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Content Based Image Retrieval Methods Using Graphical Image Retrieval Algorithm (GIRA)

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ABSTRACT

This document gives a brief description of a system developed for retrieving images similar to a query image from a large set of distinct images. It follows an image segmentation based approach to extract the different features present in an image. These features are stored in vectors called feature vectors and compared to the feature vectors of query image and thus, the image database is sorted in decreasing order of similarity. Different from traditional dimensionality reduction algorithms such as Principal Component Analysis (PCA) and Linear Discriminate Analysis (LDA), which effectively see only the global Euclidean structure, GIRA is designed for discovering the local manifold structure. Therefore, GIRA is likely to be more suitable for image retrieval, where nearest neighbor search is usually involved. After projecting the images into a lower dimensional subspace, the relevant images get closer to the query image; thus, the retrieval performance can be enhanced.

Keywords: *CBIR, Multimedia information systems, image retrieval, relevance feedback Image feature extraction, Image analysis, Image search, Image similarity*

I. INTRODUCTION

The CBIR is motivated by the fast growth of digital image databases, which, in turn, require efficient search schemes. Rather than describing an image by using text, in these systems, an image query is described using one or more example images. The low level visual features (color, texture, shape, etc.,) are automatically extracted to represent the images. However, the low-level features may not accurately characterize the high-level semantic concepts. The image retrieval techniques based on visual image content has been in-focus for more than a decade. Many web search engines retrieve similar images by searching and matching textual metadata associated with digital images. The paper addresses and analyses challenges & issues of CBIR techniques/systems, evolved during recent years covering various methods for segmentation; edge, boundary, region, color, texture, and shape based feature extraction; object detection and identification. For better precision of the retrieved resultant images, this type of search requires associating meaningful image descriptive text labels as metadata with all images of the database. In real-world image retrieval systems, the relevance feedbacks provided by the user is often limited, typically less than 20, whereas the dimensionality of the image space can range from several hundreds to thousands. Manual image labeling, known as manual image annotation, is practically difficult for exponentially increasing image database. The image search results, appearing on the first page for fired text query rose black for leading web search engines Google, Yahoo and AltaVista. Many resultant images have lack semantic matching with the query, showing vast scope of research leading to improvements in the state-of-art-techniques.

The need evolved two solutions automatic image annotation and content based image retrieval. The content based image retrieval techniques aim to respond to a query image (or sketch) with query similar resultant images obtained from the image database. The database images are preprocessed for extracting and then storing indexing corresponding image features. The query image also gets processed for extracting features which are compared with features of database images by applying appropriate similarity measures for retrieving query similar Images. In the area of CBIR, it overcomes the difficulties of manual annotations by using visual feature based representations, such as color, texture, shape, etc. However, after over a decade of intensified.

The major bottleneck of this approach is the gap between visual feature representations and semantic concepts of images. Low-level contents often don't describe the high level. Semantic concepts in users minds. GIRA researcher considered to improve this burden, one promising direction towards semantic retrieval is the adoption of relevance feedback mechanism [8]. Many researchers focus on these relevance techniques because they are important in achieving a better precision rate [9]. The technique is a variation of "query by example" that involves multiple interactions with a user at search time[6]. It refers to the feedback from a user on specific items regarding their relevance to a target image, in each iteration, the refined query is re-evaluated.

Fig 1. Image search results for query – rose

Various techniques for extraction and representation of image features like histograms local (corresponding to regions or sub-image) or global , color layouts, gradients, edges, contours, boundaries & regions, textures and shapes have been reported in the literature. Histogram is one of the simplest image features. Despite being invariant to translation and rotation about viewing axis, lack of inclusion of spatial information is its major drawback. Many totally dissimilar images may have similar histograms as spatial information of pixels is not reflected in the histograms. Consequently, many histogram refinement techniques have been reported in the literature. Histogram intersection based method for comparing model and image histograms was proposed in[1] for object identification.

II. OPTIMAL LINEAR EMBEDDING

Histogram refinement based on color coherence vectors was proposed in [3]. The technique considers spatial information and classifies pixels of histogram buckets as coherent if they belong to a small region and incoherent otherwise. Though being computationally expensive, the technique improves performance of histogram based matching. Color correlogram feature for images was proposed in [2] which take into account local color spatial correlation as well as global distribution of this spatial correlation. The correlogram gives the change of spatial correlation of pairs of colors with distance and hence performs well over classical histogram based techniques. A modified histogram based technique to incorporate spatial layout information of each color with annular, angular and hybrid histograms has been proposed in [4]. In [5], cumulative histogram and respective distances for image similarity measures, overcoming quantization problem of the histogram bins was proposed.

