An Adaptive Approach to Relevance Feedback in CBIR Using Mining Techniques

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Abstract— This paper provides a mining approach to the research area of relevance feedback (RF) in content-based image retrieval (CBIR). Relevance feedback is a powerful technique in CBIR systems, in order to improve the performance of CBIR effectively. The drawbacks in CBIR are the features of the query image and the semantic gap between low-level features and high level concepts. Especially, Mining Image data is the one of the essential features in this present scenario since image data plays vital role in every aspect of the system such as business for marketing, hospital for surgery, engineering for construction, Web for publication and so on. In this paper, we are proposed an adaptive approach for relevance feedback in CBIR using mining techniques. Where in the processes of feedback we are using a new technique called Image retrieval based on optimum clusters is proposed for improving user interaction with image retrieval systems by fully exploiting the similarity information. The index is created by describing the images according to their color characteristics, with compact feature vectors, that represent typical color distributions.

Keywords--- Relevance Feedback, Image Retrieval, Image Content-Based Retrieval, Co-Occurrence Matrix, RGB Components, Texture, Similar Image and Semantics

I. INTRODUCTION

In this present scenario, image plays vital role in every aspect of business such as business images, satellite images, medical images and so on. If we analysis these data, which can reveal useful information to the human users. And advancements in technology, enables a variety of different types of information available. However this heterogeneity surely challenges technology to provide efficient ways for accessing, sharing storage of such heterogeneous information over the networks and databases. Due to advancements in the digital photography technology, large storage capacity and high speed networks, storing large amounts of high quality images has become possible. Digital images find a wide range of applications in field of medicine, science (medical and scientific images), at virtual museums and galleries, military and security purposes, and personal photo albums etc. The CBIR focuses on Image „features” to enable the query and have been the recent focus of studies of image databases. The features further can be classified as low-level and high-level features. Users can query example images based on these features such as texture, colour, shape, region and others. By similarity comparison the target image from the image repository is retrieved.

While dealing with this sort of information like organizing and searching large volumes of images in databases, users can have the following difficulties, one is the current commercial database systems are designed for textual data, it is not well suited and compatible for digital images. Therefore there is a need for an efficient way for image retrieval. And other one is due to incomplete data, the information gathered is not processed further for any conclusion, image retrieval is the fast growing and challenging research area with regard to both still and moving images. Many Content Based Image Retrieval (CBIR) system prototypes have been proposed and few are used as commercial systems. CBIR aims at searching image databases for specific images that are similar to a given query image. It also focuses at developing new techniques that support effective searching and browsing of large digital image libraries based on automatically derived imagery features.

In order to cater to this need, researchers have tried extending the current information retrieval (IR) techniques that are used in text retrieval to the area of the image retrieval. There are different ways to retrieve the images in CBIR.

Ritendra Datta et al [1], Rui and Huang [2], Smeulders et al [3] and Kokare et al [4] had presented comprehensive and recent extensive literature survey on content based image retrieval. The oldest method is text annotation to images in the database. Image annotation is tedious task. Because, it is practically impossible to annotate all the images in the databases. Second it is also very difficult to label the same annotations to the same image by different users. To address such significant limitations, researchers have turned their attention to content-base image retrieval.

In CBIR systems, low level image features are extracted based on visual content such as color, shape and texture. Which are represented by feature vectors instead of a set of keywords However, big challenge in CBIR is the semantic gap between the low level features and high level concepts.
In order to reduce the gap between the low level features and high level concepts, relevance feedback was introduced into CBIR [5],[6]. Recently, many researchers began to consider the RF as a classification or learning problem. That is a user provides positive and/or negative examples, and the systems learn from such examples to separate all data into relevant and irrelevant groups. Hence many classical machine learning schemes may be applied to the RF such as, decision tree learning [7], Bayesian learning [8], [9], support vector machines [10], boosting [11] and so on.

Meanwhile, the next important phase today is focused on clustering techniques. Clustering algorithms can offer superior organization of multidimensional data for effective retrieval. Clustering algorithms allow a nearest-neighbor search to be efficiently performed. Hence, the image mining is rapidly gaining more attention among the researchers in the field of data mining, information retrieval and multimedia databases. Image mining presents special characteristics due to the richness of the data that an image can show. Effective evaluation of the results of image mining by content requires that the user point of view (of likeness) is used on the performance parameters [12].

