



A Review on Content Based Image Retrieval System

Suman Lata

Lect, Dept of CSE-IT, Baddi University,
India

Parul Preet Singh

Asstt. Professor, Dept of CSE-IT, Baddi University
India

Abstract: *The paper presents a review on various ways of content based image retrieval. Content Based image retrieval is a system by which various images are retrieved from a large database collection. These databases are prepared using various visual features like color, texture, shape and spatial layout which are extracted using different techniques. As image database volume is increasing rapidly, researchers are looking for a better mechanism to retrieve images and to obtain more accurate results. So the research focus has been shifted from low-level feature extraction algorithms to the high level visual feature extraction mechanism. To develop better content based image retrieval system, it is important to improve various processes involved in retrieval like feature extraction, image segmentation, image decomposition and similarity matching techniques. In this paper we discuss the fundamental aspects, visual features and techniques for fast searching and retrieval of images from the database. The use of wavelets in CBIR is also discussed.*

Keywords: *feature extraction, multidimensional indexing, wavelets, retrieval design, Hadamard matrix*

I. Introduction

As the technology growing throughout the society, the digital images, multimedia files, visual objects are also increasing. These huge amount of images requires novel methods to search and access the images. Advances in medical and other technologies have provided extensive image generation, its storage and transmission capabilities. Due to the increase in the usage of these digital images in various fields, researchers are focusing on new ways by which images can be easily, quickly and accurately retrieved and accessed from large databases. Technology is improving with the time and the usage of digital images is increasing in various fields like engineering, science, geography, history, architecture, advertising, design, publishing, fashion and medicine. So the retrieval mechanism and processing of the desired image from the database has become important. For many years researchers has been working on image retrieval processes. The two methods which are used for image retrieval are Text based image retrieval and Content based image retrieval.

Text based image retrieval system also known as concept based image retrieval system. In concept based image retrieval user poses the query using natural language text, subject heading, keywords or annotations of the image. These systems do not actually understand the actual content of the images. Metadata is used for image indexing in concept based system. There are various limitation of concept based image retrieval system. There are number of ways to say the same thing. Annotation of images is never complete and is time consuming process because human perceptivity can lead to a number of errors. A new method for image retrieval is needed where the human factor would be relieved from the annotation task and doing it automatically. Most web based image search engines rely only on metadata and this produces a lot of garbage in the results. In these search engines, humans have to enter the keywords manually and it is inefficient and expensive way to find images in a large database.

Content-based image retrieval is the modern image retrieval system. The Content based image retrieval systems are used to extract image features, index those using appropriate structures and efficiently process user queries providing the required answers. The query processing includes segments and features extraction and search in the feature space for similar images. In Content based image retrieval system various techniques are brought together effectively for the same purpose as image processing, information retrieval and database communities. It is also called query-by-image content and content-based visual information retrieval.

II. CBIR Fundamentals

The basic fundamentals of content based image retrieval are divided into three parts feature extraction, multidimensional indexing and retrieval systems design [1]. They discussed about the use of digital images and rapid increase in the size of digital image collections. The proper organization of the generated large amount of images by both military and civilian is needed, so as efficient browsing, searching and retrieval takes place. The two ways of image retrieval, text based image retrieval and visual based image retrieval. The text based image retrieval is a very popular framework of image retrieval. There exist two major difficulties. The first difficulty is when the size of image collections is large then vast amount of labour required in manual image annotation. The other difficulty is resulted from the rich content in the images and the subjectivity of human perception. That is, for the same image content different people may perceive it differently. The perception subjectivity and annotation impreciseness may cause unrecoverable mismatches in later retrieval processes. To overcome these difficulties, content-based image retrieval was proposed. Instead of being manually annotated by text-

based key words, images would be indexed by their own visual content, such as color and texture. There are three fundamental bases for CBIR. The basic architecture of a CBIR system is shown in Figure 1.1. Visual features from the database images are extracted and stored in the feature matrix. Then the query image is entered by the user using interface. The features of the query image are then matched with the feature matrix using similarity matching mechanism. Then the resulting images are retrieved.

