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REVIEW ARTICLE

Content Based Image Retrieval: A Review Paper

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Abstract

Content-based image retrieval (**CBIR**) is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. The term "content" in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself. CBIR has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features. CBIR is desirable because most web-based image search engines rely purely on metadata and this produces a lot of garbage in the results. Also having humans manually enter keywords for images in a large database can be inefficient, expensive and may not capture every keyword that describes the image. This paper describes a system that can filter images based on their content and provide better indexing and return more accurate results.

Keyword: CBIR, Image processing, Feature Extraction

1. INTRODUCTION

Content-based image retrieval (**CBIR**) is a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape. **CBIR** is also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR)[1]. It is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital images in large databases. Problems with traditional methods of image indexing have led to the rise of interest in techniques for retrieving images on the basis of automatically-derived features such as color, texture and shape – a technology now generally referred to as *Content-Based Image Retrieval* (CBIR). However, the technology still lacks maturity, and is not yet being used on a significant scale. CBIR technology is now beginning to move out of the laboratory and into the marketplace, in the form of commercial products like QBIC. Content-based image retrieval, uses the visual contents of an image such as *color*, *shape*, *texture*, and *spatial layout* to represent and index the image. CBIR draws many of its methods from the field of image processing and computer vision, and is regarded by some as a subset of that field. Image processing covers a much wider field, including image enhancement, compression, transmission, and interpretation.

2. CONTENT BASED IMAGE RETRIEVAL SYSTEM

Image Retrieval

Image search is a specialized data search used to find images. In this fast application based system where huge amount of data is handled at runtime, fast image retrieval is required. An **image retrieval** system is a computer system for browsing, searching and retrieving images from a large database of digital images. The following sub section describes the traditional image retrieval where the image data was annotated. But due to the rapid demand of an image retrieval system and the non-availability of annotated image database, content based image retrieval system has gained importance. The content based image retrieval system is also described later in this section.

Traditional Image Retrieval System

Content-based image retrieval, a technique which uses visual contents to search images from large scale image databases according to users' interests, has been an active and fast advancing research area since the 1990s. During the past decade, remarkable progress has been made in both theoretical research and system development. However, there remain many challenging research problems that continue to attract researchers from multiple disciplines. Early techniques were not generally based on visual features but on the textual annotation of images. In other words, images were first annotated with text and then searched using a text-based approach from traditional database management systems.

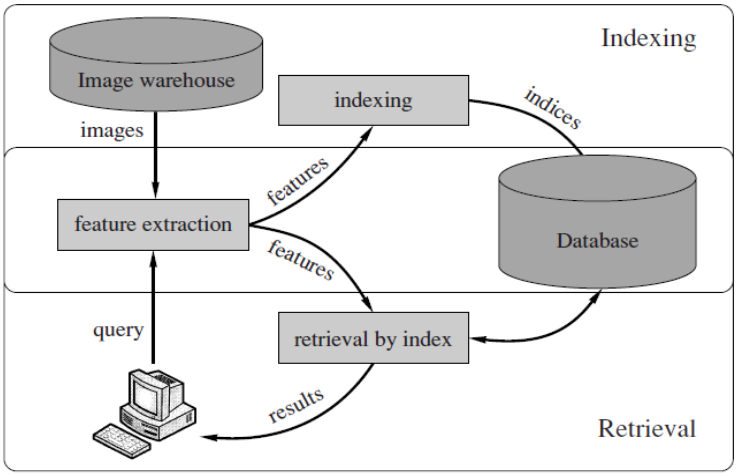

Figure 1

Text-based image retrieval uses traditional database techniques to manage images. Through text descriptions, images can be organized by topical or semantic hierarchies to facilitate easy navigation and browsing based on standard Boolean queries. However, due to rapid growth of technology the abundance of digital images a need for a system to organize un-annotated data has risen. Content Based Image Retrieval System addresses the problems of the early methods of handling huge critical database. It organises and analyses the data on the basis of the visual content of the images. A typical architecture of a traditional information (image) retrieval system is as shown in Figure 1.

General Content Based Image Retrieval System

Content based image retrieval is the retrieval of images from a large database depending on the visual content of the images rather than the textual content associated with the images. This visual content may be the *general visual content*, represented by the low level feature descriptors like color, texture, shape, spatial relationship. The visual content may be *domain specific visual content*, specific to the application the CBIR system is developed for, for example the fingerprint matching system. The Domain specific content is application dependent and requires specific domain knowledge. A typical Content Based Image Retrieval System is generally represented as in Figure 2.