A. Comparison of Image Mining with other Techniques

The researches in image mining can be classified into two kinds. The image processing is one in which, it involves a domain specific application where the focus is in the process of extracting the most relevant image features into a suitable form [13],[14],[15] and the image mining is one in which, it involves general application where the focus is on the process of generating image patterns that may be helpful in the understanding of the interaction between high-level human perception of images and low-level features [16],[17]. So, the latter may be the best one to lead the improvement in the accuracy of images retrieved from image databases. Image mining normally deals with the extraction of implicit knowledge, image data relationship, or other patterns not explicitly stored from the low-level computer vision and image processing techniques. i.e.,) the focus of image mining is the in the extraction of patterns from a large collection of images, the focus of computer vision and image processing techniques is in understanding or extracting specific features from a single image.

The main contributions of this paper are summarized as follows. Firstly, in this paper, we have provided brief survey of CBIR. Secondly, we have discussed how relevance feedback in content-based image retrieval is used and its current state of the art. Finally, comparison of image mining with other techniques. The paper is organized as follows. In section II, we discuss the related work. In section III, we discussed proposed system architecture. Finally, conclusion is presented in section IV.

II. RELATED WORK

The concept of relevance feedback was introduced into CBIR from the concept of text-based information retrieval in the 1998’s [6] and then has become a popular technique in CBIR. In 1998, Chang, et al.[18], proposed a framework, which allows for interactive construction of a set queries which detect visual concepts such as Sunsets. In 2001, Sclaroff, et al. [19], describes the first WWW image search engine, which focused on relevance feedback based improvement of the results. In their initial system, a relevance feedback was used to guide the feature selection process; it was found that the positive examples were more important towards maximizing accuracy than the negative examples.

In 2001, Rui and Huang [20], compared heuristic with optimization based parameter updating and found that the optimization based method achieves higher accuracy.

In 2001, Chen, et al.[21], described a one class SVM method for updating the feedback space which shows substantially improved results over previous work. In 2001, Guo, et al.[22], performed a comparison between AdaBoost and SVM and found that SVM gives superior retrieval results. In 2002, He, et al.[23], used both short term and long term perspectives to infer a semantic space from user’s relevance feedback for image retrieval. The long term perspective was found by updating the semantic space from the results of the short term perspective. In 2003, Dy, et al.[24], proposed a two level approach via customized queries and introduced a new unsupervised learning method called feature subset selection using expectation- maximization clustering. The proposed method doubled the accuracy for the case of a set of lung images. In 2004, Tieu and viola [25], proposed a method for applying the AdaBoost learning algorithm and noted that it is quite suitable for relevance feedback due to the fact that AdaBoost works well with small training sets. In 2005, Yin, et al.[26], found that combining multiple relevance feedback strategies gives superior results as opposed to any single strategy.

In [27], a unified log-based relevance feedback network for integrating log data of user feedback with regular relevance feedback for image retrieval was proposed. Here the framework first compute the relevance functions on the log data of user feedback and then combines the relevance information with regular relevance feedback for the retrieval task. In order to address the noisy log data problem in real world applications, a novel learning algorithm to solve the log-based relevance feedback problem was proposed. The proposed algorithm, named Soft Label support vector machines, is based on the solid regularization theory.

In [28], a relevance feedback image retrieval method based on PCA image classification was proposed. From the experiment it could be seen that more accurate classification result can be obtained by using PCA clustering algorithm. The proposed method can not only improve retrieval precision greatly but also reduce retrieval time and complexity. In [29], proposed the SSAIRA method was proposed, which addresses three special issues of relevance feedback i.e small sample size, asymmetrical training sample, and real time requirement. It was shown that the proposed SSAIRA method is superior to some existing methods. This method employs semi-supervised learning
and active learning simultaneously, which is beneficial to the improvement of the retrieval performance.

Current techniques in image retrieval and classification (two of the dominant tasks in Image Mining) concentrate on content-based techniques. Various systems like the QBIC, RetrievalWare and PhotoBook etc have a variety of features, but are still used in particular domains. Jain et al, use color features combined with shape for classification. Ma et al, use color and texture for retrieval. Smith and Chang, use color and the spatial arrangements of these color regions. Since perception is subjective, there is no single feature which is sufficient and, moreover, a single representation of a feature is also not sufficient. Hence multiple representations and a combination of features are necessary [30].

