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Content Based Image Retrivel on Non-Parametric Statistical Tests of Hypothesis

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Abstract— The field of image processing is addressed significantly by the role of CBIR. Peculiar query is the main feature on which the image retrieval of content based problems is dependent. Relevant information is required for the submission of sketches or drawing and similar type of features. Many algorithms are used for the extraction of features which are related to similar nature. The process can be optimized by the use of feedback from the retrieval step. Analysis of color and shape can be done by the visual contents of image. Here neural network, Relevance feedback techniques based on image retrieval are discussed.

Keywords— CBIR, Hypothesis, Image Retrival, Image Processing, Extraction

I. Introduction

In recent years, a number of researchers have turned their attention to the content-based image retrieval (CBIR) system. In CBIR system, the researchers concentrate on developing low-level global visual features, namely color properties, shape, texture, and spatial relationship etc., which are used as query for the retrieval process. The method proposed in classifies or segments the entire image into various regions according to the objects or structures present in the image, and the region-to-region comparison is made to measure the similarity between two images. In a region-based system, the user has to provide one or more regions from the query image to start a query session. Automatic and precise extraction of image objects is still beyond the ability of the retrieval system available with the computer vision. Therefore, the above system tends to partition one object into several regions, but none of them is representative of the semantic object.

II. CONTENT BASED IMAGE RETRIEVAL

Content Based Image Retrieval (CBIR), is a new research for many computer science groups who attempt to discover the models for similarity of digital images. Content Based Image retrieval method uses visual content of images for retrieving the most similar images from the large database. In this method visual contents from images in the database are extracted. Now whenever user gives an image to a system as input, it extracts the visual content from that image and compares the visual content (features) with the visual content of the images in database and retrieves the most similar images. Thus, CBIR uses the visual content of image such as color, shape, texture for represent and index the images.

III. FEATURE EXTRACTION

When input image (data) to an algorithm is too large to be processed and it is assumed to be disgracefully redundant, then the input image is transformed into a reduced set of features which is known as feature vector. Thus transforming an input data into set of features is called feature extraction. It is done by visual content descriptor. The descriptor could be two types either global or local. A global descriptor uses the visual feature of the whole image whereas a local descriptor use visual features of objects or regions to describe image content. The descriptor extracts the low level visual feature such as color, shape, texture and makes the feature vector.

A. Color Extraction

Color is the most expansively used visual content for image retrieval. Before choosing effective color descriptors for feature extraction first color space must be determined. Usually colors are defined in three dimensional color spaces which could be RGB (Red, Green, and Blue), HSV (Hue, Saturation and Value) and Opponent color space. RGB is widely used color space for image display and display is made using primary color (red, green, blue) or mixing of these colors. HSV color space is mostly used in computer graphics and most sensitive way of describing color. Here first component Hue is invariant to change in camera direction and illumination so it is most suitable for object retrieval. The Opponent color space use opponent color axes (R-G, 2B-R-G, R+G+B) and has advantage of differentiating brightness information on third axis and first two axis is invariant to change in shadow and illumination intensity. Some most widely use color descriptors are:

B. Color Histogram

It is used for effective representation of color content of an image if color pattern is unique compared with the rest of data. It is easy to compute for both global and local distributor of color. Though it is a good method for color extraction, it does not take the spatial information of pixels into consideration so very different images can have same color distribution.

C. Color Moment

It has been successfully used in many retrieval systems especially when the image contains just object. The first order (mean), second orders (variance), third order (skewness) color moment have been proved to be efficient and effective in representing color distribution of images. Here third order moment improves the overall retrieval performance but it is very sensitive the changes in scene and sometimes decreases the performance.

D. Color Coherence Vector

Color coherence vector is same as color histogram method but here color histogram also take the spatial information of pixel. Here each histogram is divided into two types i.e. coherent, if it belongs to large uniform color region or incoherent, if it does not. It provides better result than color histogram especially for most uniform color or texture region.

E. Color Correlegram

The color correlegram is projected to characterize not only the color distributions of pixels but also gives the information about the spatial correlation of pairs of colors. It gives best performance than color coherence vector and color histogram but has large computational expensive due to high dimensity.

F. Shape Extraction

Shape feature of object or region is be extracted for retrieving the images from the database. Number of features of object shape is computed for every object identified.Two main types of shape features most commonly extracted are global features (such as aspect ratio, circularity and moment invariants) and local features (such as sets of consecutive boundary segments).The methods of feature extraction are divided in two major categories either boundary based (rectilinear shape, polygonal approximation and Fourier based shape descriptors) and region based (statistical moments.

A good shape representation feature should be invariant to translation, rotation and scaling. Some of the widely used shape descriptors for shape feature extraction are as follows:

G. Polygonal Approximation

Polygonal approximation can be put to ignore the minor variations along the edge, and instead capture the overall shape information. In this method there are two ways to extract feature from shape, merging and splitting. Merging methods add successive pixels to a line segment if each new pixel that is added doesn't cause the segment to deviate too much from a straight line .Splitting methods work by first drawing a line from one point on the boundary to another then compute the perpendicular distance from each point along the boundary segment to the line. If this exceeds some threshold, break the line at the point of greatest distance. Repeat the process recursively for each of the two new lines until no longer need to break any more. It is simple method for contour representation and description.

H. Moment Invariant

Moment invariant is also called as geometric moment. There are total seven moments which is used for shape feature extracted. The most important advantage of using this moment invariant is that they are invariant to rotation, scaling and translation. Also the moments are simple in compute. There are some disadvantages of this method like higher order moments are very sensitive to noise and this moments also suffer from information redundancy because its basis is not orthogonal.

