A Review on Feature Extraction Techniques for CBIR

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Abstract - Content Based Image Retrieval (CBIR) is becoming effective source of fast retrieval on Image database for current internet world as it contains large collections of images. Content Based Image Retrieval (CBIR) is a technique which uses visual features of image such as color, shape, texture, etc. to search user required image from large image database according to user's requests in the form of a query image. Images are retrieved on the basis of similarity in features where features of the query specification are compared with features from the image database to determine which images match similarly with given features. Feature extraction is a crucial part for any of such retrieval systems. In this paper we survey some technical aspects of current content-based image retrieval systems and the features extraction techniques like color histogram, texture, and shape is done. Also paper gives the comparative analysis of mentioned techniques with different metrics.

Keywords - Content-Based Image Retrieval (CBIR), Color Histogram, Texture, HSV Color and Wavelet decomposition.

1. Introduction

The content based image retrieval system mainly design for solving the various problem like analysis of low level image feature, multidimensional indexing and data visualization. Content based image retrieval system does not depended on the additional image information such as time and place of the creation or text annotation. The content based image retrieval system is depended on the content of image. Image mainly contains visual content and the semantic contain. The visual content of image are color, shape, texture and the semantic content are complex and dependent on the visual content. Image if we deal with the human eyes the color is main part of image which we used for the image reorganization and verification but if we deal with the sign of images similar images are having the same sign. So the color is not enough to retrieve images so the texture of image is also used for the image retrieval system. Semantic Feature: Also known as the high level feature like text annotation. Visual Feature: Also known as the low level feature like Color, texture and shape.

Fig 1: Techniques for content based image retrieval system

2. Color Feature

Color feature is the most important and significant feature for searching image from collection of images. The color property is one of the most widely used visual features. Color feature is the most significant one in searching collections of color images of arbitrary subject matter. Color plays very important role in the human visual perception mechanism. Besides, image color is easy-to analyze, and it is invariant with respect to the size of the image and orientation of objects on it. This explains why the color feature is most frequently used in image retrieval, as well as the fact that the number of fundamentally different approaches is not too great.

The color feature can be extracted from many methods as follow

1. Histogram method
2. Statistical method
3. Color model

2.1 Color histogram

Color Histogram can be classified into the following type
Color histogram is simplest and most frequently used to represent color. The color histogram serves as an effective representation of the content. The color pattern is unique compared with the rest of data set. The color histogram is easy to compute and effective in characterizing both global and local color.

In color histogram the number of pixel of given color is calculated the color histogram extraction algorithm involves following three steps.

1) Partition of color space into cells.
2) Association of each cell to a histogram bin.
3) Counting of number of image pixel of each cell and storing this count in the perspective corresponding histogram bin.

2.2 Color Model

The color model and color space are also known as the color system. Subspace within the system where each color is represented by the single point. Therefore in color space each color has its color co-ordinates.

Following are some most frequently used color model.

- RGB model stands for the red green blue model which used in color monitoring and camera’s
- CMY model cyan magenta and yellow or CMYK stands for cyan, magenta yellow, and Black used for color printer.
- HSV stands for Hue, Saturation value. We can use the various techniques to convert from one model to another model. The RGB is most traditional space which used to representing digital image.

2.3 Statistical Model

Statistical model is alternative to the histogram model for color representation. This model is based on probability distribution of indivisible color. The QBIC system uses the color moment.

The first order (mean)

The second order (variance)

The third order (skewness)

\[
\mu = \frac{1}{N} \sum_{i=1}^{N} f_{ij}
\]

\[
\sigma = \left( \frac{1}{N} \sum_{j=1}^{N} (f_{ij} - \mu)^2 \right)^{1/2}
\]

\[
S_t = \left( \frac{1}{N} \sum_{j=1}^{N} (f_{ij} - \mu)^3 \right)^{1/3}
\]

Where \( f_{ij} \) is the value of the \( i^{th} \) color component of image pixel \( j \) and \( N \) is the number of pixel in the image. Generally the color moment is used as the first filter to cut down the search space before other color feature used for the retrieval.

