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Identifying Patterns and Knowledge Base: Content Based Image Retrieval

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Abstract: Image Mining is different from that of image processing in a way that the former is identifying knowledge patterns from different images and the latter is identifying patterns from a single image. It is highly challenging to identify high level objects and relationships from low level, pixel representation contained in raw images. In the advancing research area, Content-based image retrieval uses visual features to search images from large image databases. This research paper identifies how the knowledge patterns are retrieved from images using CBIR, to identify the features of the images and how it affects the image retrieval and also the role of finding the similarity between the images in retrieving the image based on the query image

Keywords: Content Based Image Retrieval, Image Mining, Similarity of images, Query images, Image databases.

I. INTRODUCTION

The image databases had gone to the greater distance in its growth due to the advancement in the storage technologies as well as in the capturing of images [1]. The essential issue in image repository is in handling it effectively. The handling of images involves manipulation, storing, analyzing, indexing, matching, retrieval, display, etc., It is a challenging task of handling images when compared to that of text manipulation. In the case of image processing, the determination of high-level spatial data from low-level pixels of images is a fundamental task.

In the earlier days of mining, text based search is enough to handle the data because of its availability and it is not worthy to manipulate the rich source of images nowadays. In Image Mining, the image features are highly concentrated. The features of the image are come under classifications such as low-level and high-level visions.

The Content Based Image Retrieval (CBIR) system has attracted many researchers in recent years. In it, the researchers concentrated on developing low-level visual features namely color, shape, texture, spatial relationships [2]. The CBIR system is based on the evaluation of similarity between the image databases and the query images. Many CBIR system prototypes have been proposed and few are used as commercial systems also. The essential thing is to improve the efficiency in searching images from the image databases as according to the given query image.

II. CONTENT BASED IMAGE RETRIEVAL

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. CBIR was started in the 1990s which makes use of automatic extraction of lower level image features. There exists various advance techniques involved in the extraction of image features based on the similarity between the pair of images. In CBIR, the images are indexed by features that are directly derived from the images. The features are always consistent with the image and they are extracted and analyzed by means of computer processing. Due to the difficulty in the object recognition, information extracted from images in CBIR is low level. Retrieval effectiveness is improved by starting out with an imprecise and incomplete query and iteratively and incrementally improve the query specification [3].

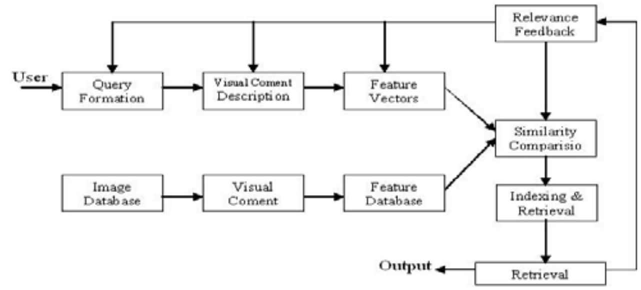

Figure 1. Content Based Image Retrieval System [16]

III. REPRESENTATION OF IMAGE DATA

The image data can be treated as a physical image representation and their meaning as a logical image representation [4, 5, 6]. The logical representation includes the description of the image, image-objects characteristics, and the relationships among the image objects.

Table I. Various techniques in Image Retrieval

Serial No	Techniques	Features	Retrieval Method
1	CBIR	Meta data, Semantic attributes, Color, Shape, Texture, Spatial	Image Content Properties
2	Clustering	Unsupervised clusters, Fuzzy logic clustering	Grouping related image data
3	K-Means	Three Matters of image; Grey, White, Dark matters	Clustering nearest mean
4	Hierarchical Clustering	Multi scale representations	Clustering cluster groups
5	RGB	Red, Green and Blue colors of pixels	Grouping based on Color

Physical Image Representation:

The most common form of the physical image representation is the *raster form*. The raster form includes the image header and image matrix. The *image header* describes the main image parameters such as image format, image resolution, number of bits per pixel, and compression information. The *image matrix* contains the image data.