The representation of color distribution features for each color channel based on average, variance and skewness, described as moments, for image similarity was also presented. Various segmentation techniques based on edge detection, contour detection and region formation have been reported in the literature. These techniques, in general, process low level cues for deriving image features by following bottom-up approach. Automatic image segmentation is a very crucial phase as the overall performance of retrieval results significantly depends on the precision of the segmentation. The most difficult task for any automatic image segmentation algorithm is to avoid under and over segmentation of images, possessing diversified characteristics. Hence, for required scale of segmentation, parameter tuning or threshold adjustment becomes unavoidable for versatile image segmentation algorithms. Directional changes in color and texture have been identified in [10], using predictive color model to detect boundaries by iteratively propagating edge flow.

This iterative method is computationally expensive because of processing of low level cues at all pixels for given scale's novel hierarchical classification frame work based approach for boundary extraction with Ultrametric Contour Maps UCM - representing geometric structure of an image has been proposed in [7]. A generic grouping algorithm based on Oriented Watershed Transform and UCM [7] has been proposed in [6] to form a hierarchical region tree, finally leading to segmentation. The method enforces bounding contour closures, avoiding leaks aroot cause of under segmentation. Exhaustive precision recall evaluation of OWT-UCM technique for different scales also has been presented. Region based image retrieval, incorporating graphs, multiple low level labels and their propagation, multilevel semantic representation and support vector machine has been proposed in [14],implying effectiveness of the method. In [14], the models and techniques were used to merge textual and image features to classify images. Lu [15] proposed the framework of relevance feedback technique to take advantage of the semantic network on top of the keyword association on the images in addition to the low-level features.

Chang [6]further improved this framework using the probabilistic output of SVM to perform annotation propagation in order to updating unlabeled images in addition to labeled images. [7] Proposed a unified image retrieval framework based on both keyword annotations and image visual feature. For each keyword, a statistical model is trained by using visual feature of labeled images. Moreover, an effective update keyword models using newly labeled images periodically approach is proposed. However, the common limitation of this framework is the keyword models built from visual feature of a set of images are labeled with semantic keywords. In this paper, we utilize the search engine to retrieve a large number of images using a given text-based query. In the low-level image retrieval process, the system provides a similar image search function for the user to update the input query for image similarity characterization.

III. PROPOSED GIRA ALGORITHM

The proposed scheme is not the same as the existing framework of unifying keywords and visual content systems. The key word models built from visual feature of a set of images are labeled with keywords. It incorporates an image analysis algorithm into the text-based image search engines. Moreover, it is implemented on real-world image database. A high-level semantic retrieval can be done by using relevance images from Yahoo image search engine. For low-level feature, we introduce a fast and robust color feature extraction technique namely auto color correlogram and correlation (ACCC) based on color correlogram (CC)[7] and auto correlogram (AC) [7] algorithms, for extracting and indexing low-level features of images. The retrieval performance is satisfactory and higher than the average precision of the retrieved images using auto correlogram (AC). Moreover, It can reduce computational time from O(m2d) to O(md) [8]. The framework of multi-threaded processing is proposed to in corporate an image analysis algorithm into the text based image search engines. It enhances the capability of an application when downloading images, indexing, and comparing the similarity of retrieved images from diverse sources.

