A Survey on Content Based Image Retrieval

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Abstract--- Literature survey is the most important for understanding and gaining much more knowledge about specific area of a subject. Content based image retrieval (CBIR) deals with the problem of searching for digital images from large databases. CBIR is also known as Query By Image Content (QBIC). CBIR works on basis of extracting low level features of an image such as color, texture and shape and compares similarity measures with feature database for finding relevant image retrieval from large database. This survey covers various low level features extraction techniques and distance measures methods.
Keywords: CBIR, Low level feature extraction, Scale and rotation invariant.

I. INTRODUCTION

Now a day we have many multimedia devices for digital images such as camera, audio/video player, cellular phone and so on. Digital images are widely used in many applications likes fashion, architecture, finger print recognition, criminal investigation, medicine etc [8]. Different from traditional search engine, in CBIR search will analyse the actual contents of the image rather than the metadata such as keywords, tags, and descriptions associated with the image. Here "Content-based" means use of colors, shapes, textures, or any other information that can be derived from the image itself [11].
In CBIR, retrieval of image is based on similarities in their contents, i.e. textures, shapes colors etc. which are considered the lower level features of an image. These low level features are extracted from the database images and stored in feature database. Also low level features extracted from the query image and compare both features using various distance measure [1].
If the distance between feature vectors of the query image and images in the database is least distance, the corresponding image in the database is to be considered as a match to the query and displayed as result.

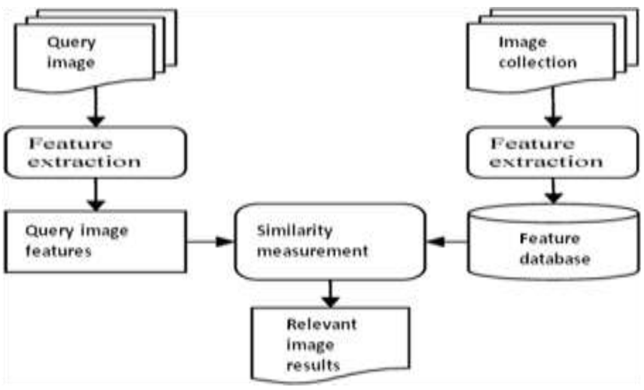

Fig 1: Architecture of CBIR System [1][8]

II. LOW LEVEL IMAGE FEATURES EXTRACTION

In CBIR system, a feature can capture image visual property for regions or objects. Feature extraction which is a process to extract the image's features based on color, texture, shapes etc to a distinguishable extent.

A. Color Features

Color property is one of the most widely used visual features in content based image retrieval systems. Color features are extracted using color histogram, color moments. These methods are explained in following sections.

1) Color Histogram

It is the most commonly used descriptor in image retrieval. The color histogram is easy to compute and effective in characterizing both the global and the local distribution of color image [2]. To create a color histogram, first step is partition into color space, but color space is too large so color space is quantized into number of bins, where each of color bins represent a range of color values. The number of cells in the image that falls in each of these ranges is counted to get the color histogram. Color histograms can be built in various color spaces such as RGB, HSV, YCbCr, etc. are used in CBIR systems [10].

2) Color Moments

To defeat the quantization results of the color histogram we use the color moments as feature vectors for image retrieval. The color distribution of image is characterized by its moments [1]. The first order, the second order and the third order color moments have been proved efficient in color distribution of images. Color moments have lowest feature vector dimension and lowest computational complexity [4].

Mean $$\mu_i = \frac{1}{N}(\sum_{j=1}^{N} P_{ij}) \quad (1)$$

Variance $$\sigma_i = ((\frac{1}{N}\sum_{j=1}^{N}(P_{ij}-\mu_i)^2)^{\frac{1}{2}} \quad (2)$$

Skewness $$\gamma_i = (\frac{1}{N}\sum_{j=1}^{N}(P_{ij}-\mu_i)^3)^{\frac{1}{3}} \quad (3)$$

Where Pij is the value of the i-color component of the image pixel j, and N is the number of pixels in the image.

B. Texture

Although there is no strict definition of the texture of an image, it is easily perceived by humans and believed to be a rich source of visual information about the nature and three dimensional shapes of physical objects [5]. Texture property is one of the most widely used visual features in content base image retrieval systems. Texture features are extracted using Gray Level Co-occurrence Matrix (GLCM), Gabor feature. These methods are explained in following sections.