Logical Image Representation:

An image object is either an entire image or some other meaningful portion of an image, which is called as semcon. The image description includes color, texture, shape, and spatial attributes. In 2-D space, many of the image features can be represented as a set of points. These points can be tagged with labels to capture any necessary semantics. Each of the individual points represents some feature of an image objects called as feature point.

a. ***Meta-attributes*** are attributes related to the process of the image creation. These attributes can be image acquisition date, image identification number and name, image modality device, image magnification, etc.
b. ***Semantic attributes*** contain subjective information about the analyzed image. A specialist in the field of the specific image collection gives the values of such attributes.
c. ***Color attributes*** could be represented as a histogram of intensity of the pixel colors. Based on a fixed partition of the image, it could be indexed by the color of the whole image and a set of inter-hierarchical distances, which encode the spatial color information. The system Color-WISE described in [7] partitions an image into 8*8 blocks with each block indexed by its dominant hue and saturation values. A histogram refinement technique is described in [6] which partitions histogram bins based on the spatial coherence of pixels. A pixel is coherent, if it is a part of some similar colored region and incoherent otherwise.

A sample histogramic representation of a query from an image is given below.

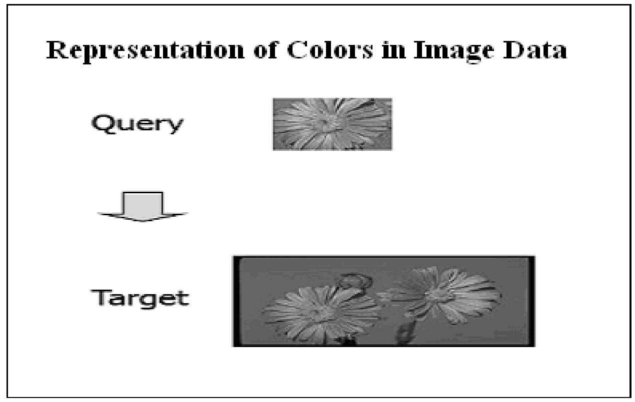

Figure 2. Color feature in an Image Representation

d. ***Texture attributes*** refers to the arrangement of the basic constituents of a material. In the digital image, texture is depicted by the spatial interrelationships between, and/or spatial arrangement of the image pixels.
e. ***Shape attributes*** techniques can be represented in two distinct categories:

a) ***Measurement-based methods*** ranging from simple, primitive measures such as area and circularity to the more sophisticated measures of various moment invariants

b) ***Transformation-based methods*** ranging from functional transformations such as Fourier descriptors to structural transformations such as chain codes [8] and curvature scale space feature vectors. An attempt to compare the various shape representation schemes is made in [9].

f. ***Spatial attributes*** could be presented in different ways:

a) ***Topological set of relations*** between two image-objects, contains the relations in, disjoint, touch, and cross.

b) ***Vector set of relations*** which consider the relevant positions of the image-objects. These include E, S, W, N, SE, SW, NW, NE in terms of the four world directions East, South, West, North.

c) ***Metric set of relations*** based on the distance between the image-objects, containing the relations close, far, very close, very far

d) ***2D-strings*** - Each image is considered as a matrix of symbols, where each symbol corresponds to an image object. The corresponding 2D-string is obtained by symbolic projection of these symbols along the horizontal and vertical axes, preserving the relative positions of the image objects. In order to improve the performance of this technique, some 2D-string variants have been proposed, such as the extended 2Dstring, 2D C-string, and 2D C+-string geometry-based θR-string approach

e) ***Spatial orientation graph***

f) ***Quad tree-based spatial arrangements of feature points approach***

IV. SIMILARITY RETRIEVAL

Let a query be converted in to an image description as *Q(q1, q2, …, qn)* and an image in the image database has the description *I(x1, x2, …, xn*). Then the retrieval value (RV) between Q and I can be defined as: *RVQ(I) = Σi = 1, …,n (wi * sim(qi, xi)),* where *wi* (*i = 1,2, …, n*) is the weight specifying the importance of the *ith* parameter in the image description and *sim(qi, xi)* is the similarity between the *ith* parameter of the query image and database image. It is calculated in the different way by depending on *qi*, *xi* are *symbol*, *numerical*, *linguistic* values, *histograms*, *attribute relational graphs* or *pictures* [10].

