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A Comprehensive Survey of Content Based Image Retrieval Techniques

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ABSTRACT – The content based image retrieval (CBIR) is one of the most important research areas of the digital image processing. The content based image retrieval is becoming a new and fast method of information retrieval. The development of the social networking mediums, so many digital images are transitioned and uploaded every day. In order to access the large collection of database, all the oldest searching methods like Google, Bingo, Yahoo are based on the on textual annotation of images. In these tools, all the images are manually annotated with keywords and then retrieved using text-based search methods. Therefore performances of these systems are not satisfactory. So, we need new techniques. These techniques will easy to handle the data and can easily access the data. The CBIR is a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape. It uses digital processing and analysis to automatically generate descriptions directly from the media data. In this paper, we survey some of the technical aspects of content based image retrieval techniques. And also we will discuss the advantages and disadvantages of CBIR methodology.

Keywords: CBIR, Texture, segmentation, color, shape, Feature Extraction

1. INTRODUCTION

In modern era, the rapid development of internet, private networks and development of multimedia technologies, many digital images are uploaded every day. The large numbers of images has posed increasing challenges to computer systems to store and manage data effectively and efficiently. The deployment of large image databases for a variety of applications has now become feasible. Even the databases of satellite and medical imagery have been attracting more and more users in various professional fields [1]. Effectively accessing desired images from large and varied image databases is now a necessity.

So users are not satisfied with the traditional text based retrieval methods. Content Based Image Retrieval (CBIR) is a technique that helps to access and arrange the digital images from a large collection of databases by using the images features. The aim of CBIR is to neglect the use of textual descriptions. CBIR is such a technique that will ease the data handling and the user can easily access the data. So in CBIR, retrieving of image based on similarities in their contents like textures, colors, shapes etc. are lower level features of image.

"Content-based" means that the search will analyze the actual contents of the image other than the metadata such as tags, keywords or descriptions linked with the image. Here the 'content' refers to colors and textures information that can be derived from the image itself. The Content Based Image Retrieval has

become essential because most web based image search engines rely purely on metadata and this produces a lot of false detection in the results [2,3].

2. CONTENT BASED IMAGE RETRIEVAL (CBIR) TECHNOLOGY

Content-based image retrieval (**CBIR**), also known as **query by image content** (**QBIC**) and **content-based visual information retrieval** (**CBVIR**) is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. Content-based image retrieval is opposed to traditional **concept-based approaches.** "Content-based" means that the search analyzes the contents of the image rather than the metadata such as keywords, tags, or descriptions associated with the image. 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 is desirable because searches that rely purely on metadata are dependent on annotation quality and completeness. Having humans manually annotate images by entering keywords or metadata in a large database can be time consuming and may not capture the keywords desired to describe the image. The evaluation of the effectiveness of keyword image search is subjective and has not been well-defined.

It is reported by [4] that, there are two retrieval frameworks: text-based and content-based. In the text- based approach, the images are manually annotated by text descriptors, which are then used by a database management system to perform image retrieval. There are two disadvantages with this approach. The first is that a human labor at considerable level is required for manual annotation. The second is the inaccuracy in annotation due to the subjectivity of human perception. To overcome these disadvantages in text-based retrieval system, content-based image retrieval (CBIR) was introduced.

It is asserted by [5], CBIR is a technique which uses visual features of image such as color, shape, texture, etc. to search user required image from large image database according to user's requests in the form of a query image. Images are retrieved on the basis of similarity in features where features of the query specification are compared with features from the image database to determine which images match similarly with given features.

According to [6] the CBIR paradigm has three fundamental basses of; visual features extraction, multidimensional indexing, and retrieval system design. The visual features (content) extraction is the basis of CBIR. In broad sense, features may include both text-based features (keyword, annotation) and visual features (color, text, shape, faces). The visual feature can be further classified as; general features, and domain specific features. The former include color, texture, and shape feature. While the latter is application-dependent and may include, for example, human faces and finger prints (pattern recognition). The figure 1 below summaries the image retrieval system architectural

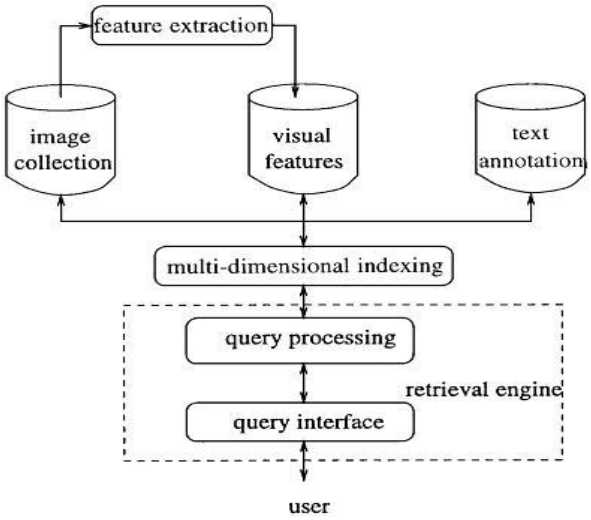

Figure-1 : An image retrieval system technique

3. CONTENT-BASED IMAGE RETRIEVAL

The method content-based image retrieval (CBIR) originated in the year 1992, and was first coined by the scientist T.Kato. He found this technique when he is dealing with the experiments that involving the retrieval of images from a small database by using their visual content. The techniques, tools, and algorithms that are used in CBIR originate from pattern recognition, signal processing, linear systems and machine vision[8].

