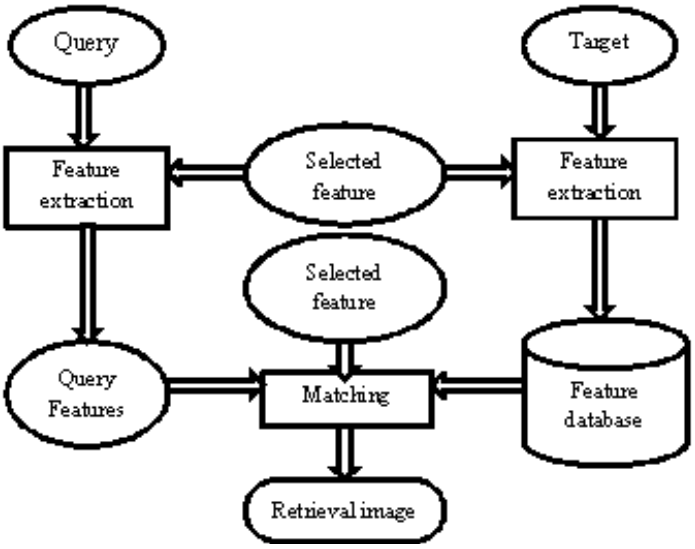

Figure:1 Diagram of Content Based Image Retrieval System

III. VARIOUS FEATURES OF IMAGE

1. Colour Feature

Colour is one of the most important features in CBIR. It is most widely used for both human perception & computer vision [9]. In colour feature extraction mainly image histogram value calculated. Image histogram is a graphical representation of an image. As we know image is a collection of pixels i.e. row and column, so the image histogram shows the proportion of pixels of each colour within the image. Image histogram for each image is then stored in the database. At search time user can specify the desired proportion of each colour. Image histogram shows how many times the particular colours occur in image. The main advantage of histogram is variation in scale, rotation &translation of image.

Currently RGB i.e. Red, Green, Blue colour model is used in digital image because it is more convenient for displaying image in CRT. But it does not give good result in CBIR so we use HSV which is mostly used in CBIR system. In this colour should be matched with human expectation. In this, Hue represents different colours, saturation represents percentage of white colour and Value represents light intensity. Advantages of HSV are suitable with human perception [3].

To calculate image histogram, image is converting into RGB to HSV space then each colour pixel divided into levels this process called quantization. Here each level shows the number of time each colour occurs in an image.

2. Texture features

Texture refers to a structural collection of pixels of an image. Many features of image can be extracted by texture features. For texture feature extraction in 1973, Haraclick proposed Gray level co-occurrence matrix (GLCM). He proposed some parameters for texture extraction [4].

- Contrast (Moment of inertia): Image contrast can be a sharpness of image. Contrast is higher when image grooves are deep [3].
- Energy: It can be measure by gray distribution of image. Coarness of image depends on high energy level [3].

- Entropy: It is a quantity which is used to describe the amount of information of an image. If entropy level is low, then image having more black area. An image that is perfect having entropy zero [4].
- Correlation: It is used to calculate the degree of similarity of the elements of image [3].

3. *Shape Features*

It represents visual content of an image. Every natural or man-made object has their own shape, so we easily recognize shape of an object [3]. Different varieties of shapes are computed by many objects which are stored in database and at search time user can easily identify desired shape. There are two types of shape features, Global Feature- aspect ratio, circularity and moment invariant, Local feature- Boundary segment. Shape feature queries apply for both example image and user drawn image [4].

Shape feature can be divided into 2 categories [4]:

- Boundary based: Outer boundary of object is calculated.
- Region based: Entire region i.e. area covered by object.

4. *Mean*

This feature is related to the brightness of an image. As I previously wrote image is a collection of row and column i.e. pixel values [1]. By these pixel values calculate the image histogram i.e. graphical representation of an image [2]. For calculating mean divide the histogram into levels, this process called quantization. Each level consists of some pixel values, and then finds out all the pixel values of all the levels and calculate average i.e. mean of all the pixel values that represent brightness of image. If mean is high then image is bright and if mean value is low then image is dark [5]. Formulas for calculating mean [6].

$$\mu_j = \frac{1}{N}\sum_{i=1}^{N} x_{ji}$$

5. *Standard Deviation and Variance*

It represents contrast of each level of image. It is calculated by using mean values of image and pixel values of each level and variance is the square of standard deviation. [5].

$$\sigma_j = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_{ji} - \mu_j)^2}$$

If the value of SD is high, then image will be in high contrast and if SD is low, then it will be low contrast in histogram [5].

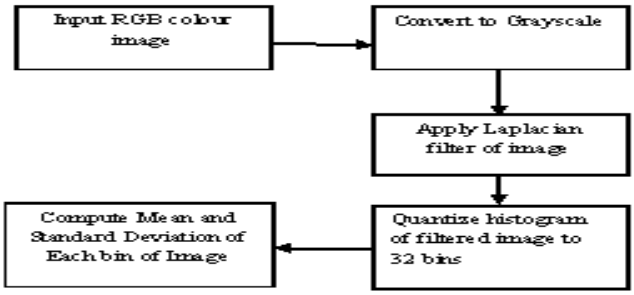

Figure:2 Block Diagram for calculating Mean and standard deviation features of an image.

