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Short Review Paper

A Survey on Content Based Image Retrieval System

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Abstract

Owing to information explosion, image databases are growing at the same pace as text and multimedia content. To organize and to search a desired image relevant to the content becoming a crucial problem that demands for efficient and effective tools in this context. Content based image retrieval systems (CBIR) have become very popular offering relatively less/nil human intervention. Efficient automatic image indexing is a real challenge for computer vision and content based image retrieval. In content based image retrieval system, an image is searched based on the contents similar to the query image. The image content can be described by a set of local features. In this paper, an overview of various attributes of an image is provided that are used in designing an efficient and inexpensive image indexing technique, the problems and challenges of different data storage structure for content based image database system. An attempt is also made to describe the existing solutions and applications in this area.

Keywords: Content Based Image Retrieval, Image Databases, Image Attribute, Image Indexing.

Introduction

Conventional image searching techniques is text-based as they index images by their names, captions, and other descriptive keywords. As a Human being we judges similarity of images according to their semantic contents. A visual object contains metadata and visual features. Metadata, textual attributes about the object, are extracted manually and stored together with visual object. Visual features are derived using feature extraction algorithms. The main objective of CBIR system is to search similar images based on their content. Content-based image retrieval mainly uses low level features like color, shape, texture and spatial information based on pixel values to describe and index the images. Content based Image retrieval system is basically used to search images that are visually similar with the query image.

Image Content Descriptors

An Image content can be classified as visual and semantic content. Visual content is very common or domain specific. Color, texture, shape, spatial relationships are the common visual content descriptor. Domain specific visual contents are application specific that content domain knowledge. Semantic content is obtained either by textual annotation or by complex inference procedures based on visual content.

Color: Color is the most extensively used visual content for image retrieval. Before selecting an appropriate color description, we have to decide a color space. A pixel image can be represented as a point in a color space. Mostly used color spaces RGB, CMY, CIE L*a*b*, CIE L*u*v*, HSV (or HSL, HSB) etc[1]. To describe an image, color histogram, color coherence vector, color correlogram, and color moments are used mostly. If number of image increases, histogram comparison gives poor result. One of the solutions is the joint histogram technique[1].

Texture: Texture finds the visual patterns in the images. It is useful to distinguish images with similar colour such as leaves and grass, sky and sea etc. It is easy to measure image texture using degree of contrast, coarseness, line-likeliness, roughness, degree of directionality, regularity, periodicity and randomness[2,3]. In statistical approach, texture is considered as a quantitative measure to describe arrangement of intensities in a particular region. Commonly used statistical methods includes Fourier power spectra, Co-occurrence matrices, Shift-invariant principal component analysis (SPCA), Tamura feature and Multi-resolution filtering techniques such as Gabor and wavelet transform[1,4]. Co-occurrence matrix can be used to calculate different feature like energy, inertia, correlation, difference moment, entropy[5].

Shape: Shape features used to describe a regions or objects within an image. Shape descriptors are classified into Region based, uses the whole area of an object for shape description, and Contour-based, uses only the information present in the contour of an object. Features calculated from objects are contour circularity, aspect ratio, discontinuity angle irregularity, length irregularity, complexity, right-angleness, sharpness, directedness etc[5].

Spatial Information: The performance of CBIR system can be improved if spatial locations of content objects in the image are considered. The spatial location of objects and how they are related can be used as discriminating information in CBIR applications. For example, if blue sky and ocean is considered, their color histograms may be same, but their spatial locations are different[6]. The most widely used representations of spatial relationship are the 2D strings, 2D G-string, 2D C-string, 2D B-string, spatial quad-tree, and symbolic image[1].

Working Principle

Content-based image retrieval (CBIR) systems works in two phases called indexing and searching. Indexing phase extracts features. Extracted features used for indexing while storing in a visual feature database. In the searching phase, when a user submits a query image, again query image feature vector is computed and compared to the vectors in the feature database. The image most similar to the query (or images for range query) is returned to the user. Figure-1 shows the basic architecture of CBIR System.

