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CBIR-An Overview of Architecture

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Abstract— The objective of this paper is to present a brief overview of existing Content-Based Image Retrieval (CBIR) technique and architecture.The CBIR method is used to retrieve relevant images from the database based on the query image submitted by the user. The retrieval of images from a database relies purely on the image features such as color, shape and object identification using texture in the query image. Advances in data storage and image acquisition technologies have enabled the creation of large image datasets. In this scenario, it is necessary to develop appropriate information systems to efficiently manage these collections. Basically,these systems try to retrieve images similar to a user-defined specification or pattern (e.g., shape sketch, image example). Their goal is to support image retrieval based on content properties (e.g., shape, color, texture), usually encoded into feature vectors.

Index Terms: CBIR, image database, image descriptors, indexing, effectiveness measures.

INTRODUCTION

This section gives an introduction to content-based image retrieval systems (CBIRSs) and the technologies used in them. In [1], an overview of the research domain in 1997 is given and in [2], the past, present and future of image retrieval is highlighted. In [3] an almost exhaustive overview of published systems is given and an evaluation of a subset of the systems is attempted [4]. Unfortunately, the evaluation is very limited and only for very few systems. The most complete overview of technologies to date is given by Smeulders et al.[5]. A very similar architecture for browsing and archiving/indexing images comprising tools for the extraction of visual features, for the storage and efficient retrieval of these features, for distance measurements or similarity calculation and a type of graphical user interface GUI). In general, two different approaches have been applied to allow searching on image collections: one based on image textual metadata and another based on image content information. In these systems, image processing algorithms (usually automatic) are used to extract feature vectors that represent image properties such as color , texture, and shape. In this approach, it is possible to retrieve images similar to one chosen by the user (query-by-example). One of the main advantages of this approach is the possibility of an automatic retrieval process, contrasting to the effort needed to annotate images. This article introduces the basic concepts of the CBIR domain presents an overview of the existing techniques for creating CBIR systems. Figure below shows the conventional CBIR architecture summarized from [9]. The visual and discriminate features (such as color, texture, shape and spatial) of database images are extracted and stored in the feature database. When the user submits the query images (input image), the feature vector(s) are determined using the visual contents. Then the similarities between the features of the query image and database images (also called as gallery images) are calculated. Based on the similarity measures, the relevant images from the database (if any) are retrieved.

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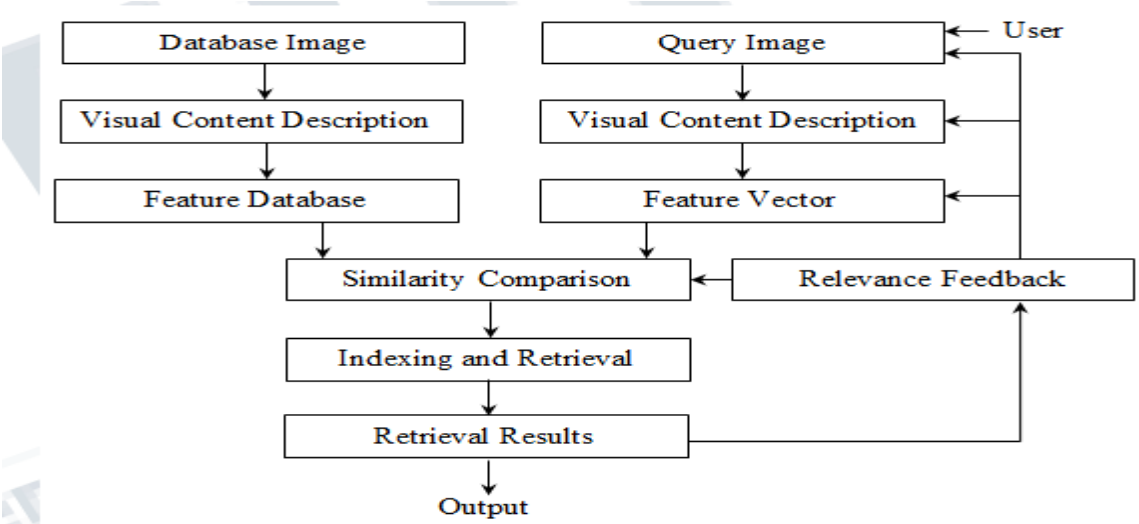

Fig. 1: Architecture of the Conventional CBIR System

Architecture of CBIR Systems:

Figure 1: shows a typical architecture of a content-based image retrieval system. Two main functionalities are supported: data insertion and query processing. The data insertion subsystem is responsible for extracting appropriate features from images and storing them into the image database. The query processing, in turn, is organized as follows: the interface allows a user to specify a query by means of a query pattern and to visualize the retrieved similar images. The query-processing module extracts a feature vector from a query pattern and applies a metric (such as the Euclidean distance) to evaluate the similarity between the query image and the database images. Next, it ranks the database images in a decreasing order of similarity to the query image and forwards the most similar images to the interface module.

