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Survey on Content-Based Image Retrieval System : Fundamentals and Parameters

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ABSTRACT

CBIR (Content-based image retrieval) is a challenging method of capturing related images from large storage spaces. Although this field has been explored for decades, there is no technology that can achieve the accuracy of human visual perception when distinguishing images. Regardless of the size and content of the image database, humans can easily identify images of the same category. From the very beginning of CBIR to study textures, colors and shapes are considered to be the original visual cues of the image. T Although image retrieval using texture features is not a completely new approach, there is still a range of improved retrieval accuracy by appropriately representing texture features. This paper studies the basic concepts of content-based image retrieval systems. This survey attempts to introduce the theory and practical application of CBIR technology.

Keywords : CBIR, Color, Shape, Texture, Classification, Feature vector, Similarity measure, Performance parameters

I. INTRODUCTION

Advancement in data storage and image acquisition technology has enabled the creation of large image data sets. In order to execute this data, it is necessary to develop an appropriate information system to effectively manage the data [1]. Image search is one of the most important services that such systems need to support. In general, two different methods have been applied to allow for the collection of search images: one based on image text metadata and the other based on image content information. The first retrieval method is based on attaching text metadata to each image and retrieving them by keyword using traditional database query techniques [2]. Though, these systems require prior database image annotations, which is a very laborious and time consuming task. In addition, the annotation process is often inefficient because users typically do not comment in a systematic manner. In fact, different users tend to use different words to describe the same image features. The lack of systematic reduction in the annotation process reduces the performance of keyword-based image searches. The so-called CBIR (Content-based image retrieval) system has solved these shortcomings [3]. In these systems, image processing algorithms (usually automated) are used to extract feature vectors that represent image attributes such as colour, texture, and shape. In this method, an image similar to the image selected by the user can be retrieved (by an example query). One of the main advantages of this approach is the possibility of an automated retrieval process that contrasts with the effort required to annotate the image [4]. To provide the satisfactory answer to the user query, CBIR provides some flow of work. Firstly CBIR system takes the RGB image as an input, performs feature extraction, performs some similarity computations with the images stored in database and retrieves the output image on the basis of similarity computation. There are some basic CBIR fundamentals and are divided into three parts such as feature extraction,

multidimensional indexing and Retrieval system architecture [5].

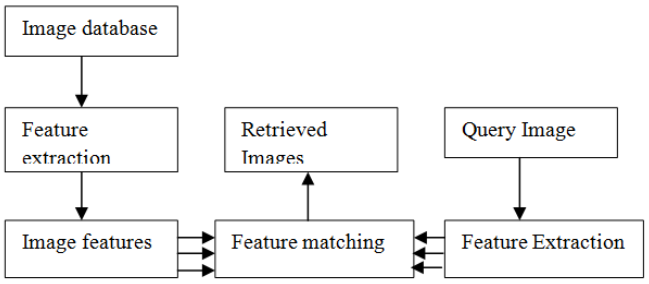

Figure 1 : CBIR Structure

The overall structure of the CBIR system is shown in Figure 1. For a given image database, features are first extracted from a single image. These features may be visual features such as colour, texture, shape, region or spatial features or certain compression domain features. The extracted features are described by feature vectors. These feature vectors are then stored to form an image feature database. For a given query image, we also extract its features and form feature vectors [6]. This feature vector matches the stored vector in the image feature database. Dimensionality reduction techniques are sometimes used to reduce the amount of calculations. The distance between the feature vector of the query image and the feature vector of the image in the database is then calculated. If the query image is in the database, its distance from itself is zero. The distances are then stored in increasing order and retrieval is performed with the help of an indexing scheme. A feature vector is a set of numeric parameters that describe an image [7]. Most such vectors represent an image feature, such as the colour, texture, or shape of an object. The feature vectors generated by the same algorithm form a space of feature vectors. Text annotations for image descriptions are classified as advanced features. Features such as colour and texture are called low-level features. The shape of an object in an image that can be obtained by analyzing an area existing in an image is classified into a low-level feature [8].

1. CBIR fundamentals

There are some basic CBIR basics that are divided into three parts, such as feature extraction, multidimensional indexing, and retrieval system architecture [9]:

i. Feature Extraction

Features are categorized into two categories, based on text and based on vision. Text features are keywords, tags, notes, and more. Visual features are colour, space and texture. Visual features are an important feature of image recognition images.

Table 1 : Visual features

Features	Description
Color	This is one of the most important features of CBIR. Histograms, based on blocks, color histogram moments are some examples of using color features to retrieve images.
	It is widely used for image representation and is independent of the size of the image. Color feature extraction uses color space, color quantization, and similarity to measure key components.
	RGB and HSV are two color-based and hardware-based color models for feature extraction.
Texture	The texture describes the visual pattern, which contains important information about the arrangement of the surface structure, including clouds, trees, bricks, hair and fabric and their relationship to the surrounding environment.
	Some methods for classifying textures include: • Color Co-Occurrence Matrix

