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A Study on Feature Extraction and Image Retrieval for Image Mining

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Abstract

This paper provides a comprehensive survey of the technical achievements in the research area of image retrieval, especially content-based image retrieval, an area that has been so active and prosperous in the past few years. The survey includes the research aspects of image feature representation and extraction, multidimensional indexing, and system design.

1. Introduction

Feature (content) extraction is the basis of content-based image retrieval. In a broad sense, features may include both text-based features (key words, annotations) and visual features (color, texture, shape, faces). However, since there already exists rich literature on text-based feature extraction in the DBMS and information retrieval research communities, we will confine ourselves to the techniques of visual feature extraction. Within the visual feature scope, the features can be further classified as general features and domain- specific features.

The former include color, texture, and shape features while the latter is application-dependent and may include, for example, human faces and finger prints. The domain-specific features are better covered in pattern recognition literature and may involve much domain knowledge which we will not have enough space to cover in this paper. Therefore, the remainder of the section will concentrate on those general features which can be used in most applications. Because of perception subjectivity, there does not exist a single best presentation for a given feature.

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1.1. Color

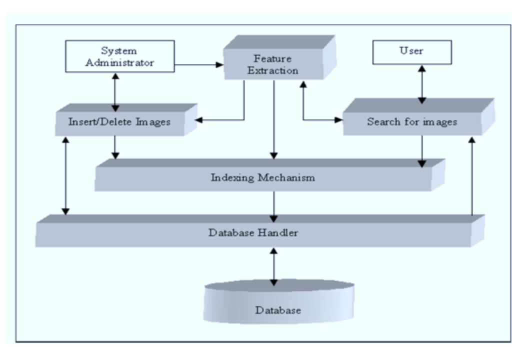

Fig: 1. Feature Extraction

The color feature is one of the most widely used visual features in image retrieval. It is relatively robust to background complication and independent of image size and orientation.

In image retrieval, the color histogram is the most commonly used color feature representation. Statistically, it denotes the joint probability of the intensities of the three color channels. Swain and Ballard proposed histogram intersection, an L 1 metric, as the similarity measure for the color histogram. To take into account the similarities between similar but not identical colors, Ioka and Niblack et al. introduced an L 2 -related metric in comparing the histograms. Furthermore, considering that most color histograms are very sparse and thus sensitive to noise, Stricker and Orengo proposed using the cumulated color histogram. Their research results demonstrated the advantages of the proposed approach over the conventional color histogram approach.

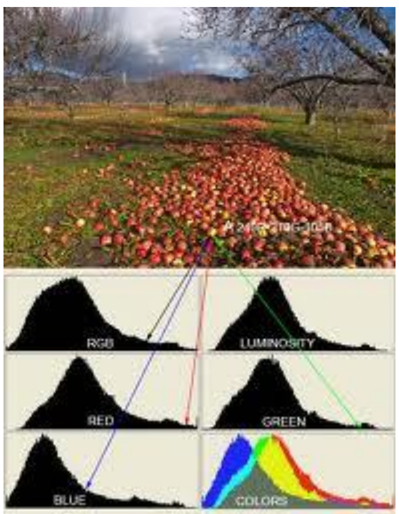

Fig: 1.1. Color Histogram Approach

The mathematical foundation of this approach is that any color distributions can beeches are cauterized by its moments. Furthermore, since most of the information is concentrated on the low-order moments, only the first moment (mean), and the second and third central moments (variance and Sleekness) were extract edams the color feature are presentation. Weighted Euclidean distance was used to calculate the color similarity.

1.2. Color Layout

Although the global color feature is simple to calculate and can provide reasonable discriminating power in image retrieval, it tends to give too many false positives when the image collection is large. Many research results suggested that using color layout (both color feature and spatial relations) is a better solution to image retrieval. To extend the global color feature to a local one, a natural approach is to divide the whole image into sub blocks and extract color features from each of the sub blocks.

A variation of this approach is the quad tree based color layout approach, where the entire image was split into a quad tree structure and each tree branch had its own histogram to describe its color content. Although conceptually simple, this regular sub block-based approach cannot provide accurate local color information and is computation and storage-expensive.

