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RESEARCH ARTICLE

Novel Techniques for Color and Texture Feature Extraction

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Abstract

Content based image retrieval (CBIR) is a challenging problem due to large size of the image database, difficulty in recognizing images, difficulty in devising a query and evaluating results in terms of semantic gap, computational load to manage large data files and overall retrieval time. Feature extraction is initial and important step in the design of content based image retrieval system. Feature extraction is a means of extracting unique and valuable information from the image. These features are also termed as signature of image. Feature extraction of the image in the database is done offline therefore it does not contribute significantly in computational complexity. Humans tend to differentiate images based on color, therefore color features are mostly used in CBIR. Color moment is mostly used to represent color features especially when image contain just an object. Regularity, directionality, smoothness and coarseness are some of the texture properties perceived by human eye. Gabor filter and wavelet transform for texture feature extraction has proved to be very effective in describing visual content via multi-resolution analysis. The paper mainly gives the brief ideas of existing retrieval techniques. Also paper gives the comparative analysis of mentioned techniques with different metrics.

Keywords – CBIR, color features, texture features

Introduction

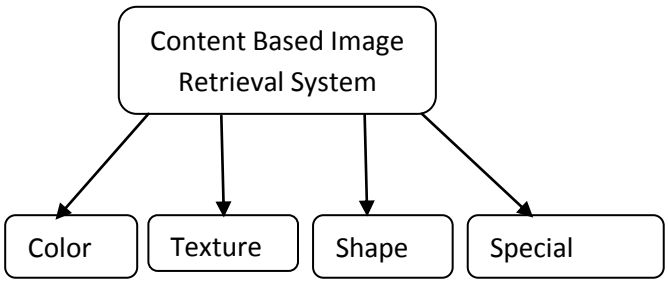
The content based image retrieval system mainly design for solving the various problem like analysis of low level image feature, multidimensional indexing and data visualization.

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.\



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

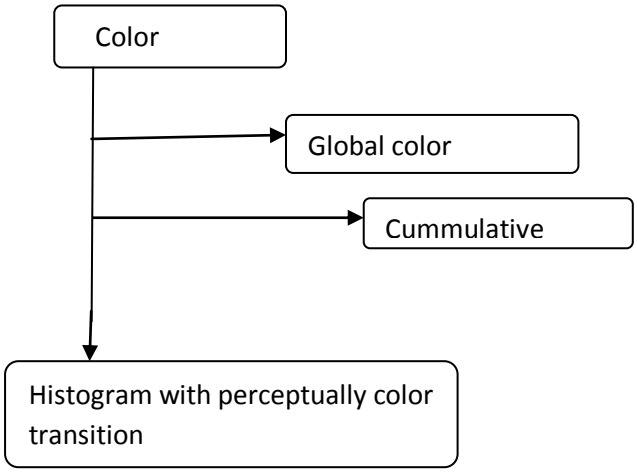
1) Histogram method

2) Statistical method

3) Color model

- **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.

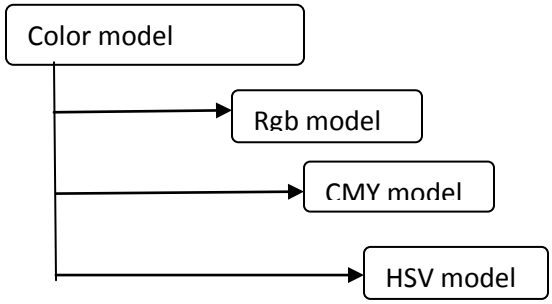
In color histogram the number of pixel of given color is calculated the color histogram extraction algorithm involves following three stapes.

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.

Color model

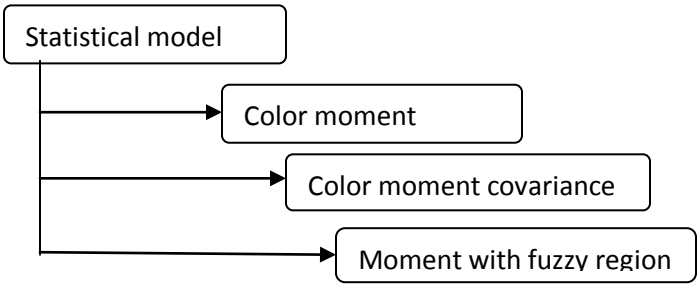


The color model and color space are also known as the color system. Subspace within the system where each color is represented by the single point .Therefore in color space each color has its color co-ordinates.

