Content based Image Retrieval: A Review

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***Abstract*— This paper presents a review of different techniques in content-based image retrieval system. Content Based Image Retrieval (CBIR) system is a very important research area in the field of computer vision and image processing. CBIR is used to solve the problem of searching a particular digital image in a large collection of image databases. This paper deal with the brief overview of the CBIR with the various technique to retrieve the relevant images based on the similarity measure among the images in database and also enlighten with the various performance measure technique to evaluate the efficiency of the CBIR system.**

Keywords-CBIR,Feature Extraction,Colour,Shape,Texture, Edge.

I. INTRODUCTION

The Content Based Image Retrieval (CBIR) System retrieves the similar images from the images database by comparing the features of the query image against all the images in the database. CBIR System works based on the extraction of the features and comparing the features between one or more images from the database. The term "Content based image retrieval " seems to have originated with the work of T. Kato in 1992 for the automatic retrieval of the images from the database, based on the color and shape present in the image itself. Since then, the research on this field picks the speed and after some decades there have been several techniques and algorithms are proposed .In the past decades there have been several implementation system based on the CBIR such as QBIC system from IBM , PHOTOBOOK from MIT and VIRAGE from Virage Corporation. During the past decades, remarkable progress has been developed in both researches as well as implementation system. However there are several challenges are still not fully solved.

The CBIR system mainly based on the low level features of an image such as colour, shape and texture . First of all the feature vector of the query image is extracted and stored in the featured database , After then features of all the images from the database are extracted and stored into separate featured database. After that the features of the query image and the rest of the features of the image database are matched by comparing the similarity distance measure. Images that having least distance from the query image are displayed as a result. There are various distance measure techniques to be applied in CBIR system. The main drawback of the CBIR System is that similar images are sometimes may not be retrieved because the perspectives of the user required images to the system observed images may be vary , this problem is called "semantic gap" between the machine and the user hence there are several research are going on this technique to overcome this problem.

II. FUNDAMENTAL ASPECT OF CBIR

Earlier CBIR system can be categorised into two types based on the type of query being taken as a input namely text based and image based . In the text based query system, images are classified by relevant text information as keyword, tag and captions. Text based image retrieval system is useful as a query, the retrieval rate will be more appropriate for intelligent text descriptions are given for image in a database. However providing appropriate description for all the images are impossible and takes much more time ,Therefore text based retrieval system can lead to a irrelevant results whenever the description of the image are not specific.

In image based query methods are more appropriate while searching the relevant images because the low level image features are extracted very efficiently such as Colour , shape and texture.

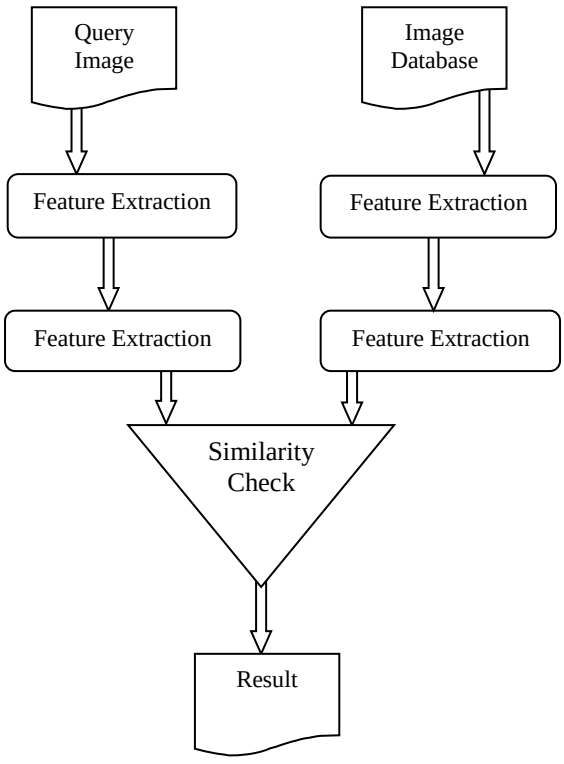

Figure 1. General Model of Content Based Image Retrieval

There are mainly two approaches for feature extraction process: Feature extraction in spatial domain and feature extraction in transform domain. The feature extraction in

spatial domain includes the content based image retrieval methods based on the histograms. Image content may include visual and semantic content .Visual content may be domain specific such as Colour, Shape, Texture and spatial information etc. Semantic content may include visual content descriptor .Again the visual content descriptor are two types: Global and Local. A global descriptor takes the visual feature of the complete image, while the local descriptor uses the visual features of regions or the object that describes the image content.

The typical CBIR system performs two major tasks. First of all feature extraction process can be done this feature extraction process called feature vector. This feature vector is very smaller size instead of the original image size. After that the second task is similarity measurement that performs the similarity between the query image and the images of the database. Image which having least distance to the query image are retrieved and provides the as a result. Typical Block diagram of CBIR is shown below in fig.1.

III. FEATURE REPRESENTATION

The Content Based Image Retrieval System provides the several low level image features that can be used to extract the relevant information about a particular image , this feature vector is then used in similarity measurement process to find the similar images in the database. Low level features such as colour, shape and texture are used either individually or combination of two or more feature vector , However there is no single method that providing the well appropriate results.

Let us discuss all of the feature extraction techniques from the researcher's point of view:

A. Colour Feature

Colour is one of the most dominant feature in image retrieval as they provide the several techniques to extract colour information. Colour features are extracted by using colour histogram, colour moments, colour coherence, colour correlogram, invariant colour histogram etc.