Fig: 2. Color layouts for 300Px Image

2. Segmentation

Segmentation is very important to image retrieval. Both the shape feature and the layout feature depend on good segmentation. In this subsection we will describe some existing segmentation techniques used in both computer vision and image retrieval.

In Lybanon et al. research endomorph logical operation (open in grand closing) approach in image segmentation. They tested their approach in various types of images, including optical astronomical images, in faredoce an images and magneto grams. While this approach was effective in dealing with the above scientific image types, its performance needs to be further evaluated for more complex natural scene images.

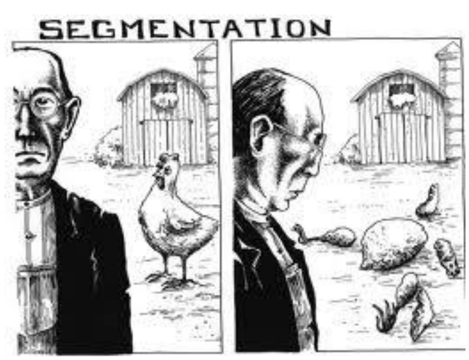

Fig: 3. Segmentation of an Image

In Hansen and Higgins exploited the individual strengths of watershed analysis and relaxation labeling. Since fast algorithm exists for the watershed method, they first used the water shed to subdivide an image into catch men basins.

They then used relaxation belling to refine and update the classification of catch men basins initially obtained from the watershed to take advantage of there lavational belting's robustness to noise.

This approach is based on the fact that local entropy maxima correspond to the uncertainties among various regions in the image. This approach was very effective for images who see his to grams do not have clear peaks and valleys. Other segmentation techniques based on Delaunay triangulation, fractals, and edge flow.

3. High Dimensional Indexing

To make the content-based image retrieval truly scalable to large size image collections, efficient multidimensional indexing techniques need to be explored. There are two main challenges in such an exploration for image retrieval.

High dimensionality, the dimensionality of the feature vectors is normally of the order of 10. Non-Euclidean similarity measure, Since Euclidean measure may not effectively simulate human perception of a certain visual content, various other similar it measures, such as histogram intersection, cosine, correlation, need to be supported.

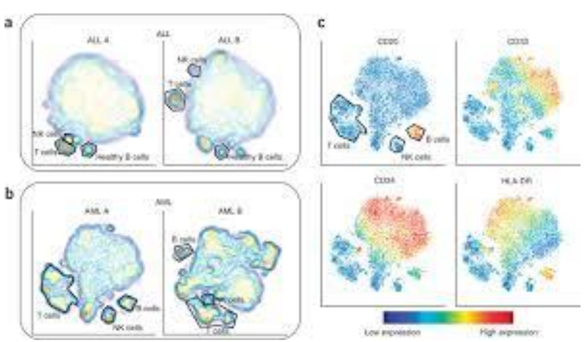

Fig: 4. High Dimensional Indexing for Cancer samples

Towards solving these problems, one promising approach is to first perform dimension reduction and then to use appropriate multidimensional in dexing techniques, which are capable of supporting non-Euclidean similar it measures.

3.1. Dimension Reduction

Even though the dimension of the feature vectors in image retrieval is normally very high, the embedded dimension is much lower. Before we utilize any indexing technique, it is beneficial to first perform dimension reduction. At least two approaches have appeared in the literature, i.e. Karhunen Loe veterans form (KLT) and column-wise clustering.

KLT and its variation in face recognition, Eigen image, and its variation in information analysis, principal component analysis (PCA), have been studied by researchers in per- forming dimension reduction. I, Ng and Sedighi an followed the Eigen image approach to carry out the dimension reduction, and in fall out sand Lin proposed a fast approximation to KLT toper form the dimension reduction. Experimental results from their research showed that most real data sets (visual feature vectors) can be considerably reduced in dimension without significant degradation in retrieval quality. Recently, Chandra sekaran et al. developed allow-rank singular valued composition (SVD) update algorithm which was efficient and numerically stable in performing KLT. Considering that the image retrieval system is a dynamic system and new images are continuously added to the image collection, a dynamic up date of indexing structure is indispensably needed. This algorithm provides such a tool.

In addition to KLT, clustering is another powerful tool in performing dimension reduction. The clustering technique is used in various disciplines such as pattern recognition speech analysis, and information retrieval.

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