3. Texture Feature

Similar to color feature the texture feature is also important for the image retrieval. The texture gives us information on the structural arrangement of surface and object on the image. Texture characterized by the basic primitives whose spatial distribution creates some visual pattern defined in term of granularity, directionality and repetitiveness.
3.1 Statistical Feature

The most frequently used statistical feature include:

- General statistical parameter calculated from pixel intensity values.
- Parameter calculated based on co-occurrences matrix.
- Texture histogram build upon Tanura feature.

Tanura feature: It contains set of visual feature. The set is coarseness, contrast, directionality, regularity, roughness.

Coarseness: is measure of granularity of texture.

Contrast: It measures how gray level varies in image and what extend their distribution towards black or white.

Directionality: is measure the frequency distribution of oriented local edge against their directional angle.

Regularity: it defines as

\[ F_{\text{reg}} = 1 - r(S_{\text{c}} + S_{\text{con}} + S_{\text{dir}} + S_{\text{im}}) \]

where \( r \) is normalizing factor and each \( S \).

Roughness: Is summation of coarsness and contrast measure.

\[ F_{\text{rgh}} = F_{\text{cn}} + F_{\text{con}} \]

Co-Occurrence matrix

The co-occurrence matrix is also known as gray level co-occurrences matrix. This is first method of Texture feature. The co-occurrence matrix is defined as frequency matrix of pair of pixels of certain intensity levels with respect to one another.

Let consider the image \( I \) of size \( N \times M \), then Co-occurrences matrix defined as

\[ C(I,j) = \sum_{p=1}^{N} \sum_{q=1}^{M} \{ 1, \text{ if } I(p,q) = i \, \text{ and } \, I(p+\Delta x, q+\Delta y) = j \} \]

O, otherwise.

3.2 Spectral Method

The spectral approach for texture analysis deals with images in the frequency domain hence this methods requires Fourier transformation to be carried out on the original images to acquire their corresponding representations in the frequency space. The 2-D power spectrum of an image reveals much about the periodically and directionality of its texture. An image of coarse texture would have a tenancy towards low frequency components in its power spectrum, whereas another image with finer texture would have higher frequency components for instance. Stripes in one direction would cause the power spectrum to concentrate near the line through the origin and perpendicular to the direction.

3.3 Gabor Filters

Gabor filters transform is a good multi resolution approach which represents the texture of an image. It is an effective way using multiple orientations and scales. The 2-D Gabor function can be specified by the frequency of the sinusoid \( W \) and the standard deviation \( \sigma_x \) and \( \sigma_y \), of the Gaussian envelope as:

\[ g(x,y) = \frac{1}{\sigma_x \sigma_y} \exp\left(-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right) + 2\pi j W x \right) \]

3.4 Wavelet-Based Texture Description

Region-based image retrieval was proposed to extend content-based image retrieval so that it can cope with the cases in which users want to retrieve images based on information about their regions. The region-based systems which use wavelet transform are classified into three categories: a hierarchical block, a moving window and a pixel. Since these methods are subject to some limitations, several improvements have been proposed. Then the texture features are calculated from wavelet coefficients of all regions (sub bands).

The segmented regions are indexed by the averaged features in the regions. After decomposing the image into non[100]. Wavelet analysis performs decomposition of signals in terms of a special basis. The basis wavelet functions are constructed from one mother wavelet function obtained by performing translation and scaling operations. The best result was achieved for the wavelet.

Approach and homogeneous decomposition, accuracy of such results was greater than 90%. This wavelet transform is known as pyramidal wavelet transforms (PWT). But this
technique has one disadvantage that frequency bands obtained are in logarithmic relation. However, this difficulty can be overcome by using tree-structured wavelet transform (TWT) in which extension of the wavelet transform that is wavelet packages. This method is suggested in 1992 by Coifman and Wickerhauser [34]. Results of experiments on comparison of efficiencies of various transformations for obtaining texture features is presented in Chang and Kuo[16].

4. Conclusion

It is concluded that a wide variety of CBIR algorithms have been proposed in different papers. The selection feature is one of the important aspects of Image Retrieval System to better capture user's intention. It will display the images from database which are the more interest to the user. The purpose of this survey is to provide an overview of the functionality of content based image retrieval systems. The color moment have the highest precision to extract for color feature and Gabor filter have highest precision for texture feature detection. Future work may include development of CBIR system for multimedia application.

References


