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Overview of Image Retrieval Techniques

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Abstract: As the tremendous growth in the volume of images as well as the widespread application in multiple fields, the requirements for development of image retrieval techniques are enhanced. The image retrieval is an interesting and rapidly growing methodology in all fields. It is an effective and well organized approach for retrieving the image. In the other end, image mining is the arising concept which can be used to extract potential information from the collection of images. Image mining is the process of searching and discovering valuable information and knowledge from large volumes of data. It is an extension of data mining techniques for images. It handles the hidden knowledge extraction, image data association and additional patterns which are not clearly accumulated in the images. In this paper we provide an overview of the fundamental theories and emerging techniques for Image Retrieval and image mining, as well as several extended work in these areas.

Keywords: Image retrieval, Image features, Extraction, Color models, Texture, Shape, Content based image retrieval.

I. INTRODUCTION

As computer technologies become worldwide, besides numerical and categorical data, various digitalized images, sounds, voices, and videos have become part of daily life. Plenty of knowledge can be hidden in these data, it is since1970th people devoted themselves into image retrieval research, and then text based image retrieval technology and context web retrieval technology were proposed, which in a certain extent solved some image retrieval and resource discovery problems. However, people are not satisfied with only being able to access information, because through image retrieval people can only find out the relative information they want, they can't dig out valuable knowledge hidden in large sets of image data [1].

Thus, image mining was introduced, Image mining concerns the extraction of implicit knowledge, image data relationship, or other patterns not explicitly stored in the images. It is more than just an extension of data mining to image domain. Image mining is an interdisciplinary endeavor which draws upon expertise in computer vision, image understanding, data mining, machine learning, database, and artificial intelligence. Some methods allow image mining to have two different approaches. First method extracts images from image databases or collection of images. Second method mines a combination of associated alphanumeric data and collection of images. Research in Image mining can be broadly classified in two main directions (1) Domain specific applications (2) General applications. Both are used to extract most relevant image feature and later to generate image patterns. A vast amount of image data is generated in daily life and in various fields like medical, astronomy, sports and all kinds of photographic images. It is still at the experimental stage and growing field of research.

Lack of understanding in the research issues of image mining is the obstacle to rapid progress. The fundamental challenge in image mining is to reveal out the knowledge relating to the images from the web pages [1]. Image mining process can be visualized as in fig-1.

Image retrieval systems attempt to search through a database to find images that are perceptually similar to a query image. Content based image retrieval (CBIR) is an important alternative and complement to traditional text-based image searching and can greatly enhance the accuracy of the information being returned.

It aims to develop an efficient visual-Content-based technique to search, browse and retrieve relevant images from large-scale digital image collections. Most proposed CBIR techniques automatically extract low-level features (e.g. color, texture, shapes and layout of objects) to measure the similarities among images by comparing the feature differences.

In early era of this emerging filed the image was retrieved by text description called as Text Based Image Retrieval [TBIR].Complete surveys of this technique can be viewed in Chang S.K. and Hsu A [2]. All text based image retrieval systems require the text description with images in large scale data bases and manually this task is not feasible. As a result, text based image retrieval systems were not applicable for task dependent queries [3]. Image retrieval process can be visualized as in fig-2.

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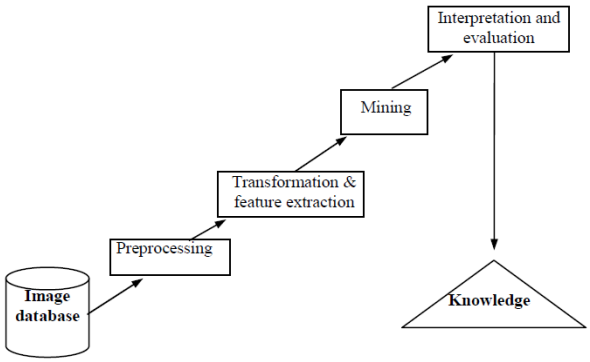

Fig-1 Image Mining Process [4]

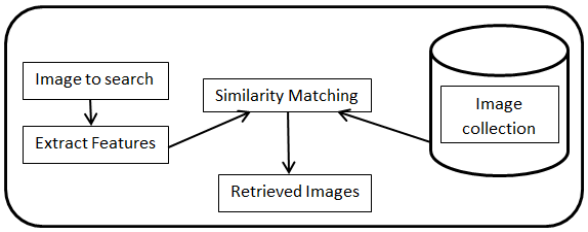

Fig-2 General Image Retrieval Process [5]

This paper is organized as follow: Over view of image mining techniques and works in this area Section II, Section III provides overview of Image Retrieval techniques and extended works in this area, Applications of image mining and image retrieval methods in section IV, and last section concludes the paper.