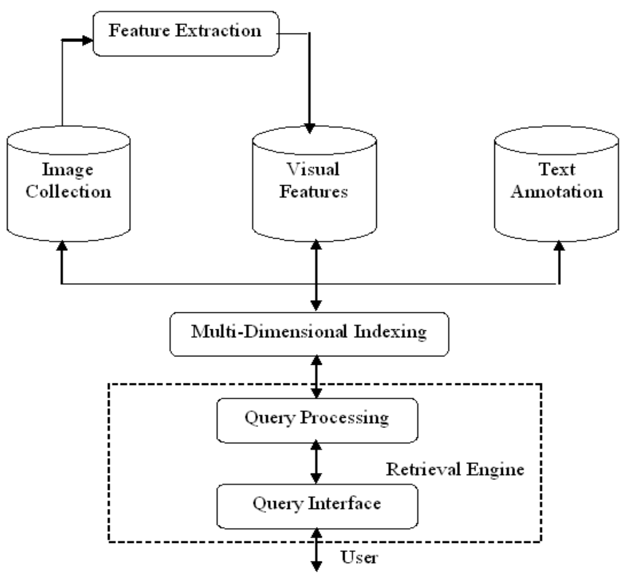

Figure 3. Image Retrieval System Architecture [17]

Minkowski-Form Distance

If each dimension of image feature vector is independent of each other and is of equal importance, the *Minkowski-form distance Lp* is appropriate for calculating the distance between two images. This distance is defined as:

$$D(I, J) = \left(\sum_i | f_i(I) - f_i(J) |^P \right)^{1/P}$$

When *p*=1, 2, and ∞, *D*(*I*, *J*) is the *L1*, *L2* (also called Euclidean distance), and *L*∞ distance respectively. Minkowski-form distance is the most widely used metric for image retrieval. For instance, MARS system [11] used Euclidean distance to compute the similarity between texture features; Netra [12, 13] used Euclidean distance for color and shape feature, and *L1* distance for texture feature; Blobworld [14] used Euclidean distance for texture and shape feature. In addition, Voorhees and Poggio [15] used *L*∞ distance to compute the similarity between texture images. The *Histogram intersection* can be taken as a special case of *L1* distance, which is used by Swain and Ballard [16] to compute the similarity between color images. As said above there exist various methods used for measuring distances between pixels.

V. INDEXING AND RETRIEVAL

Efficient image searching, browsing and retrieval tools are required by users from various domains, including remote sensing, fashion, crime prevention, publishing, medicine, architecture, etc.[18]. For this purpose, many general purpose image retrieval systems have been developed. Many picture libraries use keywords as their main form of retrieval which often uses indexing schemes, which reflects the special nature of their collections. Index terms are assigned to the whole image, where the main objects are depicted, and their settings are valued. A number of indexing schemes use classification codes rather than keywords or subject descriptors to describe image content, as these can give a greater degree of language independence and show concept hierarchies more clearly. A number of less widely-known schemes have been devised to classify images and drawings for specialist purposes.

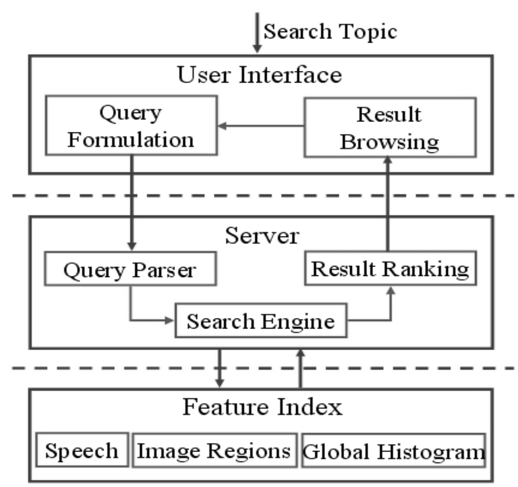

Figure 4. Representation of Feature Indexing

While indexing the images and videos, one needs to distinguish between systems which are geared to the formal description of the image which are concerned with subject indexing and retrieval. A typical system allows users to formulate queries by submitting an example of the type of image being sought. The system then identifies those stored images whose feature values match those of the query most closely, and displays thumbnails of these images on the screen. Retrieval software has been developed to allow users to submit and refine queries at a range of different levels.

VI. CONCLUSION

The technology of Content Based Image Retrieval is an exciting aspect in the field of research. The visual features that are widely used in content-based image retrieval are color, texture, shape, and spatial information. In addition, the general visual features on each pixel can be used to segment each image into homogenous regions or objects. Local features of these regions or objects can be extracted to facilitate region-based image retrieval. There are various ways to calculate the similarity distances between visual features. Efficient indexing of visual feature vectors is important for image retrieval. Image retrieval systems rely heavily on user interaction. On the one hand, images to be retrieved are determined by the user's specification of the query. On the other hand, query results can be refined to include more relevant candidates from the related feedback of users. Updating the retrieval results based on the user's feedback can be achieved by updating the images, the feature models, the weights of features in similarity distance, and selecting different similarity measures

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