Databases are indexed with descriptors derived from the visual content of the images. Most of the CBIR systems are concerned with approximate queries where the aim is to find images visually similar to a specified target image. In most cases the aim of CBIR systems is to replicate human perception of image similarity as well as possible, [9].

3.1 CONTENT BASED IMAGE RETRIEVAL PROCESS

CBIR contains six main stages of: image acquisition, image preprocessing, feature extraction, similarity matching, resultant retrieval image and user interface and feedback.

3.1.1 IMAGE ACQUISITION

It is the first step of the process to acquire a digital image from the image database. The image database consists of the collection of n number of images depends on the user range and choice.

3.1.2 IMAGE PREPROCESSING

It is the process of improving the image in its appearance and efficient representation. It involves extraction, analysis, and recognition of image coding, filtering, normalization, segmentation, and object identification. Image segmentation is the process of dividing an image into multiple parts. The output of this stage is a set of significant regions and objects, [9].

3.1.3 SIMILARITY MATCHING

It is a process that entails the information about each image is stored in its feature vectors for computation process and these feature vectors are matched with the feature vectors of query image which helps in measuring the similarity. This step involves the matching of the above stated features to yield a result that is visually similar with the use of similarity measure method called as Distance method. There are various distances methods available such as Euclidean distance, City Block Distance, and Canberra Distance, [10].

3.1.4 RESULTANT RETRIEVED IMAGES

It is the process that searches the previously maintained information to find the matched images from database. The output will be the similar images having same or very closest features as that of the query image, [11].

3.1.5 USER INTERFACE AND FEEDBACK

It is the process which governs the display of the outcomes, their ranking, the type of user interaction with possibility of refining the search through some automatic or manual preferences scheme etc.

4. FEATURE EXTRACTION

Feature extraction is the basis of content based image retrieval. Typically two types of visual feature in CBIR. They are

1.Primitive features- which include color, texture and shape

2. Domain specific- which are application specific and may include, for example human faces and finger prints.

4.1 COLOR

The most important feature in retrieving a digital image is color. Color space is used to represent color images. The RGB space is where the gray level intensity is represented as the sum of red, green and blue gray level intensities. There are so many methods used to retrieve the color feature. They include color histogram, color moments etc.

Color Histogram is the commonly used method for color feature extraction in digital images. In CBIR systems Color histograms are widely used in the image retrieval area. It is one of the most common methods for predicting the features of an image. The great advantages of the Color are speed and low memory space. Color histogram method is invariant to rotation but it is not invariant to scaling. It also varies with the angle of view. The color moments widely used are mean, standard deviation, and kurtosis. Color moments are mainly used for color indexing .The other advantages of color moments are: - they are good under lighting conditions, the requirement for their storage are very less.

The comparison between query image and image in database is accomplished through the use of some metric which determines the distance or similarity between the two histograms. Besides the color histogram several other color features representation like color moments and color sets have been applied [12].

4.2 SHAPES

In image retrieval, Shape does not refer to the shape of an image but to the shape of a particular region that is being sought out. Shapes will often be determined first applying segmentation or edge detection to an image. Shape description can be categorized into two categories

1. Boundary-based which use only the outer boundary of the shape
2. Region-based which uses the entire shape regions.

The most successful representative for these two categories are Fourier descriptors and Moment invariants. The main idea of a Fourier descriptor is to use the Fourier transformed boundary as the shape feature. Rui et al. proposed a modified Fourier descriptor which is robust to noise and invariant to geometric transformation [13].

4.3 TEXTURE

Texture is another important property of images. Basically, texture representation methods can be classified into two categories: *structural* and *statistical*.

1. **Structural methods**, including morphological operator and adjacency graph, describe texture by identifying structural primitives and their placement rules. They tend to be most effective when applied to textures that are very regular.

2. **Statistical methods**, including Fourier power spectra, co-occurrence matrices, shift-invariant principal component analysis (SPCA), Tamura feature, Word decomposition, Markov random field, fractal model, and multi-resolution filtering techniques such as Gabor and wavelet transform, characterize texture by the statistical distribution of the image intensity.

The six visual texture properties were coarseness, contrast, directionality, line likeness, regularity and roughness [14].

4.4 SEGMENTATION

According to [15] in computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s), [15].

4.5 CONTENT LEVELS

Most researchers accept the assertion that there are multiple levels of content. For example, luminance, and color are regarded as low-level content, and physical objects (such as an automobile or a person) are regarded as high-level content. (Texture and patterns, which blend different types of content, might be regarded as mid-level content.) However, there is no broad agreement about how many levels of content can be perceived by a human, how many types of content there are in each level, or how the content of a particular image might be classified into types and levels, [16].