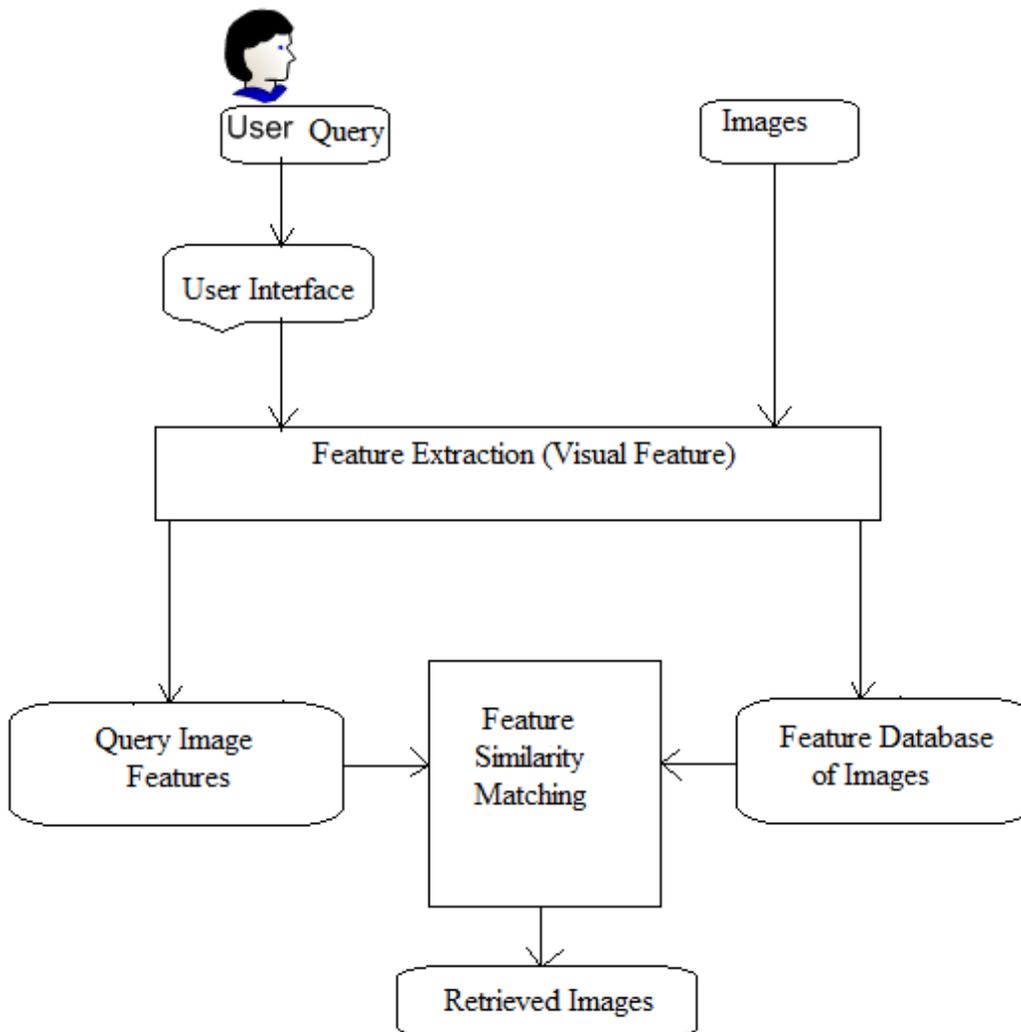


Figure 1.1: Basic Architecture of a CBIR system

A. Feature Extraction

In the broad sense, the features may be text based and visual based. Textual (text based) features are keywords, tags, annotations etc. Visual (visual based) image features are color, shape, texture etc. The visual features are further classified as general features and domain specific features. General features are color, texture, shape and domain specific features are application dependent for e.g. human faces and finger prints. Domain specific features are related to pattern recognition. A feature is defined as an interesting part of an image and features are used as a starting point for many computer vision algorithms. Since features are used as the starting point and main primitives for subsequent algorithms, the overall algorithm will often only be as good as its feature detector.