In typical content-based image retrieval systems, the visual contents of the images in the database are extracted and described by multi-dimensional feature vectors.[3]. The color content of an image (in the form of a histogram or probability distribution depicting the intensities of pixels in an image) is the most widely used feature for content-based image retrieval (CBIR), while texture and shape features are also used, albeit to a lesser degree. A single feature is not enough to discriminate among a homogeneous group of images. In such cases, either pairs of these features or all of them are used for the purpose of indexing and retrieval. Similarity matching, through metrics called similarity measures, is done to determine the degree of relevance of an image in a collection to a query. This is a key component of a content-based image retrieval (CBIR) system because finding a set of images similar to the image the user had in mind is its primary goal.

A general and simplified model of a query-by-example (QBE) content-based image retrieval (CBIR) system is shown in Figure 1.

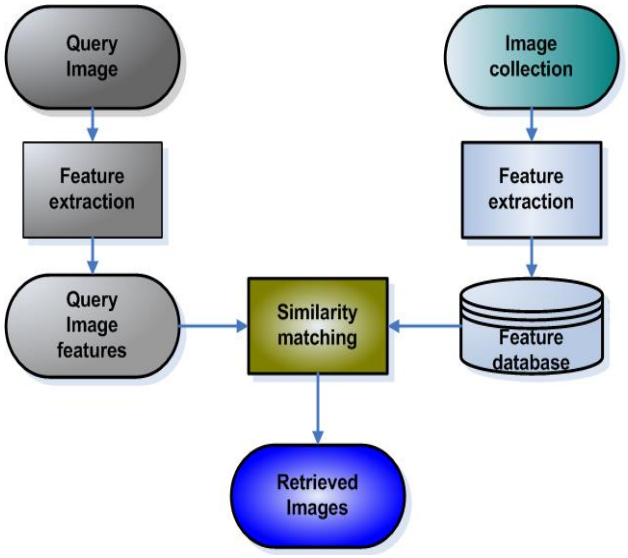

Figure 2: A general model of CBIR system

In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. It involves two steps.

Feature Extraction: The first step in the process is extracting image features to a distinguishable extent.

Matching: The second step involves matching these features to yield a result that is visually similar.

3. RELATED WORK

A lot of work has been done in the field of content based image retrieval.

In MARS, Multimedia Analysis and Retrieval System, [12], a feature's weight is determined by examining the feature's variance across the set of retrieved images marked as relevant by the user. A low variance indicates that these relevant images are consistent in this feature and that the feature should be assigned a relatively high weight. A feature whose value across the relevant images varies significantly is, conversely, given a relatively small weight. It is unclear how this technique would fare given only a handful of marked images.

In [4], a relevance feedback system is presented that can learn diagonal queries, that is, queries where two or more features have nonzero covariance. The system is able to learn generalized ellipsoids by approximating covariance matrices to fit the training instances as well as providing a mechanism for movement of the query position.

Seidl and Kriegel [15] present a similar framework for learning generalized distance functions such as ellipsoids. In particular, they have adapted and elaborated upon much of this theory in terms of color.

In [20], Zhou and Huang use biased descriminant analysis to address the problem that while relevant retrievals have common attributes, irrelevant retrievals may be different from the positive examples in any

number of ways. The research proposes a transform to cluster relevant examples in a new space while avoiding efforts to cluster the negative examples.

4. DIFFICULTIES OF CONTENT BASED IMAGE RETRIEVAL SYSTEM

The revolutionary internet and digital technologies have imposed a need to have a system to organize abundantly available digital images for easy categorization and retrieval.The biggest issue for CBIR system is to incorporate versatile techniques so as to process images of diversified characteristics and categories.

Many techniques for processing of low level cues are distinguished by the characteristics of domain-images. The performance of these techniques is challenged by various factors like image resolution, intra-image illumination variations, non-homogeneity of intra-region and inter-region textures, multiple and occluded objects etc. The other major difficulty, described as semantic-gap in the literature, is a gap between inferred understanding / semantics by pixel domain processing using low level cues and human perceptions of visual cues of given image. In other words, there exists a gap between mapping of extracted features and human perceived semantics. The dimensionality of the difficulty becomes adverse because of subjectivity in the visually perceived semantics, making image content description a subjective phenomenon of human perception, characterized by human psychology, emotions, and imaginations. The image retrieval system comprises of multiple inter-dependent tasks performed by various phases. Inter-tuning of all these phases of the retrieval system is inevitable for over all good results. The diversity in the images and semantic-gap generally enforce parameter tuning & threshold-value specification suiting to the requirements. For development of a real time CBIR system, feature processing time and query response time should be optimized. A better performance can be achieved if feature-dimensionality and space complexity of the algorithms are optimized. Specific issues, pertaining to application domains are to be addressed for meeting application-specific requirements. Choice of techniques, parameters and threshold-values are many a times application domain specific e.g. a set of techniques and parameters producing good results on an image database of natural images may not produce equally good results for medical or microbiological images.