II. IMAGE MINING AND RELATED WORKS

There has been a steadily growing interest in image mining. Image mining is a technique which handles the mining of information, image data association, or additional patterns not unambiguously stored in the images. It utilizes methods from computer vision, image processing, image retrieval, data mining, machine learning, database, and artificial intelligence [6]. Rule mining has been implemented to huge image databases in 1999[7]. There are two most significant techniques. The first technique is to mine from huge amount of images alone and the second technique is to mine from the integrated collections of images and related alphanumeric data. Rule mining technique is exploited to determine relations between structures and functions of human brain. An image mining algorithm using blob required to be carry out the mining of relations within the context of images is provided by Zaiane& Han [8].

The main intention of image mining is to produce all considerable patterns without any information of the image content, the patterns types are different. They could be classification patterns, description patterns, correlation patterns, temporal patterns and spatial patterns. Image mining handles with all features of huge image databases which comprises of indexing methods, image storages, and image retrieval, all regarding in an image mining system[9]. The establishment of an image mining system is frequently an intricate process because it implies joining diverse techniques ranging from image retrieval and indexing schemes up to data mining and pattern recognition. Further, it is anticipated that a good quality image mining system provides users with a useful access into the image storage area at the same time it recognizes data patterns and generates knowledge beneath image representation. Such system basically be supposed to bring together the following functions: image storage, image processing, feature extraction, image indexing and retrieval and, pattern and knowledge discovery.

Image mining is just at its infancy, however, observing from some of the existing image mining systems, overall process can be divided into the following parts:

A. Data preprocess

Image mining deals with large collection of image datasets that are high-dimensional and have multiple features, so time and space cost are relative high when analysis them. There exist a lot of dirty and noisy data in large image databases, for instance, images that are extremely unclear and images that are already breached. Those data often cause chaos in mining process and give birth to bad mining results, so it is necessary to preprocess data, clean up the noisy, broken, dirty data. In order to improve quality and efficiency of the following mining steps, it is vital to discover suitable preprocessing technologies to clean up the un-related data and make useful hidden information more obvious. Traditional image processing technologies are applied to the image data ready to be mined. Some image preprocess has been introduced, for instance, Han propose a palm-print-based identification system in [10], the pre-processing steps including image-thresholding ,border tracing and wavelet-based segmentation, the preprocessing method is proved to be effective and can be simulated in other scenarios as well.

B. Extracting multi-dimensional feature vectors

One of the key problems is how to express image data, which can usually be represented by features such as texture, color, edge, shape. According to the mining object, extract the basic elements that can present the images, omit features in essential to mining result. In some cases, to get better mining result, it is necessary to converge many features to form multidimensional feature vectors. Color, edge, texture are very important features in image mining and are widely used. [11] Presents a feature extraction method that uses a combination of features: color, edge, texture, the method achieves high recall and precision. Using image processing technologies such as image segmentation, picking up the edge to extract task-related feature vectors, form multi-dimensional feature vectors.

C. Mining on vectors and acquire high-level knowledge

Most commonly used image mining technologies are image classification, image clustering, mining association

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rules and neural network. Various methods such as object recognition, image indexing and retrieval, image classification and clustering, neural network are used on feature vectors for mining and acquiring hidden and valuable high-level knowledge, then evaluate and explain that knowledge.

1) Image classification

Image classification is to do quantity analysis on image, and, it is a supervised learning method, a set of pre-labeled images are provided, then based on prior knowledge, tag the new images with suitable labels, often there are three processes involved in image classification:(1): Feature extraction, first build up a image representation model, extract features from sample images that are already labeled and establish feature description for each image; (2): Train the samples of each class and establish model description for each class; (3): Use the model to classify and index images that are not labeled. The most commonly used image classification technologies are as follows: Bayes, neural network, decision tree, support vector machine, K-nearest–neighbor-classifier, genetic algorithm etc. Performance of a classifier is normally measured by accuracy of prediction, speed, robustness, extensibility.

