



Descriptor Based Image Mining: A Review

¹Rohini H. Kale, ²Prof.S.A.Ladhake

¹M.E (Scholar), Computer Science & Engineering, SCE &T, Amravati, Maharashtra, INDIA.

²Principal, SCE &T, Amravati, Maharashtra, India.

Abstract: Content based image retrieval is the task of retrieve the images from the large collection of database on the basis of their own visual content. This paper provides the survey of technical achievements in the research area of image retrieval, especially content based image retrieval (CBIR). The research in this field way began way back at the end of nineteenth century but this has gained impetus from 1970 onwards with the thrust from two major research communities, database management and computer vision. In this paper an effort has been made to show the chronological growth in this field.

Keywords: CBIR; feature extraction; image indexing

I. Introduction

Due to exponential increase of size of so called multimedia files in recent years because of the substantial increase of affordable memory storage on one hand and the wide spread of World Wide Web (www) on the other hand, the need for the efficient tool to retrieve the images from the large data base becomes crucial. This motivates the extensive research into image retrieval systems. From the historical perspective, the earlier image retrieval systems are rather text-based with the thrust from database management community since the images are required to be annotated and indexed accordingly [1]. However with the substantial increase of the size of images as well as size of image database, the task of user-based annotation becomes very cumbersome and at some extent subjective and thereby, incomplete as the text often fails to convey the rich structure of images. In the early 1990s, to overcome these difficulties this motivates the research into what is referred as content based image retrieval (CBIR) where retrieval is based on the automating matching of feature of query image with that of image database through some image-image similarity evaluation [5]. Therefore images will be indexed according to their own visual content such as color, texture, shape or any other feature or a combination of set of visual features. The advances in this research direction are mainly contributed by the computer vision community.

The various applications these systems are:

- The advantages of such systems range from simple users searching a particular image on the web.
- Various types of professionals like police force for picture recognition in crime prevention.
- Medicine diagnosis
- Architectural and engineering design
- Fashion and publishing
- Geographical information and remote sensing systems
- Home entertainment

II. CBIR: an overview

The Figure 1 shows a generic description of a standard image retrieval system. There are three fundamental bases for content based image retrieval, i.e. visual feature extraction, multidimensional indexing, and retrieval system design[2].

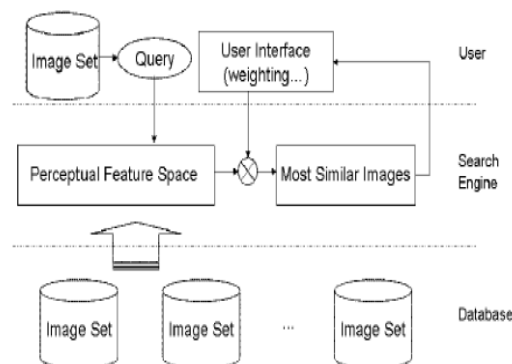


Figure 1 Generic CBIR System

- Feature extraction and indexing of image database according to the chosen visual features, which from the perceptual feature space, for example color, shape, texture or any combination of above.
- Feature extraction of query image.
- Matching the query image to the most similar images in the database according to some image-image similarity measure. This forms the search part of CBIR systems.
- User interface and feedback 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.

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

- i. Primitive features which include color, texture and shape.
- ii. Domain specific which are application specific and may include, for example human faces and finger prints.

Color: Color represents one of the most widely used visual features in CBIR systems[11]. First a color space is used to represent color images. Typically, RGB space where the gray level intensity is represented as the sum of red, green and blue gray level intensities [7]. Swain and Ballard proposed histogram intersection, an L1 metric as the similarity measure for color histogram. In image retrieval a histogram is employed to represent the distribution of colors in image (Swain et al.,1991). The number of bins of histogram determines the color quantization. Therefore the histogram shows the number of pixels whose gray level falls within the range indicated by corresponding bin. 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 colors feature representation like color moments and color sets have been applied.

To overcome the quantization effects as in the color histogram, Stricker and Orengo (1994) proposed color moments approach. The mathematical foundation of this approach is that any color distribution can be characterized by its moments. To facilitate the fast search over large scale image collection, Smith and Chang proposed color sets as an approximation of color histogram. A color set is defined as a selection of color from the quantized color space.

Color Layout: In this spatial relationship are used in conjunction to color feature. A natural way of doing so is by dividing the whole image into a set of sub images and takes a color histogram of each sub image. A variation of this approach is the quad-tree based color layout approach, where the entire image was dividing into a quad-tree structure and each branch has its own color histogram to describe its color content. Although this regular sub block approach cannot provide the accurate color information and its computation and storage expensive.

A more sophisticated approach is to segment the image into regions with salient color feature by color set back projection given by Smith and Chang. The advantages of this approach are its accuracy while the disadvantages are the general difficult problem of reliable image segmentation. Hsu et al., (1995) suggested using two color histogram, one for the entire region and another for the predefined central part. A heuristic was then used to select representative colors based on these two color histograms. Next the maximum entropy algorithm was used to partition the image into rectangular regions. Pass et al., (1996) proposed a histogram refinement approach using the so called Color Coherent Vector where a pixel is added by a binary entity reflecting its coherence.