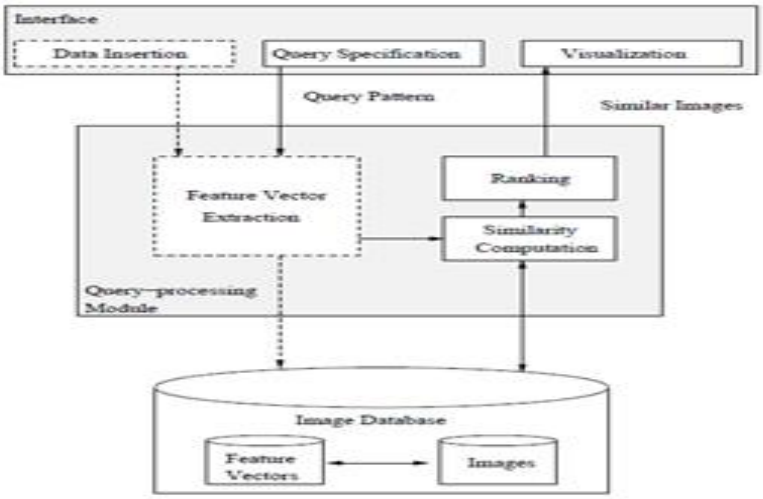

Fig.2 Architecture of CBIR System

Image, Feature Vectors, and Image Descriptors:

A typical CBIR solution requires the construction of an **image descriptor**, which is characterized by:

(i) an extraction algorithm to encode image features into feature vectors; and

(ii) a similarity measure to compare two images. The similarity measure is a matching function, which gives the degree of similarity for a given pair of images as represented by their feature vectors, often defined as an inverse function of the distance (e.g., Euclidean), that is, the larger the distance value, the less similar the images are.

Related Work:

This section aims to present a brief overview of existing approaches in the CBIR area.

Image Descriptors:

An image descriptor is a pair, feature vector extraction function and distance function, used for image indexation by similarity. The extracted feature vector subsumes the image properties and the distance function measures the dissimilarity between two images with respect to their properties. This section aims to present a brief overview of existing image descriptors.

Color Descriptors:

Color property is one of the most widely used visual feature in content-based image retrieval (CBIR) systems. Researches in this field can be grouped into three main subareas:

(a) definition of adequate color space for a given target application,

(b) proposal of appropriate extraction algorithms, and

(c) study/evaluation of similarity measures.

Texture Descriptors:

There is no widely accepted definition of texture. However, this image property can be characterized by the existence of basic primitives, whose spatial distribution creates some visual patterns defined in terms of granularity, directionality, and repetitiveness. There exists different approaches to extract and represent textures. They can be classified into space-based, frequency-based models, and texture signatures [6].

Shape Descriptors:

Shape descriptors are classified into boundary-based (or contour-based) and region based methods [7]. This classification takes into account whether shape features are extracted from the contour only or from the whole shape region.

Indexing Structures:

Not only does the effectiveness but also the efficiency (measured in terms of retrieving time) needs to be taken into account during the design of CBIR systems. Usually, fast searching strategies rely on the use of effective indexing schemes.

Effectiveness Measures: Image descriptors vary with the application domain and expert requirements. Thus, in order to identify appropriate image descriptors (used in extraction and distance computation algorithms), experts must perform a set of experiments to evaluate them in terms of effectiveness for a given collection of images. In the literature of CBIR systems, where one of the most used effectiveness measures is *Precision* × *Recall* [8]. Precision vs. Recall (P×R) curve is the commonest evaluation measure used in CBIR domain. Precision is defined as the fraction of retrieved images which is relevant to a query. In contrast, recall measures the fraction of the relevant images which has been retrieved. A recall is a non-decreasing function of rank, while precision can be regarded as a function of recall rather than rank. In general, the curve closest to the top of the chart indicates the best performance.

Conclusions:

The large number of research publications in the field of content-based medical image retrieval especially in recent years shows that it is very active and that it is starting to get more attention. This paper has presented a brief overview of content-based image retrieval area. Firstly, we have presented a set of constructs aiming to define precisely the main related concepts. Next, we have described the main issues that need to be taken into account when designing this kind of image retrieving system: definition of appropriate image descriptors, feature vector representation and indexing, interaction mechanisms, among others.

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