	• Low Texture Energy • Wavelet Transform
Shape	Shape does not refer to the shape of the image, but to the shape of the particular area being sought.
	Shape descriptors may also need to be unchanged for translation, rotation, and scaling. Some shape descriptors include: • Fourier Transform • Moment Invariant

ii. Multidimensional Indexing

Multidimensional indexing techniques are primarily used to make CBIR truly scalable large-size image collections. Most images have a high dimension. Therefore, the best way to index such images is to lower the dimensions and then index the images [10]. For dimensionality reduction, clustering is used. Clustering can be used in a variety of forms, such as pattern recognition, speech analysis, and information retrieval. Clustering can be performed in rows and columns to perform identification or grouping.

iii. Retrieval System Architecture and Similarity matching

The image is indexed after feature extraction and then similarity measurements are performed. A similarity assessment is performed between the features of the query image and the features of the target image in the database. The similarity measure calculates the similarity between a pair of images. It represents the distance between the feature vectors representing the image. The distance between similar images should be small, and the distance between different images should be large.

Following are some of the applications that primarily use CBIR technology.

- CBIR is very popular among police forces for image recognition in crime prevention
- Medical diagnosis
- Architectural and engineering design
- Fashion and publishing
- Geographic information and remote sensing
- family entertainment

II. CBIR TECHNIQUES

In many applications, there are techniques for content-based image retrieval systems for image retrieval [11].

Table 1 : CBIR techniques

Techniques	Description
Relevance Feedback	Different users may have different needs depending on the time.
	The user follows the following typical CBIR related feedback scheme: i) The machine provides early image retrieval results. ii) The user provides his opinion as to whether the retrieved image is relevant. iii) The machine takes user feedback and searches for images again based on user queries.
Semantic Template	This technique was generated to support advanced image retrieval and is not so widely used.
	This technique is usually defined as a representative feature of the concept computed from a sample image set.
Wavelet Transform	Wavelet transforms are based on wavelets called wavelets, which have varying frequencies and limited duration.

	The discrete wavelet transform divides the image into four distinct parts, the high frequency part (HH), the high and low frequency part (HL), the low high frequency part (LH) and the low frequency part (LL).
	After the vertical portion is decomposed as a level 1 image, it calculates the time of all parts and stores it as a feature for acquiring the image.
Gabor Filter	It is widely used for texture analysis because of its similar characteristics to human perception.
	The two-dimensional Gabor function g(x, y) consists of sinusoidal plane waves of some frequencies and directions (carriers) and is two-dimensionally translated. The Gaussian envelope is used to modulate it.
Support Vector Machine	It is a supervised learning technique in which data is analyzed and patterns are identified for classification purposes.
	In the classification, it takes the input set, reads it and forms an output for each required input, and performs regression if the output is continuous.

2. Similarity And Performance Measurement Parameters

i. Similarity Feature Extraction

These are used to compare similarity features of various features. In order to retrieve similar images from a large image database, three types of measurements are used for similarity extraction [12].

a) Euclidean Distance

The Euclidean distance is described as the displacement of the pixel from the nearest background point. The Euclidean distance equation is:

$$d = \sum (a_i - b_i)^2$$

b) Chi Square Distance

The Euclidean distance between the components of profiles, on which weighting is defined (weight means the inverse of its frequency), is called the chi-square distance. The equation of Chi-square distance is:

It defines the Euclidean distance among weighted contour components (weight means the reciprocal of its frequency) is known as chi-square distance. The chi-square distance equation is:

$$y^2th = \sqrt{\sum_{k=1}^{q} \frac{1}{b+k} \left[\frac{b_{ik}}{bi+} - \frac{b_{jk}}{bj+} \right]^2} \ldots\ldots$$

c) Weighted Euclidean Distance

It Multiplies the squared difference by the equivalent weight is called as weighted Euclidean distance. The weighted Euclidean distance formula is:

$$d(y,x) = \sqrt{\sum_{k=1}^{k} \frac{1}{R_k^2} (y_k - x_k)^2}$$

ii. Performance Parameters

Evaluation of the retrieval process is a key issue in CBIR. Different methods are used to measure the performance of the retrieval system. The most common performance parameters are Precision and Recall [13].

a) Precision

Precision rate is defined as a ratio of number of retrieve relevant images similar to the query to the total number of retrieved images in response to query It is described as the ratio of the amount of search related images similar to the query to the total amount of retrieved images in response to the query.

$$Precision = \frac{\text{Amount of relevant images retrieved}}{\text{Total amount of images retrieved}}$$

b) Recall

It is described as the ratio of the amount of search related images similar to the query to the total amount of related images available in the database.

$$Recall = \frac{\text{Amount of relevant images retrieved}}{\text{Total amount of images in database}}$$

III. CONCLUSION

This article reviews the basic concepts of content-based image retrieval. Matching images using visual features such as textures, color and shape feature vectors can provide better areas. While content-based retrieval provides an automated and intelligent solution for efficient search of images, most current technologies are based on low-level features, or current technologies are primarily based on low-level features. For similarity measurements, Euclidean distance, weighted Euclidean distance and chi-square distance can be used. For performance measurements, precision and recall can be used. Content-based methods provide some clear directions for image retrieval. But in general, the results are based on the similarity of pure visual features and are not always meaningful in terms of perception and semantics.

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