1) Grey Level Co-occurrence Matrix (GLCM)

GLCM is statistical approach of the texture that gives characterizations of textures such as smooth, common and so on. Gray level Co-occurrence matrix (GLCM) is the popular representation for the distributions of the intensities and the information about relative positions of neighboring pixels of an image. Now Q defines the position of two pixels relative to each other either vertical, horizontal, or diagonally. GLCM matrix G whose element Pij is the number of times that pixel pairs with intensities i and j occur in image in the position specified by Q. The matrix found in this manner is called to gray level co-occurrence matrix. Several statistical properties like contrast, correlation, energy and homogeneity can be derived from the GLCM and formula are given in below equation [6].

$$Contrast = \sum i \sum j |(i-j)|^2 P(i,j) \quad (4)$$

$$correlation = \Sigma_i \Sigma_j \frac{(i-\mu_i)(j-\mu_j)P(i,j)}{\sigma_i \sigma_j} \quad (5)$$

$$Energy = \Sigma_i \Sigma_j P(i,j)^2 \quad (6)$$

$$Homogeneity = \Sigma_i \Sigma_j \frac{P(i,j)}{1+|i-j|} \quad (7)$$

2) Gabor Feature

Gabor filters have been found appropriate for textural processing for several reasons: they have tuneable orientation and radial frequency bandwidths, tuneable center frequencies, and optimally achieve joint resolution in space and spatial frequency [5][10].

A two dimensional Gabor function g(x, y) and Fourier transform can be written as:

$$g(x,y) = \frac{1}{2\Pi\sigma_x\sigma_y} \exp\left[-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right) + j2\Pi Wx \right] \quad (8)$$

$$G(u,v) = \exp\left\{ -\frac{1}{2}\left[\frac{(u-W)^2}{\sigma_u^2} + \frac{v^2}{\sigma_v^2} \right] \right\} \quad (9)$$

Where a $\sigma_u = \frac{1}{2\Pi\sigma_x}$ nd $\sigma_v = \frac{1}{2\Pi\sigma_y}$

Here σx and σy are characterizing the spatial extent and frequency bandwidth of the Gabor filter and W is a modulation frequency. Gabor function gm, n (x, y) can be obtained by rotating and scaling g(x, y) through the generating function [1][5] :

$g_{mn}(x,y) = a^{-2m} g(x', y')$ a>1 m,n are integers

Where

$x' = a^{-m}(x\cos\theta + y\sin\theta)$, $y' = a^{-m}(x\sin\theta + y\cos\theta)$

and m and n specify the scale and orientation of wavelet respectively, with m=0, 1..M-1, n= 0, 1….N-1, and θ = nπ / N and $a = (U_h / U_l)^{\frac{1}{M-1}}$

For an image g(x, y) with size P × Q, its gabor wavelet transform is given by equation (9) and g*mn is the complex conjugate [1].The mean and standard deviation of the magnitude of the orientation bands, which are used to construct the texture feature vector, can be calculated as:

$$G_{mn}(x,y) = \Sigma_s \Sigma_t I(x,y) g^*_{mn}(x-s, y-t) \quad (9)$$

$$\mu_{mn} = \frac{1}{PQ} \Sigma_x \Sigma_y |G_{mn}(x,y)| \quad (10)$$

$$\sigma_{mn} = \sqrt{\frac{\Sigma_x \Sigma_y (|G_{mn}(x,y)| - \mu_{mn})^2}{PQ}} \quad (11)$$

A feature vector can be created using μmn Σmn as feature components. For M scales and N orientation, the feature vector can be written as [5]:

$$F^{TEX} = [\mu_{00}\ \sigma_{00}\ \mu_{00} \ldots \ldots \mu_{(M-1)(N-1)}\ \sigma_{(M-1)(N-1)}]$$

3) Tamura Features

CBIR systems use a set of six visual features based on psychological experiment, namely, coarseness, contrast, directionality, linelikeness, regularity and roughness [7].

C. Shape

Many content based image retrieval systems use shape features of object or region. Shape features are usually described after images have been segmented into regions or objects as compared with color and texture features. The most frequently used methods for shape description can be boundary based or region based. A good shape representation feature for an object should be invariant to translation, rotation and scaling [2][9].

1) Moment Invariant

Moments invariants are used for classical shape representation. Central moments of order p+q for the shape of object R are defined as [2]:

$\mu AB = \sum_{(x,y)\in R} (X - Xc)^p (Y-Yc)^2$ (12)

Where R is the object presented as binary im… (Xc, Yc) is the center of the object. This central mo… can be normalized to be scale invariant [2]:

$H_{p,q} = \mu_{p,q} / \mu^{\Upsilon}_{0,0}$, $\Upsilon = p+q+z / z$ (13)

Depending on these moments translation, rotat… scale moments can be derived [2].

III. CONCLUSION

In this section we surveyed the field of content base image retrieval. In this paper we have presented the various low level feature extraction and various distance measures to retrieve the similarity matching between images. We have presented the recommendations to improve image retrieval using a novel composite approach of multiple low level feature extraction.

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