ISSN:0975-9646

Semantic Image Retrieval:A Review

Ashitha.S.S,

Faculty of Lourdes Matha College of Science and Technology,Kuttichal,Trivandrum

***Abstract*— Image retrieval systems play a key role in big image database systems. User may search for the image using keywords, phrases or image itself. CBIR approaches helps to retrieve image based on the contents or features of the image. RBIR approach helps to retrieve images based on the regions.The images retrieved using RBIR have more close similarity with human approaches.But the semantic gap still remains as a challenge.Multiple semantic interpretations and lexical ambiguity of the same image still remains as a challenge.**

***Keywords*— Content based approach, region based approach, semantic retrieval.**

I. INTRODUCTION

Now a days, image retrieval techniques help users access images from web for different applications. The search for images may be text based or content based. Most of the existing image retrieval systems are user interactive.These image retrieval systems classify images based on their features, then ranked and displayed at a higher speed. For comparing the similarities, any one of the distance measures are used. A comparative study on the distance measures shows that Euclidean distance measure is the popular and the faster one.The commonly used features are color,texture,shape or a combination of any of them.

The rest of the paper is organized as follows.Section II represents several CBIR approaches.Section III presents several RBIR approaches.The conclusion is presented in section IV.

II.CBIR BASED APPROACHES

Fuzzy values are used to classify image based on the intensity of color in this approach. The neural network technique helps to retrieve images from the database in a faster way[1].The color, texture and position features are extracted from the scaled pixel values. The scale is selected based on the polarity of each pixel[3]. Another approach of retrieving images are based on salient points.Salient points represent locations in the image where color and texture are varied to database image.Texture features are extracted using gabor filters and the first and second order statistical moments of color bands are computed around every sailent point.The shape descriptors are also computed from gray level edge images of R,G,B individual planes. Canberra distance measure is used for checking the similarity of feature vectors [6].

Another simple and fast approach uses wavelet like structure in contourlet transform, which helps in detecting the edges and segments.The normalized standard deviation on each directional subband of the decomposed image is represented as a vector. The manhattan distance measure is applied to measure the similarity.This distance measure works well than Euclidean measure[8].The global features extracted using Independent Component Analysis(ICA)[9], provides better results with greater accuracy than with gabor filters.

Several approaches uses shape feature to retrieve the image. The images are pre-processed to improve the edges. The improved edges are used for identifying shapes[10].To reduce the number of edges, the shape is simplified and stored in the database. The user inputted image is processed in the same manner and compared with the images in the database. Another approach uses Canny Edge Detection to extract the shape features. Based on the edge histograms, the images are classified using SVM(Support Vector Machine)tool and indexed using low dimensional shape based techniques. To retrieve a relevant image, a similar image is inputted, and the Euclidean distance measure is applied [25].

Image and video retrieval applications also use histogram based techniques. The Legendre moments and wavelet coefficients provide better indexing and faster retrieval [24].

[17]Content-based image retrieval using graph-based semi-supervised learning has attracted many researchers. In this work, a framework based on multilabel neighbourhood propagation is proposed for RBIR, which is characterized by three key properties: (1) For graph construction, to determine the edge weights robustly and automatically, mixture distribution is introduced into the Earth mover's distance (EMD) and a linear programming framework is involved. (2) Multiple low-level labels for each image is obtained based on a generative model, and the correlations among different labels are explored when the labels are propagated simultaneously on the weighted graph. (3)By introducing multilayer semantic representation (MSR) and support vector machine (SVM)into the long-term learning, more exact weighted graph for label propagation and more meaningful high-level labels to describe the images are obtained.

The SIMPLICITY system segments each image into blocks. Each block is represented as a feature vector of color, texture and shape. The features include the average color components and energy in high frequency bands of wavelet transforms. The images are classified as textured, non textured, photograph and graph respectively. [14]By using K means clustering, feature vectors are clustered into several classes. Most of the similarity measures help us to find out the distance between feature points. But the similarity measure based on the regions is softened by applying Integrated Region Matching (IRM).The weighted sum between similar regions is used to retrieve the image.