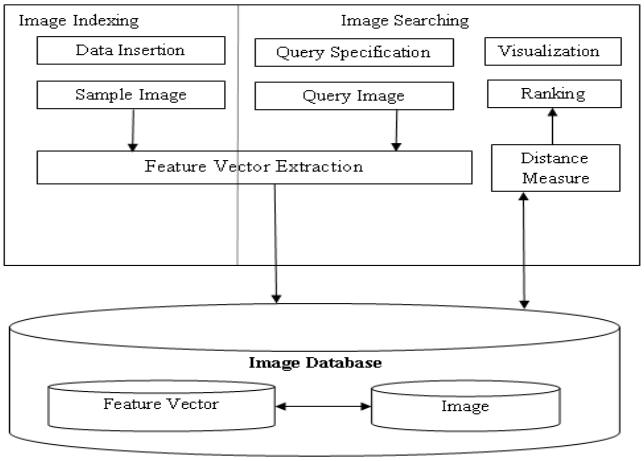

Figure-1
Typical Architecture of Content Based Image Retrieval System

Image Indexing

Effective indexing means fast searching of images based on visual features. The feature vectors of images tend to have high dimensionality. Dimension is reduced before setting up an efficient indexing scheme. Various tools for features dimension reduction are principal component analysis (PCA), Karhunen-Loeve (KL) transform and neural network. After that the images are indexed using various approaches like R-tree, R^+ tree, R*-tree ,Buddy tree, P tree, X tree, SR-Tree, SS-Tree, TV-Tree, linear quad-trees, K-d-B tree , G-Tree, MB+ tree, BV tree, hB tree, VP, MVP Trees LSD-Tree, and grid files[7,8]. Most of have good performance for a small dimensions (< 20). When dimension increases it explores exponentially and eventually reduces to sequential searching.

Image Searching

CBIR System calculates visual similarities between a query image and stored images. Search result may be a single image or group of images ranked by their similarities with the query image.

The indexing technique satisfies several different types of queries. Range query returns all images within a specified region in the image vector space. If the specified region is very small as a single point then the query is the exact match or point query. In Nearest neighbour query, the users request a number of data elements those are belongs to a specified region in the multidimensional space. Spatial join return pairs of similar data elements. For example, find the redundant images in a database[7]. For these queries define a similarity function which takes two images as input and returns a scalar value as output which is called the distance. The distance measures the similarity between the two images. The query is returns pairs of images whose distance is less than some specified value[8].

Some popular similarity measures or distance measure techniques are Euclidean Distance, Minkowski-Form Distance, Quadratic Form (QF) Distance, Mahalanobis Distance, Kullback-Leibler (KL) Divergence and Jeffrey-Divergence (JD)[1].

Multidimensional indexing provides an ordering and grouping of similar elements together so that searching can be done very fast.

Performance Metrics

Performance of retrieval system can be measured by recall and precision[9]. They are defined as: Precision = (No. of relevant images retrieved / Total no. of images retrieved). Recall = (No. of relevant images retrieved / Total No. of relevant images in the collection).

Graphical representations of Precision and recall, also called graph PR graph, is a standard evaluation method mostly used by the CBIR community.

Some other performance measure metrics are average-precision, before-after comparison, rank of the best match, average rank of relevant images, target testing, error rate, retrieval efficiency, correct and incorrect detection etc[10,11].

Application

CBIR plays an important role in various application areas such as remote sensing and satellite imaging, GIS, architectural and engineering, invention, vehicle identification, journalism data management, education and training services and general consumer use[12]. In military applications, it is useful to recognize enemy aircraft from radar screens, identify targets from satellite

photographs, and guide cruise missiles. In medical diagnosis, it finds images relating to a named patient, identifies similar past cases[13]. Some popular existing CBIR systems are IBM's QBIC, WebSeek, MIT's Photobook, NETRA, Chabot, SYNAPSE etc[14,15].

Conclusion

The main challenge in CBIR system is time complexity to search relevant images. We also have to design a good, efficient GUI. In this paper we have reviewed different attributes of the image that are used to describe the content of an image and various techniques for indexing based on feature vector. It is showing that most content-based image retrieval system deals with low level features. In future we have to include features at a higher semantic level. It also gives an overview of existing performance evaluation measures in CBIR system. We also have to measure the usefulness of a system for a user.

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