5 .APPLICATIONS OF CBIR

There are various Potential uses for CBIR. They are

1. Investigations: face recognition systems, copyright on the Internet
2. Shapes identification: identification of defect and fault in industrial automation.
3. Medical diagnosis: Tumours detection, Improve MRI and CT scan Understand ability.
4. Journalism, advertising Media, Fashion and graphic design.
5. Remote sensing: Various information systems, weather forecast, satellite images.
6. Trademark databases, Art galleries, museums and archaeology.
7. Architectural and engineering designs.
8. Cartography: map making from photographs, synthesis of weather maps.
9. Digital Forensics: finger print matching for crime detection.
10. Radar engineering: helps in detection and identification of targets.

6.LITERATURE SURVEY

In **[17],** Navigation-Pattern-based Relevance Feedback (NPRF) Approach is used. This Approach has high efficiency and effectiveness of CBIR in coping with the large-scale image data. In terms of efficiency, the iterations of feedback are reduced substantially by using the navigation patterns discovered from the user query log. It supports a large set of downloaded images. This paper cannot handle three issues:- First, in view of very large data sets, it have to scale the proposed method by utilizing parallel and distributed computing techniques. Second, to integrate user‟s profile into NPRF to further increase the retrieval quality. Third, to apply the NPRF approach to more kinds of applications on multimedia retrieval. It supports the minimum number of logs, and most relevant seeds. In **[18],** learning to combine ad-hoc Ranking Functions for Image Retrieval, the

approach used is ad-hoc Ranking Functions with Support vector machines (SVM). The proposed method brings little computational burden to the system and the efficiency analysis proves its scalability. This method cannot construct the ranking features by investigating the various image visual features. The Approach gives a performance of 95.6%.The future enhancement is that by considering the image visual features, ranking features can be constructed. In **[19],** latent semantic indexing (LSI) method is used to support the downloaded natural images. This method is especially suitable for mass image databases such as web environment. The Future work remains to include structural information in order to see whether this improves performance or not. In **[20],** Recursive orthogonal least squares (ROLS) algorithm is used. The advantages of this approach are less computer memory, Network reduction to achieve smaller architectures with acceptable accuracy and without retraining. Online adaptation cannot be done in this method. So the future work can lead to an approach for on-line adaptation of both the structure and weights of an RBF network, which is useful for application to time-varying problems. In **[21],** "Learning from Negative Example in Relevance Feedback for Content-Based Image Retrieval", a method which is a combination of Relevance Feedback with discriminators are used. Here negative examples are combined with positive example to identify important features to be used in retrieval process. The Approach is implemented in a set of natural images particularly in Trees. This Approach denies the Partial Information needs of the user and can be extended as a future work. In **[22],** random walker algorithm is used. Each unlabeled image is ranked according to the probability that a random walker starting from that image will reach a relevant seed before encountering a non-relevant one. This method is easy to implement, it has no parameters to tune and scales well to large datasets. It can give a performance of 95% and can extend to other visual features too. In **[23],** Geometric Optimum Experimental Design for Collaborative Image Retrieval, the algorithm used is GOED algorithm (geometric optimum experimental design. Collaborative image retrieval in this approach aims to reduce the labeling efforts of the user by resorting to the auxiliary information. Enhance the performance of image retrieval. By minimizing the expected average prediction variance on the test data, GOED has a clear geometric interpretation to select a set of the most representative samples in the database iteratively with the global optimum. This approach retrieved only shape and texture from synthetic datasets and real world image database. The retrieval performance is good .In **[24],** Combining positive and negative examples in relevance feedback for content-based image retrieval minimize the intra dispersion between positive examples. Here the partial information needs of the user are totally denied. This method is implemented in a set of downloaded natural images. Euclidean distance is used as the similarity measure here. It gives a better accuracy compared to existing approaches. In **[25],** Radial basis functions are used for implementation. Neuro-Fuzzy control (NFC) exhibits greater robustness with large changes in plant dynamic. And moreover no tuning is needed. By using Tuning Parameters, good classification accuracy can be used. In **[26],** Radial basis functions are used to implement Satellite images of land region. This approach is very useful for queries involving texture patterns that represent a region of interest, nonlinear kernel for the evaluation of image similarity. Here both positive and negative feedbacks are taken for effectiveness of learning capability. The Parameters used here are RBF centres and widths, the tuning parameters and the adjustable centres. RBF networks

possess an excellent nonlinear approximation capability. Nonlinear kernel for the evaluation of image similarity.RBF networks possesses an excellent nonlinear approximation capability.

7.CONCLUSION

CBIR is a fast developing technology with considerable potential. The goal of this survey is to provide an overview of the functionality of content based image retrieval systems. This paper provides comprehensive survey on feature extraction in various CBIR systems and texture analysis with various applications. Various features with their method of representation are discussed. The area of content-based image retrieval is a hybrid research area that requires knowledge of both computer vision and of database systems. There are various applications of CBIR in every fields of life like blood cell detection, archeology, criminal investigation, image search, social networking sites, forensic Labs, and satellite etc. The field appears to be generating interesting and valid results, even though it has so far led to few commercial applications.

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