Most of the existing CBIR systems are non-interactive. To increase the involvement of user, several relevance

feedback techniques are applied. So interactivity adds iterative feedback and query refinement. The success of feedback techniques depends on the users' patience. Using precision and recall any of the retrieval techniques can be evaluated. With the existing large scale of images, the retrieval of high quality images still remains as a challenge.

[12]CBIR approach with multimodality and relevance feedback is another approach. With multimodality, each image is represented as an object model with its low level features and feature representations with dynamically updated weights [11, 12].By applying distance measures, the relevant images are retrieved. Based on the user's feedback the weights are updated automatically. The system with its enhanced browsing in the image database is an additional attractive feature.

Currently,CBIR with relevance feedback approaches are common. But most of the image processing approaches are not suitable for images with variation in intensity, sharpness, shape distortion etc. Histogram based search techniques are also not suitable for such images[13].

Most of the existing image retrieval systems use Histogram based search or Color layout search.The Histogram based searches ignore shape, texture and object location and is sensitive to intensity variation, color distortion and cropping[14].Color layout searches are also sensitive to shifting, cropping, scaling and rotation. Hence region based approaches seems to be useful in such applications.

III. REGION BASED APPROACHES

A region based approach is used in Expectation-Maximization [3]. It is a fully automatic system and has been found successful on a collection of 1000 images. For each region, the color is identified from the histogram of the pixels. The quadratic distance between colors of two regions is calculated from their corresponding histograms. The user can select one or more similar blobs to retrieve the image from the database. The Euclidean distance measure is used to retrieve the similar image. The performance seems to be better for distinctive objects. More information about the blobs and shape will enhance the features.

The RBIR with fuzzy feature matching also helps to retrieve the images. The regions in each image is represented as a multidimensional fuzzy set based on the color, texture and shape features[4].Based on the region, weights are assigned to each feature vector. Unified Feature Matching (UFM) , a fuzzy based similarity measure is used to retrieve the similar images from database.

IRM uses RBIR approach to divide image into blocks [5].The k-means algorithm segments images into blocks based on the mean values of color & frequency features. Each block is represented with a feature vector. The segmented regions are compared with the regions of the database. IRM allows one region to be matched to several regions. If the regions are matching ,edges are created to connect the matched regions. If the graphs of input image and database image are matching, distance is calculated as the sum of all weighted lengths. Most of the retrieval systems compare the similarity of individual regions, but not the overall similarity. Since IRM utilizes the concept of overall similarity measure, it works faster and reduces the effects of inaccurate segmentation.

Another approach groups pixels into regions, known as blobs [15].This is a fully automatic image retrieval system. The pixels are scaled and grouped. The scale helps in controlling the size of integration window around each pixel. The pixels with similar color, texture & position features are grouped and the Mahalanobis distance between the blobs helps to retrieve the relevant image.

A lot of researches has been carried out on image retrieval resulting in various approaches and techniques to retrieve images. A graph-theoretic [16] approach is used for interactive region-based image retrieval. Graphs are used to represent images, and then transform the region correspondence estimation problem into an inexact graph matching problem. An optimization technique is proposed to retrieve the images. They defined the image distance in terms of the estimated region correspondence. In the relevance feedback steps, with the estimated region correspondence, they used a maximum likelihood method to re-estimate the ideal query and the image distance measurement. The maximum likelihood method combined with the estimated region correspondence improved the retrieval performance in feedback steps.