III. PROPOSED SYSTEM

Fig. 1 shows the general scheme of image retrieval from a database using relevance feedback. The basic idea of relevance feedback is to shift the burden of finding the right query formulation from the user to the system. In order to make this true, the user has to provide system with some information, so that system can perform well in answering the original query. To retrieve the image from the database, we first extract feature vectors from images (the features can be shape, color, texture etc), then store feature vectors into another database for future use. When given query image, we similarly extract its feature vectors, and match those features with database image features. If the distance between two images feature vectors is small enough; we consider the corresponding image in the database similar to the query. The search is usually based on similarity rather than on exact match, and the retrieval results are given to the user. Then user gives the feedback in the form of „relevance judgments” expressed over the retrieval results. The relevance judgments evaluate the results based on a three value assessment. These three values are relevant, non-relevant and don’t care.

Relevant means the image relevant to the user, non-relevant means the image is definitely not relevant, and don’t cares mean the user does not say anything about the image. If the user feedback is relevant, then feedback loop stops otherwise it continues until user get satisfied with results.

The content of image is grouped under three categories as:

1. High-texture detailed Image
2. Average-texture detailed Image
3. Low-texture detailed Image

Thereby, we can reduce the search space by one third of what was earlier. If we go more number of groups or less number of groups, they may reveal unnecessary overlapping overhead problems or may produce approximate results. So, the main focus on this classification is by making use of “textures” present in an image. This is because this texture-based classification is simple, easy and efficient for real time applications as compared to classifications based on Entropy method as well as segmentation based techniques. The primary objective of this work is to develop algorithms in order to create true databases from collections of multimedia data (specifically images) by mining content from the data offline in order to efficiently support complex queries at run-time [16].

In Fig. 1, the block diagram consists of following main blocks like image database, feature extraction, similarity measure, user feedback, and feedback algorithm. The function of each block is discussed below. Where U/R is the user satisfaction or result remains same.

![Figure 1: Proposed System Architecture](image)

A. Feature Extraction

Feature extraction involves extracting the meaningful information from the images. So that it reduces the storage required and hence the system becomes faster and effective in CBIR. Once the features are extracted, they are stored in the database for future use. The degree to which a computer can extract meaningful information from the image is the most powerful key to the advancement of intelligent image interpreting systems. One of the biggest advantages of feature extraction is that, it significantly reduces the information (compared to the original image) to represent an image for understanding the content of that image. There has been tremendous work on different approaches to the detection of various kinds of features in images.

These features can be classified as global features and local features. The most commonly used features are color, texture, and shape. They are all application independent.

1. Global Features: Global features should be calculated over the entire image. For example, average gray level, shape of intensity histogram etc. The advantage of global extraction is its high speed for both extracting features and computing similarity. Specifically, they can be oversensitive to location and hence fail to identify important visual characteristics. To increase the
robustness to spatial transformation, we can go for local feature extraction.

2. **Local Features**: In global features, the features are computed from the entire image. However, these global features cannot handle all parts of the image having different characteristics. Therefore, local features of the image are necessary. These features can be calculated over the results of image segmentation and edge detection algorithms, that is, they are all based on the part of the image with some special properties.

3. **Salient Points**: In local feature computation, the feature extraction of the image is limited to a subset of the image pixels; the interest points, the set of interest points are called salient points. The salient points are points of high variability in the features of the local pixel neighborhood. Many CBIR systems extract salient points [12][13]. In [14], they defined localized content-based image retrieval as a CBIR task, where the user is only interested in a portion of the image, and the rest is irrelevant. For example, we can refer to some local features as image primitives; circles, lines, texels (elements composing a textured region) other local features; shape of contours etc.

**B. Mining**

Image mining normally deals with the extraction of implicit knowledge, image data relationship, or other patterns not explicitly stored from the low-level computer vision and image processing techniques. i.e.) the focus of image mining is the in the extraction of patterns from a large collection of images, the focus of computer vision and image processing techniques is in understanding or extracting specific features from a single image.

**C. Similarity Measure**

In similarity measure, the query image feature vector and database image feature vector are compared using the distance metric. The images are ranked based on the distance value. It is proposed the detailed comparison of nine different metrics such as Manhattan, weighted mean-variance, Euclidean, Chebychev, Mahanobis etc distance for texture image retrieval with empirical evaluation. They found that Canberra and Bray-Curtis distance metrics performed exceptionally well than all other distance metrics.