IV. SUPPORT VECTOR MACHINE

SVM is a supervised learning process in machine learning. The main purpose of SVM is to build optimal separating hyper planes [14]. It accepts data and identifies patterns which are used for classification and regression analysis [8]. It takes a set of input data and produces an inferred function called classifier (if input is discrete) or regression (if output is continuous) [1]. The main aim is to draw hyper plan as wide as possible for a good separation that means largest distance to nearest training data of pixel values [7]. The distance between two hyper planes is the margin of the hyper planes with respect to the sample. The purpose of SVMs is to maximize this distance [11].If distance of pixels to hyper plan is large than generalization error of classifier is low [8].

SVMs method consists of the following phases:

1. Mapping input data to high-dimensional feature space.

2. Selecting a kernel and computes the hyper planes.
3. To maximize the distance from the closest points, this is called the margin.
4. To detect the outer boundaries.

Its performance was auspicious because it reduces prediction error and complexity at the same time. [14].

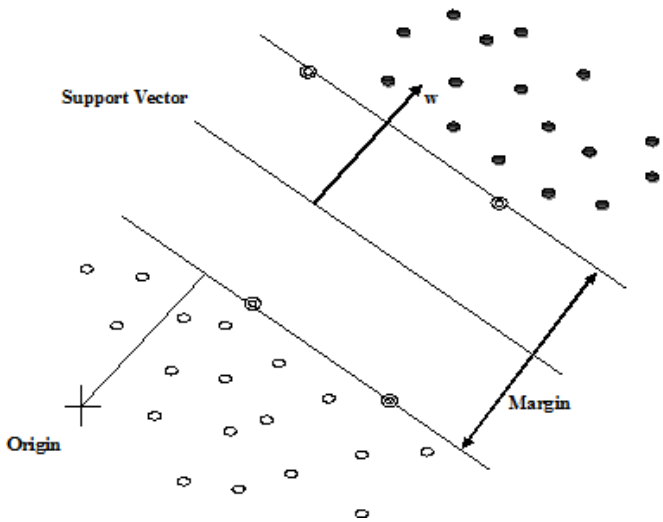

Figure:3 Linear separating hyper planes for two class separation

V. FEATURE EXTRACTION

In the proposed system there are three phases:

- Pre-processing
- Feature extraction
- SVM classifier

Pre-processing: the main aim of pre-processing is to remove the noise and error from image. The purpose of removing noise is to get error free exact extraction of feature. If any noise remains in image then extraction gives unsatisfactory result.

Feature extraction: In this step more features of image like colour, texture, shape, mean, standard deviation, histogram value, length to width ratio, entropy are extracted.

SVM classifier: SVM is act as a classifier. Basically it is used for image classification of those features of image which are extracted from previous step. Here all the images are classified to their respective feature [7].

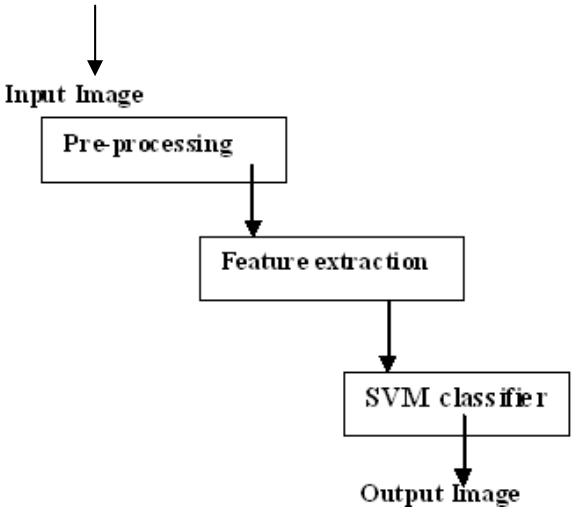

Figure:4 Block diagram of Feature extraction system

Following figure shows the step wise working of feature extraction. When input image is ready for feature extraction first it goes through pre-processing phase than goes to next phase here feature extraction is performed. In next phase extracted feature goes to SVM classifier here all the features of image classify. Some features treated as a training data and some are testing data [8].

VI. PERFORMANCE EVALUATION

The performance of CBIR system is calculated with the help of training set and test set. Here we can measure the accuracy and error rate by given formulas [7]:

For example 100 images are there 80 used for training and remaining 20 used for testing.

$$\text{Accuracy} = \frac{\text{No. of training data}}{\text{Total No. of Image}}$$

$$\text{Error} = \frac{\text{No. of test data}}{\text{Total No. of image}}$$

VII. CONCLUSION

In this proposed work, content based image retrieval system are used to overcome the problem of textual approach using visual features of an image. We extract all the relevant and irrelevant features such as colour, texture, shape, mean, standard, variance, and histogram value of an image using feature extraction method. In this paper we use SVM as a classifier for classification of various categories of image and find optimal result. Accuracy and error rate found for precise result. This method is much better performance than the traditional method of image retrieval.

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