Another approach is based on the local description of images.This region based proposal [18]has received significant attention from recent researches. It provides local description of images, and uses object based query with semantic learning. In their paper, they apply curvelet transform of color images. The curvelet transform provides better results for image de-noising, character recognition, and texture image retrieval. But curvelet feature extraction for segmented regions is challenging because it requires regular (e.g., rectangular) shape images or regions, while segmented regions are usually irregular. An efficient method is proposed to convert irregular regions to regular regions. Discrete curvelet transform is applied on these regular shape regions. Experimental results and analyses show the effectiveness of the proposed shape transform method. This result obtained from the transformed regions outperforms the widely used Gabor features in retrieving natural color images.

Another Region based color image retrieval is based on wavelets[19].They proposed a new kind of the color image retrieval method based on wavelet transformation-Regions Of Interest (GROI).They use HVS(Human Visual System) characteristic to choose the color space which fit for the visual characteristics, then use K-means clustering to extract the areas of interest in the wavelet transform domain, and use the local energy of the wavelet coefficients in the areas of interest as the texture feature, color's mean and variance as the color feature, and the barycentric coordinates as the position feature. Finally, they calculate the similarity between the image content and retrieval.

A system for Medical cerebral MRI images [20]was proposed with region based image retrieval and relevant feedback (RF) system. In this system, the brain images were extracted from cerebral images by a modified BET algorithm, and then segmented into regions by EM

algorithm based on Gauss Mixture Model. Each region was represented by fuzzy features. For image retrieval, both regional and global features were used. To optimize the retrieval result, the reweighting relevance feedback method (RW) was used to optimize regional features. The proposed reweighting BiasMap based relevance feedback method (RW-BiasMap) helps to optimize global features. The computation of RW is very fast, but only uses the relevant images. RW-BiasMap is based on RW and BiasMap feedback method. It can use both the relevant images and the irrelevant images, but the computation of RW-BiasMap is in a slow manner, so it is used to optimize the global features.

Another image retrieval proposal is based on interest image region by asymmetrical blocking[21].An image is segmented into the interest region and background region on a certain rule. For the interest image regions, the color histogram of the uneven blocks is extracted as the color characteristic. They also collect the mean and variance value of the Gabor filtered results of background blocks as texture features of the background image. Then, the images are retrieved by synthesizing the image color and texture features. They tested their approaches on Corel image database. An analysis is done based on the results of recall and precision indicators.

Although much research in region-based image retrieval has already been done[22],still three main problems need to be tackled properly: (a) local region-based features, (b) similarity measures, and (c) relevance feedback based on regions.

The proposed localized content-based image retrieval (LCBIR) [23] has emerged as a hot topic more recently due to the fact that in the scenario of CBIR, the user was interested in a portion of the image and the rest of the image is irrelevant. In their paper, they propose a novel region-level relevance feedback method to solve the LCBIR problem. Firstly, the visual attention model is employed to measure the regional saliency of each image in the feedback image set provided by the user. Secondly, the regions in the image set are constructed to form an affinity matrix and a novel propagation energy function is defined which takes both low-level visual features and regional significance into consideration. After the iteration, regions in the positive images with high confident scores were selected as the candidate query set to conduct the next-round retrieval task until the retrieval results were satisfactory.

To cluster the images,a lot of techniques are used.Among them FCM works well on noise free images.Several enhancements of FCM algorithms were developed like FCM_S, EnFCM, FGFCM etc[26].But FLICM is a better clustering technique which is free of any parameter and it preserves image details.Thus FLICM(Fuzzy Local Information C Means) works well on noisy images.

The concept of local orientation of texture feature is used in MultiTexton Histogram (MTH)[27].Textons are patterns having some common properties all over the image.The features of Co-occurrence matrix and histogram are integrated in MTH.The retrieval process is faster and suitable for large databases.

IV. Conclusions

A lot of recent works suggests several methods for the image retrieval based on the feature extraction and feedback from users.But still the ‘semantic gap’ exists.So to add more user interaction and to reduce the semantic gap is more complex work.The system must be able to interpret the user query and automatically extract the semantic feature that can make the retrieval more efficient and accurate.

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