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.

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)

$$\mu i = 1/N \sum_{j=1}^{N} fij$$

$$\sigma i = (\frac{1}{N}\sum_{j=1}^{N}(fij - \mu i)^{2)^{1/2}}$$

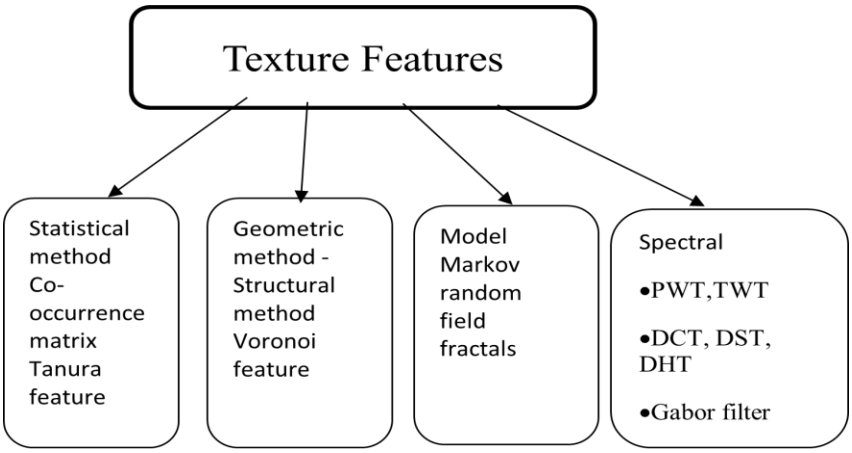
$$Si = (1/N\sum_{j=1}^{N}(fij - \mu i)^3)^{1/3}$$

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.

Method name	**Recall**	**precision**
Color histogram	56.77%	23.02%
Color model	55.98%	25.06%
Color moment	67%	10%

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.



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_{reg} =1-r(s_{crs}+S_{con}+S_{dir}+S_{lim}) where r is normalizing factor and each S.

Roughness: Is summation of coarsness and contrast measure.

$$F_{rgh}= F_{crs} + F_{com}$$

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*M, then Co-occurrences matrix defined as

$$C(I,j)=\sum^{N}_{p=1}\sum^{M}_{q=1}\{ 1 , \text{if } I(p,q)=i$$

$$I(p+\Delta x,q+\Delta y)=j$$

$$O, \text{otherwise. } \}$$

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.

Gabor filters

Gabor filters transform is a good multiresolution 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 *σx* and *σy*, of the Gaussian envelope as:

$$g(x,y) = \frac{1}{\sigma_x \sigma_y} \exp(-\frac{1}{2}\left(\frac{x^2}{\sigma^2{}_x} + \frac{y^2}{\sigma^2{}_y}\right) + 2\pi j W_x$$

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[35].

ICA Filters

Maximum methods of texture description have one common characteristic that they are universal for all types of images analyzed. But methods are based on the idea of expansion of the image in terms of a basis obtained by analyzing a training set of images. ICA filter is an example of such methods. ICA filter obtained by applying the independent component analysis to the training set. ICA filters explain in [44–46]. The construction of ICA filters similar to the training process of the human vision system. Human vision system gives us sense to assume that the result of image comparison. The use of these filters will be in agreement with the human perception of image similarity.

Method name	**precision**
Co-occurrence matrix	19.8%
Gabor filter	35.5%
Tamura feature	20.7%

Conclusion

A detailed classification of color and texture features is presented in paper. In this survey we discuss the various techniques of color and texture feature detection like histogram and statistical method for color detection and statistical and spectral methods for texture detection. In which color moment have the highest precision to extract color feature and Gabor filter have highest precision for texture feature detection. Future work may include combination of color moment and gabor filter which would lead to higher precision than any other existing technique. As said the combination may applied on multimedia application.

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