1.) Color: color describes one of the important visual features in content based image retrieval. There are number of examples, where color features in retrieving image are used like histograms, moments, block-based. Color histogram is used for computing distance measures based on color similarity for each image. A color histogram is used to describe the global color distribution in an image and is more frequently used method because of its advantages like high efficiency.

Other feature representation like color moments and color sets are also used than color histogram. The color is a widely used important feature for image representation. This is very important as it is invariant with respect to scaling, translation and rotation of an image [2]. Color space, color quantification and similarity measurement are the key components of color feature extraction. Color feature is not dependent upon size of image. The color models can

be classified as User & Hardware based models; such as RGB and HSV. Many color spaces are there which offers different applications.

- 2.) Texture: Texture contains important information about the structural arrangement of surfaces and their relationship to the surrounding environment. It is an inherent property of virtually all surfaces including clouds, trees, bricks, hair, and fabric. Texture provides useful information of the surfaces about their structures and the relationship with the surrounding. texture analysis can be studied at three levels i.e. on statistical level, a set of statistics extracted from the image is called texture. On the structural level, the primitives of the image and their placement rules are known as its texture. On the spectral level, the texture is defines as a set of coefficients in the transform domain. With the help of these levels the textures can be identified but the textures may not agree with human way of evaluating the textures.[3] These reasons are semantic gap and human perception subjectivity. Texture feature describes spectral features which are taken using wavelet transform, statistical features, tamura texture features etc. Tamura explored the texture representation from a different viewpoint. [4]Texture and color queries can be formulated in similar way, by selecting desired textures or by supplying an query image.
- 3.) Shape: Shape does not refer to the shape of an image but to the shape of a particular region that is being sought out. In image retrieval, depending on the applications, some require the shape representation to be invariant to translation, rotation, and scaling, while others do not. Shape features of objects or regions have been used in many content-based image retrieval systems. Compared with color and texture features, shape features are usually described after images have been segmented into regions or objects. Shape features are divided into two categories boundary based and region based. Boundary based shape features uses only boundary of the shape whereas region-based shape features uses entire shape region[5]. The term shape refers to the information that can be deduced directly from the image. Shape is represented through perceptually grouped geometric cues such as edges, contours, joints, and polygonal regions extracted from an image. Such a grouping can serve as a spatial layout or as a rough sketch by additional post processing. Shape features are known as geometric features. shape feature are commonly used – global features such as aspect ratio, circularity and moment invariants and local features such as sets of consecutive boundary.[6]

B. Multidimensional indexing

To make the content-based image retrieval truly scalable to large size image collections, efficient multidimensional indexing techniques need to be explored. Main challenge in such an exploration for image retrieval is high dimensionality. The best way to index is to reduce the dimensionality and then indexing the images. Clustering is a powerful tool in performing dimension reduction. The clustering technique is used in various disciplines such as pattern recognition, speech analysis and information retrieval. Normally it is used to cluster similar objects (patterns, signals, and documents) together to perform recognition or grouping. This type of clustering is called row-wise clustering. However, clustering can also be used column-wise to reduce the dimensionality of the feature space. But blind dimension reduction can be dangerous, since information can be lost if the reduction is below the embedded dimension. To avoid blind dimension reduction, a post-verification stage is needed.

The Figure 1.2 shows the process of indexing of images. When a query is posed in the high level phrase, the data is retrieved from the database. Image indexing is done to improve the retrieval mechanism. The indexing helps retrieving the images when a query is posed by the user.