The colour histogram is one of the most widely used colour feature that consist of series of distribution of colours in a image. Jin et.al [4] proposed the histogram based method to obtain the colour features[7,8,11,14,21,29] uses colour histogram based technique.

colour correlogram based colour feature extraction process that having capability to find pixels of certain colours in certain neighbourhoods this concept was proposed by P.V.et .al [9] .

The colour coherence concept was proposed by Reshma et.al [10] . Fast colour quantization have been proposed by Xing-Yang et al[5].

Colour moments have been mostly used in the many retrieval systems such as Query Based Image Retrieval System (QBIC) and this is well suited when the image contains only a object. The first order(*mean*),second order(*variance*) and the third order (*skewness*) colour moments have been obtained more efficient and ease to represent the colour distribution. M. Singha et.al[13], A.J.Afifi et.al[2] have been proposed this technique.

B. Texture Feature

Texture is important feature that can be more feasible of human visual perception and can be used for finding different image region. Texture feature of query image is extracted and stored in the texture query feature vector , Similarly the texture feature of all the images of the image database is extracted and stored in the texture image feature database . Finally the similarity algorithm will be applied and finds the least distance among the texture attribute of the image and shows the obtained results.

Wavelet transform extract information from signal at different scales by passing the signal through low pass and high pass filters. Wavelet provides the multi resolution capacity and good energy compaction. Wavelet transformation can be computed linearly with the time therefore it is a fast algorithm.

There are several techniques are proposed by a lot of researchers. They are listed below:

Wavelet transformation is one of the key technique for texture feature extraction that transform the image from the spatial domain to the frequency domain [26], Discrete Wavelet Transformation[1,21] transform the single level ,one dimensional discrete wavelet transform. Haar wavelet transform enables us to speed up the wavelet computation step for thousands of sliding windows of varying sizes in an image [7].

Fast wavelet transform [14] is a computationally efficient implementation of the discrete wavelet transformation (DWT) that has been developed by Mallat.

A co-occurrence matrix [3,4,6] is a matrix that is defined over an image to be the distribution of co-occurance values at a given offset. The value of the pixel of an image should be in a gray level.

Gabor filter (or Gabor wavelet) is widely adopted to extract texture features from the images for image retrieval and has been shown to be very efficient for retrieving the texture based image retrieval [13, 24].

Steerable filter is a class of filters in which a filter of arbitrary orientation is synthesized as a linear combination of a set of "basis filters". The edge that are located at different orientations in an image con be obtained by spliting the image into orientation sub bands obtained by the basis filters having these orientation.

C. Shape Feature

Shape is an important visual features that a human perception can easily be detected based on object sizes. Therefore it is also a most frequently used method for extracting feature of the CBIR system.

Shape Content based image retrieval [13] is difficult to obtained a good result because there are no such accurate algorithms exits that clearly measure the shape of the image.

Shape feature descriptor can be classified by two categories: contour based and region based. Region based technique uses the complete area of an object for shape descriptor and in contour based image retrieval method use only the information present in the contour of an object.

The Zernike moment[5] descriptor is the most suitable for shape similar-based retrieval in terms of computation complexity, compact representation, robustness, and retrieval performance.

Another technique for measuring the shape of an image is to segment the image into 5 classes initially based on their brightness level .Then three attributes: Mass, Centroid and Dispersion [10] for each class are computed and stored into the shape vector.

Moments [11, 13, 24] is a method to obtain the shape based extraction feature, Moments provides a better identification for the perimeter and the area of an image.

Edge detection is one of the most appreciated and widely adopted method for determining the shape of the query image and the images at the image databases. There are several methods for the edge detection technique.

Canny edge detector algorithm [1, 19] is based on the work of Marr and Hildreth edge detection method, In this algorithm canny is used to identifying the points in an image at which the image brightness changes sharply or more formally, leads to the discontinuities. The points at which digital image brightness changes are typically arranged into a set of curved line segments called as "edge" of the image.

Sobel edge detection method is a discrete differentiation operator used to compute an approximation of the gradient of the image intensity for edge detection. At edge pixel of an image, Sobel operator gives the corresponding gradient vector or normal to the vector. Prewitt is also a similar to the sobel algorithms.

Robert is a gradient based operator that computes the sum of the square of the difference between the diagonally adjacent pixels through discrete differentiation after that compute approximation gradient of the image.

IV. SIMILARITY MEASUREMENT

Similarity measurement is a process of matching the visual similarity between a query image and the images in the database. There are many distance measurement techniques are used so far but no one of the method gives the full accuracy. Different similarity measures techniques will affect the retrieval performances of an image retrieval system significantly.

The different distance measures used for matching are as follows:

1) Euclidean distance
2) Minkowski-Form Distance
3) Quadratic Form (QF) Distance
4) Mahalanobis Distance
5) Kullback-Leibler (KL) Divergence and Jeffrey-Divergence (JD).

V. PERFORMANCE EVOLUTION

The performance evolution measurement provides the information that how much efficient of a proposed method for retrieval of the image. There are basically two techniques for evolution:

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

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

The Precision and recall value are taken in the percentage , Therefore it should be higher for lower computational time. Higher value tells the proposed algorithm is optimal.

VI. CONCLUSION

In this Paper, We have discussed about the various feature extraction techniques and their corresponding result. We observed that canny edge detection technique for shape feature extraction is optimal because it have the capability to distinguish noise from data in an image and also it takes lower computational time among other detection techniques. For detecting texture, wavelet transformation reduces the feature vector that optimizes the time and the space. Therefore we can recommend the combination of the canny edge detection and the wavelet transformation technique to get the good results with lower computational time.

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