Major difficulties faced [17] during content based retrieval are as follows:

 Semantic Gap: Semantic gap refers to the difference in the way a human perceives an image and the way a system perceives it on the basis of its certain characteristics. A major problem in content based retrieval is of semantic gap. A human compares two images, based on their semantics, whereas a retrieval system relies on comparison of feature vectors corresponding to visual image features.

 Inconvenience of Querying-by-Example

One of the most frequently used kinds of queries in content-based image retrieval systems is a query-by-example. Such a query is not convenient for the user, who may not have such an example; moreover, the user addresses the retrieval system in order to find such an image. Many systems suggest the user to select the image to be used as a query from a random set of images taken from a database. Such a random set may not contain an appropriate image, and the user is obliged to look through one set after another trying to find a desired query. Users prefer text queries, since it is simpler to describe content of the desired image in words. However, in order to search by a text query, the system should possess some text information on images.

Data Volume and Retrieval Performance

Images can be retrieved thorough the indexes attached to them in the form of text or a hashing value generated by a hash function. However in case of un-annotated image database this form of *textual retrieval* becomes difficult, content based retrieval needs to be done in this case. Content based image retrieval is the retrieval of images from a large database depending on the visual content of the images rather than the textual content associated with the images. This visual content of the image can be analyzed through a feature vector of a specific dimension, depending on the feature extraction technique adopted for retrieval. The greater, the dimension of the feature vector, the greater is the system's performance. However the increased data space affects the processing speed and the data management of the system.

5. ADVANTAGES

CBIR of medical images is a useful tool, and could provide physicians with assistance in the form of a display of relevant past cases with proven pathology, along with the associated clinical, diagnostic, and other information. The appearance of a wound or lesion provides important clues that can help with the diagnosis, determination of severity, and the prognosis of healing. Quantification of the color distribution of skin lesions by image processing techniques may help in the analysis of the dynamics of the pathological processes as well as the progress of healing.

6. CONCLUSION

The extent to which CBIR technology is currently in routine use is clearly still very limited. This is an interesting and complex problem studied by many researchers all over the world. In particular, CBIR technology has so far had little impact on the more general applications of image searching, such as journalism or home entertainment. Only in very specialist areas such as crime prevention has CBIR technology been adopted to any significant extent. This is no coincidence – while the problems of image retrieval in a general context have not yet been satisfactorily solved, the well-known artificial intelligence principle of exploiting natural constraints has been successfully adopted by system designers working within restricted domains where shape, color or texture features play an important part in retrieval.

CBIR at present is still very much a research topic. The technology is exciting but immature, and few operational image archives have yet shown any serious interest in adoption. The crucial question that this report attempts to answer is whether CBIR will turn out to be a flash in the pan, or the wave of the future. Our view is that CBIR is here to stay. It is not as effective as some of its more ardent enthusiasts claim – but it is a lot better than many of its critics allow, and its capabilities are improving all the time. Most current keyword-based image retrieval systems leave a great deal to be desired. In hard-nosed commercial terms, only one application of CBIR (video asset management) appears our view is that CBIR is here to stay. It is not as effective as some of its more ardent enthusiasts claim – but it is a lot better than many of its critics allow, and its capabilities are improving all the time. And as we argue in section Error! Reference source not found. above, most current keyword-based image retrieval systems leave a great deal to be desired. In hard-nosed commercial terms, only one application of CBIR (video asset management) appears to be cost-effective – but few conventional image management systems could pass the test of commercial viability either. The future of this field depends on the collective focus and overall progress in each aspect of image retrieval.

7. FUTURE WORK

CBIR is a vast field with a large number of researchers working on it. The success of a CBIR system lies in the fact how efficiently the features of an image can be extracted. This project can be further extended to retrieve the objects by using a combination of different types of features. The Image Understanding process combines the various results of object identification and depending on the decision generating algorithms performs scene analysis. The Image Understanding system generated is applicable to specific case of airbase. It can be developed to support a more generic system. The expectation values used for analysis are based on research work; it can be developed to understand the images of a varied environment instead of a fixed case.

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