$$y_i(x_i^T w = b) \geq 1 - \xi_i, \forall i = 1...n \qquad (1)$$

A brief summary of GIRA of the CBIR systems has been presented in this section. QBIC - Query By Image Content system, developed by IBM, makes visual content similarity comparisons of images based on properties such as color percentages, color layout, and textures occurring in the images. The query can either be example images, user-constructed sketches and drawings or selected color and texture patterns [6] [7]. The IBM developed QBIC technology based Ultimedia Manager Product for retrieval of visually similar images [8]. Virage 35] and Excalibur are other developers of commercial CBIR systems. Visual Seek- a joint spatial-feature image search engine developed at Columbia university performs image similarity comparison by matching salient color regions for their colors, sizes and absolute & relative spatial locations[9][3]. Photo book developed at Media Laboratory, Massachusetts Institute of Technology – MIT for image retrieval based on image contents where in color, shape and texture features are matched for euclidean, mahalanob is, divergence, vector space angle, histogram, Fourier peak, and wavelet tree distances. The incorporation of interactive learning agent, named Four Eyes for selecting & combining feature-based models has been a unique feature of Photo book [11]. MARS - Multimedia Analysis and Retrieval Systems [12] and FIRE- Flexible Image Retrieval Engine [13] incorporate relevance feedback from the user for subsequent result refinements. Similar images are retrieved based on color features, Gabor filter bank based texture features, Fourier descriptor based shape features and spatial location information of segmented image regions in NeTra [14].For efficient indexing, color features of image regions has been represented as subsets of color code book containing total of 256 colors.

The frame work proposed in [10] has been incorporated for image segmentation in NeTra. Pic GIRA (Picture & Self-organizing Map) was implemented using tree structured GIRA, where GIRA was used for image similarity scoring method [3]. Visual content descriptors of MPEG-7 (Moving Pictures Expert Group Multimedia Content Description Interface) were used in Pic GIRA [6] for CBIR techniques and performance comparison with Vector Quantization based system was proposed in [3]. Incorporation of relevance feedback in it caused improvements in the precision of results of Pic GIRA. SIMPLIcity Semantics sensitive Integrated Matching for Picture Libraries incorporates integrated region matching methodology for overcoming issues related to improper image segmentation. The segmented images are represented as sets of regions. These regions, roughly corresponding to objects are characterized by their colors, shapes, textures and locations. The way of distance computation was inspired by the paper[5], where the detailed description of the method can be found. To measure the distance on the basis of the part **v**CLD the method was modified to deal with the three values referring to the three components of a color.

The distance is transformed into the range (0-100). In particular 0 means the same image. The example of visual distance calculation between a query image and each of images in the database. For the query image the similarity vector to each image in the base is obtained. In the performed experiments weights wFCTH and wCEDD were set to 2, because these descriptors have the best individual retrieval scores. Remaining weights were equal to 1.The second component in evaluation of images similarity takes into account emotional aspect and is based on the vector**e**. For every matching label, 1 is added to a temporal result and then the final number is casted on the range 0-100, with0 denoting maximal similarity. The query image is described by a vector of emotional similarities to each database image. Finally, both results (visual and emotional) are added and divided by 2. This is the final answer of the system. In a case with multiple query images, an average from all rankings is taken. Twelve images from the database with the smallest values are presented to the user.

IV. IMAGE BROWSING EXAMPLE

Query based on texture properties will have many applications in image and multimedia databases. Here, we describe with an example our current work on incorporating these features for browsing large satellite images and air photos. This work relates to the UCSB Alexandria digital library project [11] whose goal is to create a digital library of spatially indexed data such as maps and satellite images. Typical images in such a database range from few megabytes to hundreds of megabytes, posing challenging problems in image analysis and visualization of data. Content based retrieval will be very useful in this context in answering queries such as "Retrieve all LANDSAT images of Santa Barbara which have less than 20% cloud cover," or "Find a vegetation patch that looks like this region."We are currently investigating the use of texture primitives to accomplish rapid content based browsing within an image or across similar images.

The example of browsing 5,248 x 5,248air photos. The original image is analyzed in blocks 128 x 128 pixels and the texture features are computed and stored as image "meta-data." The user can select any position and use that pattern to search for similar looking regions. Our current work is on incorporating simple texture based segmentation schemes into this browsing thus allowing arbitrarily shapeoi regions into the analysis. Percentage of correctly assigned labels is used as measurement of system's efficiency because more common measures like recall and precision cannot be used here. The system hasto return 12 pictures in every run, so there is no possibility to define a set of false positives (even if GIRA pictures score less than others, they are still present in results as complement to true positives). Moreover, if more than 12 images in the database are similar to the query image, the system has no possibility to show them all as a result. As it can be seen in Table II, the network trained on a more general learning set (LS3) performs better than the one trained on less general one (LS1).