Shapes: In image retrieval, depending on the applications, some require the shape representation to be invariant to translation, rotation and scaling, while others do not. In general shape representation can be divided into two categories:

- i. Boundary based which uses only the outer boundary of the shape.
- ii. Region-based which uses the entire shape regions.

The most successful representative for these two categories is Fourier descriptor and Moment invariants. The main idea of a Fourier descriptor is to use the Fourier transformed boundary as the shape feature. Rui et al., (1999) proposed a modified Fourier descriptor which is robust to noise and invariant to geometric transformation.

The main idea of moment invariant is to use region based moments which are invariant to transformation, as the shape feature. Hu identified seven such moments. Based on discrete version of Green's theorem, Yang and Albregtsen proposed a fast method of computing moments in the binary images. Polynomial filtering is done to represent local geometric information, from which geometric invariants are used in object matching and recognition. Some recent work in the shape representation includes the finite element method (FEM), the turning function and wavelet transform. In addition to 2D shape representation, there were many methods developed for 3D shape representation. Wallace and Wintz presented a technique for normalizing Fourier descriptor which retained all shape information. They also took advantages of interpolation property of Fourier descriptor which resulted in efficient representation of 3D shapes.

Texture: Texture is another important property of images. It refers to the visual patterns that have property of homogeneity or arrangement that do not result from the presence of only a single color or intensity. Various texture representation have been investigated in both pattern recognition and computer vision. In the early 1990s, Haralick et al. proposed the co- occurrence matrix representation of texture feature. This approach explored the gray level spatial dependence of structure. Tamura developed computational approximation to the visual texture properties found to be important in psychology studies. The six visual texture properties were coarseness, contrast, directionality, line likeness, regularity and roughness. One major distinction between Tamura texture representation and the co- occurrence matrix is that all the texture properties in Tamura Representation are visually meaningful.

Two classes of texture representation method can be distinguished:

- i. Structural methods including morphological operator and adjacency graph, describe texture by identifying structural primitives and their placement rules. They deal with the arrangement of image primitives, presence of parallel or regularly spaced objects.
- ii. Statistical methods which include the popular co-occurrence matrix, Fourier power spectra, Shift invariant principal component analysis (SPCA), Tamura feature, Multi-resolution filtering technique such as Gabor and wavelet transform, characterize the texture by statistical distribution of the image intensity.

Main Challenges to CBIR systems: From the above review, we can see that many advances have been made in various directions including visual feature extraction, multidimensional indexing and system design. But there are still many open research issues or challenges that need to be solved.

- Personalization of the search and image interpretation is part of big challenge that may lead to big success of CBIR. This approach is under the development in text retrieval systems and still subject to intense studies by the Google Inc. and Yahoo Inc .
- Unlike text retrieval where one notice the emergence of TREC like competition, which had a lot in the development of the field of text retrieval system, the development of coherent database that will help in enhancing the performance of CBIR systems.
- High dimensionality is one of the important challenges in CBIR due to possible size of feature space and images. Therefore dimension reduction needs to improve.
- Several researchers encompassed the need for enhanced user interface as it often argued that the interfacing plays central role in CBIR systems that customizing the interface to fit user's specific query is not an easy task.
- The ultimate end user of an image retrieval system is human, so aiming at exploring how humans perceive image content and how we can integrate such a human model into the image retrieval systems. The early research was conducted independently by the MIT team and NEC team and UIUC team. Most recent study of human perception focuses on the psychological aspects of human perception.
- In reality most database community systems are non image databases, while most computer visions are image non databases A successful image database systems requires an interdisciplinary research effort. Some successful examples of such research effort include the adaptation of Boolean retrieval model in image retrieval [6] another thing is that integration of multimedia, multi- modalities provides great potential for improved indexing and classification of images in general domains
- The development of automated indexing schemes is still an open issue. Indeed, while text indexing is widely accepted, there is an open debate on current indexing practice in CBIR.
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III. Conclusions

From the above it can be concluded that content based image retrieval is not a replacement of, but rather a complementary component to text based image retrieval. Only the integration of the two can result in satisfactory retrieval performance. This paper reviewed the main components of a content based image retrieval system, including image feature representation, indexing, and system design, while highlighting the past and current technical achievement Open research issues are identified and future research directions are suggested.

In retrieval system to achieve fast retrieval speed and make the retrieval system scalable to large size image collection, an effective multidimensional technique is required and an indispensable part of whole system .The retrieval engine module includes a query interface sub module and query processing sub module. This module will be pushed forward by computational geometry, database management and pattern recognition communities.

There are two major characteristics of this system architecture. One is multidiscipline and interdisciplinary nature of the system. In all integration of various disciplines of multiple information sources and of human and computer will lead to a successful image retrieval systems.

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