**D. Image Retrieval**

Image Retrieval from the image collections involved with the following steps

i. Pre-processing
ii. Image Classification based on some true factor
iii. RGB processing
iv. Preclustering
v. Texture feature extraction Similarity comparison
   - **Pre-Processing**

Pre-processing is the name used for operations of images at the lowest level of abstraction. The aim of the pre-processing is an improvement of the image that suppresses unwilling distortions or enhances some image features, which is important for future processing of the images. This step focuses on image feature processing.

- **Noise Reduction Filtering**

Filtering is a technique for modifying or enhancing an image. The image is filtered to emphasize certain features or remove other features. The noise in the images is filtered using linear and non-linear filtering techniques. Median filtering is used here to reduce the noise.

Steps for median filtering

i. Read the image and display it. Add noise to it.
ii. Filter the noisy image with an averaging filter and display the results.
iii. Now use a median filter to filter the noisy image and display the results.

- **RGB Components Processing**

An RGB colour images is an M*N*3 array of colour pixels, where each colour pixel is a triplet corresponding to the red, green, and blue components of an image at a spatial location. An RGB image can be viewed as the stack of three gray scale images that, when fed into the red, green, blue inputs of a colour monitor, produce the colour image on the screen. By convention the three images form an RGB images are called as red, green and blue components.

- **Image Texture Classification**

The texture represents the energy content of the image. If an image contains more and high textures, then the energy will be high as compared to that of average and low texture images. So when combining the energy values defined for a local patch of an image the values will be high for highly textured areas and will be low for smooth areas. Also the local patches of same kind of textured areas will approximate same energy level. So it can be effectively called the “Texture Activity Index”. If it is tried to fit the energy values in to any distribution then the classification of images into High, Average and Low detail images can be easily and effectively done because the statistical parameters of the respective distribution will be different for all the three categories as because they possess different energy levels. The calculated MLE value varies for all the three kind of images. The boundaries for the three categories are fixed based on experimental values.

- **Image Clustering**

Clustering will be advantage for reducing the searching time of images in the database.

Fuzzy C-means (FCM) is one of the clustering methods which allow one piece of data to belong to two or more clusters. In this clustering, each point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster may be in the cluster to a lesser degree than points in the centre of cluster. FCM groups data in specific number of clusters.
Similarity Comparison

The retrieval process starts with feature extraction for a query image. The features for target images (images in the database) are usually precomputed and stored as feature files. Using these features together with an image similarity measure, the resemblance between the query image and target images are evaluated and sorted. Similarity measure quantifies the resemblance in contents between a pair of images. Depending on the type of features, the formulation of the similarity measure varies greatly. The Mahalanobis distance and intersection distance are commonly used to compute the difference between two histograms with the same number of bins. When the number of bins is different, the Earthmover’s distance (EMD) is applied. Here the Euclidean distance is used for similarity comparison.

Neighbouring Target Image Selection

Collections of target images that are “close” to the query image are selected as the neighbourhood of the query image. The major difference between a cluster-based image retrieval system and CBIR systems lies in the two processing stages, selecting neighbouring target images and image clustering, which are the major components of this image retrieval system. A typical CBIR system bypasses these two stages and directly outputs the sorted results to the display and feedback stage. This system can be designed independent of the rest of the components because the only information needed for the system is the sorted similarities. This implies that this module may be embedded in a typical CBIR system regardless of the image features being used, the sorting method, and whether there is feedback or not. The only requirement is a real-valued similarity measure satisfying the symmetry property.

E. User Feedback

After obtaining the retrieval results, user provides the feedback as to whether the results are relevant or nonrelevant. If the results are non-relevant the feedback loop is repeated many times until the user is satisfied. The typical scenario for relevance feedback in CBIR is as follows:

Algorithm: Typical scenario for relevance feedback in CBIR

Begin
Obtain the initial retrieval results of CBIR
Repeat until user satisfaction or result remains same
From user interaction, obtain the feedback from the users on prior results. Feedback is in the form of relevant or irrelevant to request.
If results found to be not satisfied
Learn the system through a feedback algorithm and hence results are refined
End repeat
End

IV. CONCLUSION

Relevance feedback is a powerful technique in CBIR systems, in order to improve the performance of CBIR effectively. In this paper, various RF techniques and issues are discussed in detail. The main objective of the image mining is to remove the data loss and extracting the meaningful potential information to the human expected needs. There are several Content Based Image Retrieval Systems existing in this present scenario. In this system, a new image retrieval technique based on clusters is introduced in order to reduce the searching time space. Moreover, the RGB components of the colour images are classified in different dimension in order to create Red, Blue and Green image clusters.

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