2) Image clustering

The process of grouping a set of images into classes of similar images without prior knowledge is called image clustering. It is a unsupervised learning method, images within a cluster have high similarity in comparison to one another but are very dissimilar to images in other clusters. The process normally comprises of 4 steps: (1) Image representation, feature extraction and selection; (2) Set up similarity metrics suitable for special application; (3) Image clustering; (4) Form clusters. After clustering, field experts are required to examine each cluster and label it with abstract concepts. Nowadays there are many clustering algorithms such as: partitioning methods, hierarchical methods, grid-based methods, model-based methods, etc.

3) Association rules mining

Association rule mining finds interesting associations and correlation relationships among large set of image data. Association rules show attributes value conditions that occur frequently together in a given dataset. Association rule mining consists of first finding frequent item sets, from which strong association rules are generated. These rules also satisfy a minimum confidence threshold. In recent years, association rule mining has become a heated problem and draws upon wide attention. Apriori is a typical algorithm for association rule mining, based on which there are a lot of improvement, for example, in [12], Anthony proposes a novel spatial mining algorithm to mine the spatial association rules from an image database, which prunes most of impossible candidates in the mining process, thus the proposed algorithm is more efficient than the Apriori algorithm. The experiment results show that it runs 2–5 times faster than the Apriori algorithm.

III. IMAGE RETRIEVAL AND RELATED WORKS

Popular knowledge claims that an image is worth 1000 words. Unfortunately, these 1000 words may differ from one individual to another depending on their perspective and/or knowledge of the image context. Thus, even if a 1000 word image description were available, it is not certain that the image could be retrieved by a user with a different description. The image retrieval is an interesting and fastest developing methodology in all fields. It is an effective and well organized approach for retrieving the image.

Image retrieval techniques are splitted into two categories text and content-based categories. The text-based algorithm comprises some special words like keywords. Keywords and annotations should be dispenses to each image, when the images are stored in a database. The annotation operation is time consuming and tedious. In addition, it is subjective. Furthermore, the annotations are sometimes incomplete and it is possible that some image features may not be mentioned in annotations [13]. In a CBIR system, images are automatically indexed by their visual contents through extracted low-level features, such as shape, texture, color, size and so on [13, 14]. However, extracting all visual features of an image is a difficult task and there is a problem namely semantic gap in the semantic gap, presenting high-level visual concepts using low-level visual concept is very hard. In order to alleviate these limitations, some researchers use both techniques together using different features. This combination improves the performance compared to each technique separately [15, 16]. Many image retrieval systems, both commercial and research, have been built.

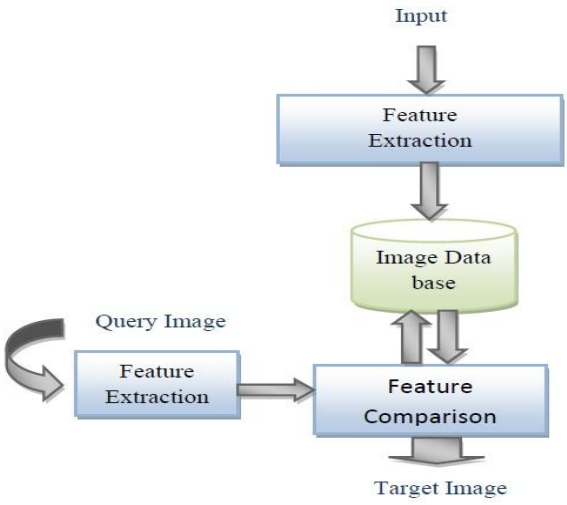

Fig-3 Typical Image Retrieval Process

Most image retrieval systems support one or more of the following options:

- random browsing

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- search by example
- search by sketch
- search by text (including key word or speech)
- navigation with customized image categories

We have seen the provision of a rich set of search options today, but systematic studies involving actual users in practical applications still need to be done to explore the trade-offs among the different options mentioned above.
Content-based image retrieval (CBIR) was originated in 1992, by scientist T.Kato. He was found it during the time when he is doing the experiments about the retrieval of images from a small database by using their visual content. Pattern recognition, signal processing, linear systems and machine vision areas are used to create the techniques, tools and algorithms that are used in CBIR.