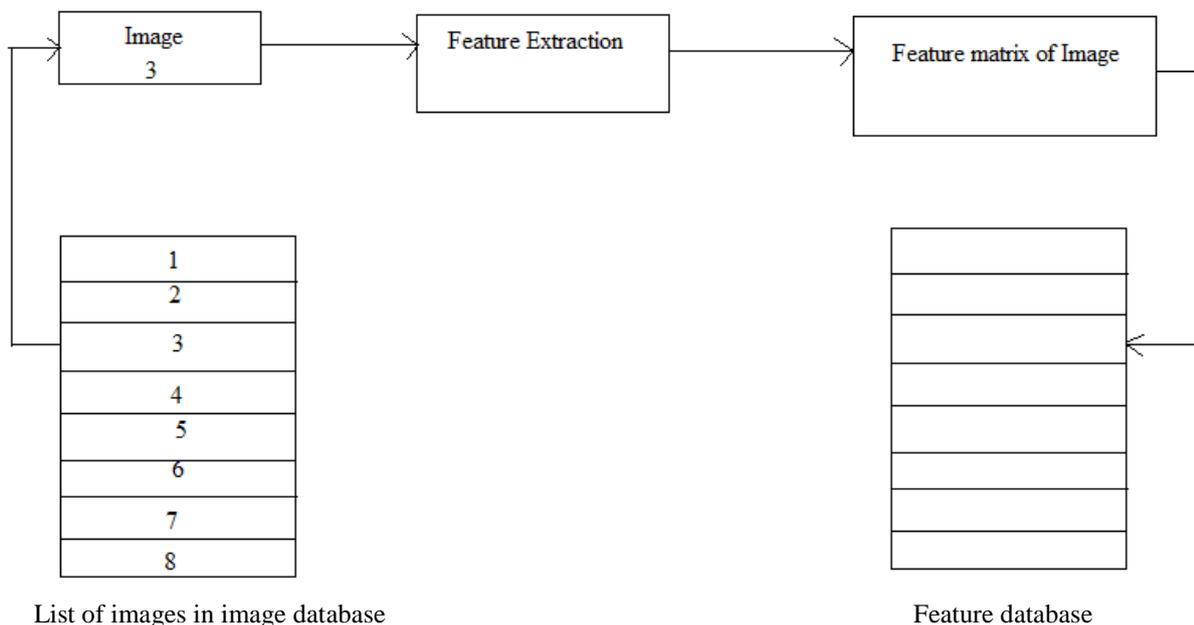


Figure 1.2: Image indexing process

C. Retrieval system design and Similarity Matching

After extracting the image features, the images are indexed. After indexing, similarity is measured. The similarity measures in the Retrieval of images are essentially the determination of similarity between the features of the query image and the features of the target images in the database. Similarity measure is the distance between feature vectors representing the images. The similarity measure is a function which computes the degree of similarity between a pair of images.[7] . Similar images should have smaller distance between them and different images should have larger distances. The similarity measure gives good result if the retrieval is accurate. Most image retrieval systems support one or more ways for retrieval of images such as random browsing, search by example, search by sketch, search by text (including key word or speech), and navigation with customized image categories.

III. Wavelets in CBIR System

The wavelet transform was introduced in 1990s and its theoretical framework was established. The statistics (mean and variance) extracted from the wavelet sub bands as the texture representation is used in 1994 by researchers. This approach achieved over 90% accuracy. The wavelet transform was also combined with other techniques to achieve better performance. The use of the wavelet transforms, together with KL expansion and Kohonen maps, to perform texture analysis. There is another way by evaluating the texture image annotation by various wavelet transform representations including orthogonal and bi-orthogonal wavelet transforms, the tree-structured wavelet transform, and the Gabor wavelet transform.

There are mainly two ways of research for image retrieval. The first is focusing on image indexing and other one is by describing the image content in the form of features. Most of the images indexing approaches are based on color, texture or shape. The performance can be improved by combining these three features. The size of the feature vector plays an important role in the retrieval of images.

The Walsh matrix is a set of m number of rows and can be denoted by W_k for $0, 1, \dots, m-1$. The Walsh matrix can have number of properties. Walsh transform matrix row is the row of the Hadamard matrix specified by the Walsh code index, which must be an integer in the range $[0, \dots, m-1]$. For the Walsh code index equal to an integer j , the respective Hadamard output code has exactly j zero crossings, for $j = 0, 1, \dots, m-1$. Haar used these functions to give an example of a countable orthonormal system for the space of square-integrable functions on the real line. The Haar wavelet is also the simplest possible wavelet. The technical disadvantage of the Haar wavelet is that it is not continuous, and therefore not differentiable. This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines. Kekre's transform matrix can be of any size $N \times N$, which need not have to be in powers of 2 (as is the case with most of other transforms). All upper diagonal and diagonal values of Kekre's transform matrix are one, while the lower diagonal part except the values just below diagonal is zero. [8]