The most problematic categories are basic emotions and positive-negative. It proves that emotional content of pictures cannot be fully expressed only with chosen by us visual descriptors. The network was trained two times on learning set LS3(starting from random values of weights) and answers of the network from both trials were compared. Only in 17% of cases both networks were wrong and most of these mistakes were connected to basic emotions, which were not possible to be discovered without semantic knowledge about the picture. In20% of cases one of the networks was wrong. Emotion filter is a tool which uses vector **e** to produce final similarity score between two pictures. Without it, only vector **v** is used. To evaluate an input of an emotion filter to the final result, the same tests as in the subsection IV-B were run, but without calculating the vector of emotional distance between pictures. It is clear that emotions are important in the image retrieval process and improve results of traditional CBIR systems. In the EBIR

$$\min_w \frac{1}{2}\|w\|^2 + C\sum_{i=1}^{n}\xi_i \qquad (2)$$

system, more adequate pictures are found and it is done faster. Moreover, it can be noticed that the number of not relevant images (for example green building returned for tropical forest query) decreases when emotions' filter was used. Quality of results is higher for the system with the filter, what supports our theory.

V. THE PROPOSED FRAMEWORK

The GIRA before introducing our framework of multi-threading for a joint querying image search scheme, we will briefly examine the properties of the queries to be answered. The query modalities require different processing methods and support for user interaction. We can characterize query processing from a system perspective including text-based, content-based, composite, interactive-simple, and interactive-composite [9].Our retrieval model is interactive-composite because it integrates multi-model information (associated text, visual similarity, and user's feedbacks) for providing search results. We have developed a novel framework of real-time processing for an on-line CBIR system, using relevance images from Yahoo images search.

This method uses the following major steps: (a) Yahoo Images is first used to obtain a large number of images that are returned for a given text-based query; (b) The users can select any certain images to perform an update the input query for image similarity characterization; (c)A multi-threaded processing method is used to manage and perform data parallelism or loop-level parallelism such as downloading images, extraction of visual features and computation of visual similarity measures.(d) If necessary, users can also change a keyword before selecting a relevance image for the query; (e) The updated queries are further used to adaptively create a new answer for the next set of returned images according to the users' preferences.

$$y_i(x_i^T w + b) \geq 1 - \xi_i, \xi_i > 0 \qquad (3)$$

The image indexation and similarity measure computation of images are complex processes and they are an obstacle for the development of a practical CBIR system. Especially, when it is developed based on a real-time process optimization approach. There are a number of papers concerning parallel computing for image processing [10] [11] [12] , For instance, Yongquan Lu, et al [3] presented a parallel technique to perform feature extraction and a similarity comparison of visual features, developed on cluster architecture. The experiments conducted show that a parallel computing technique can be applied that will significantly improve the performance of a retrieval system. Kao, et al [4] proposed a cluster platform, which supports the implementation of retrieval approaches used in CBIR systems.

$$COST = \sum_{1 \leq i < H} a(i,j)(i+1,k)J - 1 \leq k \leq j+1 \qquad (4)$$

Their paper introduces the basic principles of image retrieval with dynamic feature extraction using cluster platform architecture. The main focus is workload balancing across the cluster with a scheduling heuristic and execution performance measurements of the implemented prototype. Although, cluster computing is popularly used in images retrieval approaches, it only attacks this problem at the macro level. Fortunately, with the increasing computational power of modern computers, GIRA of the most time-consuming tasks in image indexing and retrieval are easily parallelized, so that the multi-core architecture in modern CPU and multi-threaded processing may be exploited to speed up image processing tasks. It is possible to incorporate an image analysis algorithm into the text-based image search engines such as Google, Yahoo, and Bing without degrading their response time. Multi-threading is not the same as distributed processing.