The more recent works in the area of content based image retrieval consists of Relevance feedback, Radial basis function networks and fuzzy approaches. These three help to add more human interaction with the CBIR systems, thus significantly reduces the time for retrieving the output. Relevance feedback is a technique to overcome the semantic gap, where users provide feedback on the relevance of the retrieved images by the system, and this information is given back to the system for learning the user information needs. Important relevance feedback algorithms includes query refinement, re-weighting, Bayesian learning, optimal learning over heuristic-based feature weighting, artificial neural networks , discriminant-EM algorithm, and kernel-based learning etc., these have been adopted in CBIR systems and demonstrated considerable performance improvement. Fuzzy logic is a logic that deals with reasoning which is approximate rather than fixed and exact. Compared to traditional binary sets fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been expected to handle the partial truth information concept, where the truth value may range between true and false that is partial information needs. Fuzzy deals with concepts that cannot be expressed as relevant or irrelevant but rather as partially relevant. The other approaches such as genetic algorithms and neural networks can perform as equal to fuzzy logic in many cases, fuzzy logic has the advantage that the problem solution can be cast in terms that human users can understand. Therefore fuzzy logic can be able to include more human interaction in the retrieval process. Fuzzy Radial Basis function networks are neural networks which perform the process in sessions. If the CBIR system is in real time, then RBF networks are the best. Moreover they have fast learning speed, simple network structure and global generalization power. Fuzzy logic for the interpretation of the texture queries for content-based image retrieval is latest and effective technique.

Some extended works in this area are, a new technique called Image retrieval based on optimum clusters is proposed for improving user inter-action 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. In this, a new method for image classification is formulated in order to reduce the searching time of images from the image database [17].

A method for color image indexing by exploiting the simplicity of the Error Diffusion Block Truncation Coding (EDBTC) method. A feature descriptor obtained from a color image is constructed from the EDBTC encoded data (two representative quanitzers and its bitmap image) by incorporating the Vector Quantization(VQ).The CHF effectively represents the color distribution within an image, while the BHF characterizes the image edge and texture[18]. To solve the problem of Object-Centric Content Based Image Retrieval (CBIR), motivated by concepts from theory of cognitive sciences. According to cognitive models, there are two lobes in human brain; one is responsible to solve the problem of object recognition, while the other solves the problem of localization (or detection).

It is the exchange of mutual information (back and forth) between these two lobes which enables the human brain to simultaneously detect and recognize the objects in a complex scene[19]. For content-based image retrieval (CBIR) by exploiting the advantage of low complexity ordered-dither block truncation coding (ODBTC) for the generation of image content descriptor. In the encoding step, ODBTC compresses an image block into corresponding quantizers and bitmap image. Two image features are proposed to index an image, namely, color co-occurrence feature (CCF) and bit pattern features (BPF), which are generated directly from the ODBTC encoded data streams without performing the decoding process. The CCF and BPF of an image are simply derived from the two ODBTC quantizers and bitmap, respectively, by involving the visual codebook [20]. A new application of a well-studied image coding technique, namely block truncation coding(BTC). It is shown that BTC can not only be used for compressing color images, it can also be conveniently used for content-based image retrieval from image databases. From the BTC compressed stream (without performing decoding), They derive two image content description features, one termed the block color co-occurrence matrix (BCCM) and the other block pattern histogram (BPH).They use BCCM and BPH to compute the similarity measures of images for content-based image retrieval applications[21].