Wavelet based approaches uses wavelet moment and wavelet transform. In wavelet transform a CBIR system decomposes the images of database in offline mode, and then performs feature extraction using F-norm theory. And apply progressive retrieval strategy to retrieve the images from the database when compared with the query image was introduced. [9] To provide a more accurate image retrieval method various features can be combined to provide accurate image. So features are combined with certain other techniques for feature extraction, similarity matching, clustering to provide effective results. In spite of the significant advances made in imaging techniques, several practical factors often led to the average results in image retrieval of images .Therefore, it is necessary to improve the quality of the content based system for image retrieval. Content based image retrieval, allowing to automatically extracting targets according to objective visual contents of images. With appealing time frequency localization and multi-scale properties, wavelet transform proved to be effective in visual feature extraction and representation. It can be used to characterize textures using statistical properties of the gray levels of the points/pixels comprising a surface image. Wavelet transform can be used to characterize textures using statistical properties of the gray levels of the pixels comprising a surface image. The wavelet transform is a tool that cuts up data or functions or operators into different frequency components and then studies each component with a resolution matched to its scale.

IV. Conclusion

Content based image retrieval system is an emerging way of image retrieval from a large database. Although this area has been explored for decades, there is still a very large scope for achieving the accuracy of human visual perception in distinguishing images. The CBIR system can be improved by improving the indexing, retrieval design and feature extraction mechanism and to reduce the time better clustering approach with image decomposition and feature extraction can be used. To achieve more accurate and fast results better methods of image decomposition can be applied. Other techniques of clustering can be used with the system. At last in this paper we studied the basic Content based image retrieval system and the use as well as the evolution of wavelets in the field of CBIR systems.

References

- [1] Huang, T. and Rui, Y. (1999) "Image Retrieval: Current Techniques, Promising Directions, and Open Issues" *Journal of Visual Communication and Image Representation* 10, pp.39–62.
- [2] Henning Müller, Nicolas Michoux, David Bandon, Antoine Geissbuhler (2004), "A review of content- based image retrieval systems in medical applications—clinical benefits and future directions", *International Journal of Medical Informatics* 73, 1—23.

- [3] Chiu, C.Y., Yang, S. and Lin, H.C.(2002), "Learning human perceptual concepts in a fuzzy content based image retrieval system", 5th International Conference on Computational intelligence and Multimedia Applications, pp. 330-335.
- [4] Ying Liu, Dengsheng Zhang, Guojun Lu, Wei-Ying Ma.(2007)," A survey of content-based image retrieval with high-level semantics" The Journal of the pattern recognition society. Pattern Recognition 40 (2007) 262 – 282
- [5] Jayant Mishra, Anubhav Sharma and Kapil Chaturvedi(2011)," An Unsupervised Cluster-based Image Retrieval Algorithm using Relevance Feedback" International Journal of Managing Information Technology (IJMIT) Vol.3, No.2, May 2011
- [6] Murthy V.S.V.S E.Vamsidhar P.Sankara Rao G.Samuel Varaprasad Raju(2010), " application of hierarchical and k-means techniques in content based image retrieval" International Journal of Engineering Science and Technology Vol. 2(5), 2010, 749-755
- [7] Zhang, D. and Li, G.(2003) "Evaluation of similarity measurement for image retrieval", Neural Networks and signal processing, proceedings of the conference. Vol2.
- [8] Dr. H.B.Kekre, Sudeep D. Thepade, Akshay Maloo(2010)," Performance comparison of image retrieval techniques using wavelet pyramids of walsh, haar and kekre Transforms", International Journal of computer applications (0975 – 8887) Volume 4– No.10.
- [9] Parul Preet, Kulvinder Singh Mann (2013), "An Approach of image retrieval using content based retrieval system" International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 2, February 2013 ISSN: 2277 128X.