VI. FEATURE EXTRACTION

There are various visual descriptors used to extract a low-level feature vector of an image[3]. However, in this paper, we used color descriptors for retrieving images. The color the texture database used in the experiments consists of 116 different texture classes. Each of the 512 x 512 images is divided into16 128 x 128 no overlapping sub images, thus creating a database of 1,856 texture images. A query pattern in the following is anyone of the 1,856 patterns in the database. This pattern is then processed to compute the feature vector as in (7). The distance d(i, j),where i is the query pattern and j is a pattern from the database, is computed. The distances are then sorted in increasing order and the closest sets of patterns are then retrieved. Correlogram is an efficient feature extraction techniques used in content-based image retrieval (CBIR) systems. The technique, namely color correlogram, is widely used for finding the spatial correlation of each color in an image. It was introduced by Huang J. et al [7]. The technique was implemented and it was found that the retrieval performance of a color correlogram was better than the standard color histogram and the color coherence vector methods. However, the color correlogram is expensive to compute and the computation time of the correlogram is O(m2d). The authors also present a technique that captures the spatial correlation between identical colors called an auto correlogram with a computation time of O(md).However, an auto correlogram only captures the distribution of each color in the image. The disadvantages are: 1) the color correlogram has computation complexity, and 2) the auto correlogram mainly captures the distribution of each color in the images. They mainly capture spatial information of the colors. In this section, we present an efficient color feature extraction algorithm for low-level feature similarity in query process, namely Auto Color Correlogram and Correlation (ACCC) [8], The retrieval performance is satisfactory and higher than the average precision of the retrieved images using auto correlogram(AC). The ACCC is the integration of Auto correlogram and Auto Color Correlation techniques [6]. It is a fast and robust algorithm for spatial color feature extraction for image indexing.

VII. EXPERIMENTAL RESULT

We have implemented a joint querying image search scheme using the Yahoo image database based on the Evaluation of retrieval performance is a crucial problem in Content-Based Image Retrieval (CBIR).Many different methods for measuring the performance of a system have been created and used by researchers. We have used the most common evaluation methods namely, Precision and Recall Yahoo BOSS' API.

The application are developed by using Microsoft .NET and implemented on Quad Intel Xeon processor E5310 1.60 GHz, 1066 MHz FSB 1 GB (2 x 512 MB) PC2-5300 DDR2, and tested on the Windows NT environment. The goal of this experiment is to show that relevant images can be found after a small number of iterations, the first round was used in this experiment. From the viewpoint of user design, precision and recall measures are less appropriate for assessing an interactive system evaluate the performance of the system in terms of user feedback user-

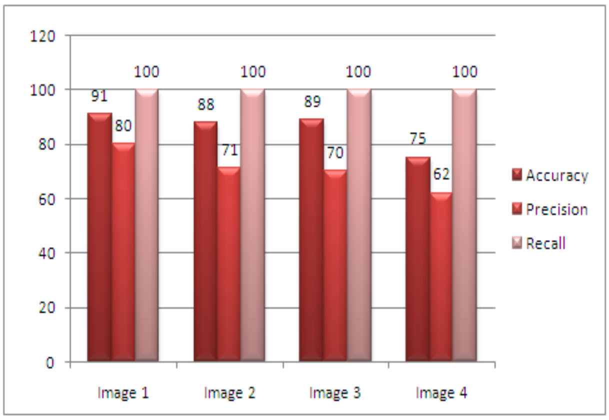

Fig 2. Comparison of the traditional Yahoo text-based search and our scheme with the GIR algorithm

orientation measures are used. There have been other design factors proposed such as relative recall, recall effort, coverage ratio, and novelty ratio [4]. In this experiment the coverage ratio measure is selected. Let R be the set of relevant images of query q and A be the answer set retrieved.

Table 1: Number of Representatives GIRA

Sample Data		Test 1	Test 2	Test 3	Total
Tested Set	Tested Image	860	750	600	2210
	% Tested	91.4	88.2	89.9	
Trained Set	Trained Image	150	120	110	380
	% Tested	87.9	88.2	91.4	

Table 1. Number of training image of GIRA

It also decreases the opportunity of the images in other categories to be retrieved. In the experiment, we used two sample images obtained from the keyword search to test querying images for evaluating the performance of the system.

VIII. CONCLUSION

This paper presents a novel manifold learning algorithm, called GIR, for image retrieval. In the first step, we construct a between-class nearest neighbor graph and a within-class nearest neighbor graph to model both geometrical and discriminate structures in the data. The standard spectral technique is then used to find an optimal projection, which respects the graph structure. This way, the Euclidean distances in the reduced subspace can reflect the semantic structure in the data to some extent. The proposed framework can be efficiently merged textual and image features for image retrieval systems. To incorporate an image analysis algorithm into the text-based image search engines without degrading their response time, the framework of multi-threaded processing is developed. In a high-level semantic retrieval system, we utilized the search engine to retrieve a large number of images using a given text based query. In low-level image retrieval process, the system provides a similar image search function.

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