A Content based image retrieval method is a modification in original block truncation coding (BTC) for content based image retrieval system. Texture features are found by calculating the standard deviation of the Gabor filtered image. Gabor Filter Modified Block Truncation Coding based feature vector is extracted then compared with corresponding feature vector of images stored in the database. Images are retrieved based on the similarities features [22]. A survey some technical aspects of current

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content-based image retrieval systems and described the image segmentation in image processing and the features like neuro fuzzy technique, color histogram, texture, and shape for accurate and effective Content Based Image Retrieval System after doing the deep study of related works[23]. Content based image retrieval system in Hadoop framework. The Hadoop-CBIR developed in this work has immense potential to be used in various other fields in addition to medicine. Hadoop has been used in this work to set up a grid in a large scale environment which supports large amount of data processing. Hadoop distributed File system (HDFS) is used to store and retrieve medical images. Application developed using the proposed approach is fast and efficient in retrieving medical images. It also facilitates accurate retrieval of images matching the queried image [24].

A model for content-based image retrieval (CBIR) which depends only on extracting the most relevant features according to a feature selection technique. The suggested feature selection technique aims at selecting the optimal features that not only maximize the detection rate but also simplify the computation of the image retrieval process. The proposed model is divided into three main techniques, the first one is concerned with the features extraction from images database, the second is performing feature discrimination, and the third is concerned with the feature selection from the original ones[25]. A new method for image retrieval using high level semantic features is proposed. It is based on extraction of low level color, shape and texture characteristics and their conversion into high level semantic features using fuzzy production rules, derived with the help of an image mining technique [26].

Effective color image retrieval scheme for combining all the three i.e. color, texture and shape information, which achieved higher retrieval efficiency. Firstly, the image is predetermined by using fast color quantization algorithm with clusters merging, and then a small number of dominant colors and their percentages can be obtained. Secondly, the spatial texture features are extracted using a steerable filter decomposition, which offers an efficient and flexible approximation of early processing in the human visual system. Thirdly, the pseudo-Zernike moments of an image are used for shape descriptor, which have better features representation capabilities and are more robust to noise than other moment representations. Finally, the combination of the color, texture and shape features provide a robust feature set for image retrieval [27].

IV. APPLICATIONS OF IMAGE MINING AND IMAGE RETRIEVAL

Image mining is a future trend, although it is a new research area, its development shows great potential, as far as now its application has expanded to various domains and gained good results. Mining on medical images is to acquire valuable knowledge and modes, which can later be used for discovering abnormal situations not consistent with the previous common modes. This can act as a reference and help doctors diagnose diseases. [27] Presents a new image mining technique for brain tumor classification using pruned association rule, which combines the low-level features extracted from images and high level knowledge from specialists. The method can classify the CT scan brain images into three categories namely normal, benign and malign. It can assist the physicians for efficient classification with multiple keywords per image to improve the accuracy.

The experimental result on pre-diagnosed database of brain images showed 96% and 93% sensitivity and accuracy respectively. Image mining can also be used on satellite cloud imagery, Asanobu use SOM (Self-Organizing Feature Map) neural network to do image clustering on Typhoon image collections [28], and use the data mining methods to analysis typhoon patterns and predict typhoon. Edward etc apply a new clustering method and build up a system called RIME for detecting copying unauthorized image on the internet, the system first cluster similar images, then index each cluster, it achieves high accuracy[29].

Content Based Image Retrieval has many applications in almost all fields of life.

- Some software manufactures are using CBIR based applications into the internet medium and law enforcement fields for identifying the criminals and to censor the images with skin-color.
- Zoomy Images, a stock photo enhanced its service by utilizing CBIR in its Visually Similar Images and Reverse Image Search functions, allowing clients to view more accurate search results.
- Art Collections Example: - Fine Arts Museum of San Francisco.
- Medical Image Databases Example:-CT, MRI, Ultrasound,
- Scientific Databases Example:-Earth Sciences
- General Image Collections for Licensing
- Architectural and engineering design.
- Fashion and publishing

V. CONCLUSION

With the increasing demands of multimedia applications over the Internet, the importance of image mining and image retrieval has also increased. Currently, many new schemes are proposed in the field of Image Mining and Retrieval. In this paper we provide an overview of the fundamental theories and emerging techniques for Image Retrieval and image mining, as well as several extended work in these areas. All these techniques have their own advantages as well as certain limitations. In other words, there is not a single technique that fits best in all sorts of user's requirements; therefore, the doors are still open to

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keep inventing new methodologies according to the requirements of image mining and retrieval applications.

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