I. Texture Extraction

Texture is that inherent property of all surfaces that describes visual patterns and contains significant information about the structural arrangement of the surface and its relationship to the surrounding environment. Various texture representations have been investigated in computer vision and pattern recognition. The texture representation method can be classified in four major groups: (i) Structural (ii) Statistical (iii) Model based methods (iv) Signal Processing based methods.

1. Structural Methods: Structural methods represent the texture by well defined primitives and spatial arrangement of these primitives. So for feature extraction this primitive may be extracted. Once the primitives have been extracted, the analysis is completed by computing statistics of the

primitives (e.g. intensity, area, elongation, and orientation). These methods are very effective when textures are in regular pattern but mostly natural images do not have regular patterns of texture so it is not good for those images. Morphological and various clustering methods are example of these.

2. Statistical Methods: Statistical methods examine the spatial distribution of gray values by computing local features at each point in the image, and deriving a set of statistics from the local features. Depending on the number of pixels that defining the local feature statistical methods can be further classified into first-order (one pixel), second-order (two pixels) and higher-order (three or more pixels) statistics. The basic difference between those methods are : first-order statistics estimate properties (e.g. average and variance) of individual pixel values, ignoring the spatial interaction between image pixels, where second- and higher-order statistics estimate properties of two or more pixel values occurring at specific locations relative to each other. Grey Level Co occurances Metrix (GLCM), Local Binary Pattern are widely used statistical methods.

3. Model based Methods: Model based texture analysis method use the fractal and stochastic models and make effort to interpret an image texture by use of respectively, generative image model and stochastic model. The parameters of the model are estimated and then used for image analysis. The disadvantage of this method is high computational complexity that arising in the estimation of stochastic model parameters. The model based method has been useful for modeling some natural textures however it lacks orientation selectivity and is not suitable for describing local image structures. Autoregressive model, Markov Random field, Gauss-Markov random field are some model based methods those are use for texture feature extraction.

4. Signal Processing Based Methods: Signal processing based method represent an image in a space whose coordinate system has an interpretation that is closely related to the characteristics of a texture (such as frequency or size). Both frequency and spatial domain approaches are used for filtering the image and then relevant information is captured. Various transform like Fourier, Wevelet, Gabor etc. are example of this method. Signal processing method gives better result than any type of methods for feature extraction but computational time of these methods may be large.

IV. EVALUATION PARAMETERS OF IMAGE RETRIEVAL

In this paper, we use the standard measures such as precision and recall to evaluate the results. These parameters are defined as below:

$$\text{Recall} = \frac{-\text{Number of images retrieved and relevant}}{\text{Total number of relevent images in the database}}$$

$$\text{precision} = \frac{-\text{Number of images retrieved and relevant}}{\text{Total number of retrieved images}}$$

V. IMAGE DATABASE DESIGN AND EXPERIMENTAL RESULTS

In order to implement the proposed method, 477 color images of size 512×512 pixels have been collected from online image database resources, i.e. 113 texture images from SIPI database, 102 images from CuReT image database and 100 images from KTH-TIPS image database. The remaining 58 images with size 128×128 are photographed with our digital camera; 43 images with size 128×128 have been downloaded from internet [30]. The textured images collected from SIPI, CuReT and KTH-TIPS image databases are divided into 12 non-overlapping sub-images of size 128×128. To examine the proposed system is invariant for rotation and scaling; the images are rotated by 900 , 1800 and 2700 , and scaled. To validate the proposed system, based on statistical non-parametric tests. Due to space constraints, for sample, some of the images considered for the experiment are presented in Figures 1 and 2. The experiment is conducted at various levels of significance for the input query image given in column 1 of Figure 1. The images in columns 2, 3, 4, 5 of Figure 1 are retrieved at level of significance, 0.001; images in columns 6, 7 are retrieved at 0.05 level of significance; at 0.15 level of significance, the system retrieves the images in columns 8, 9, 10 and 11.

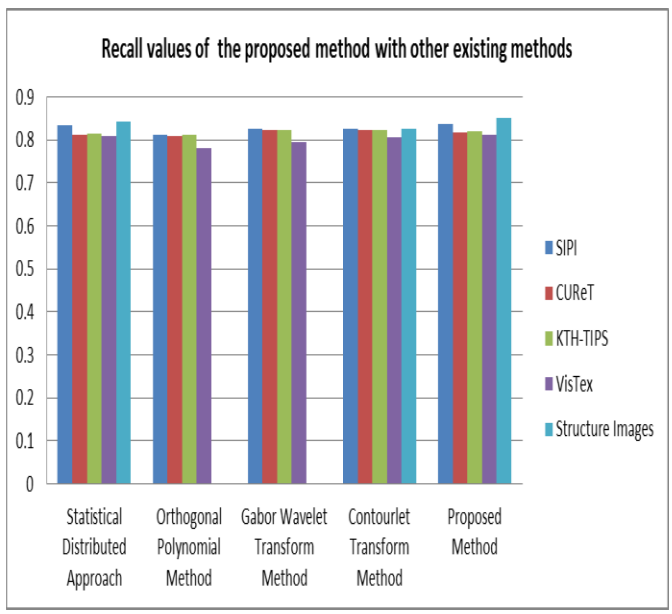

Figure 1: Recall values of the proposed method with other existing methods

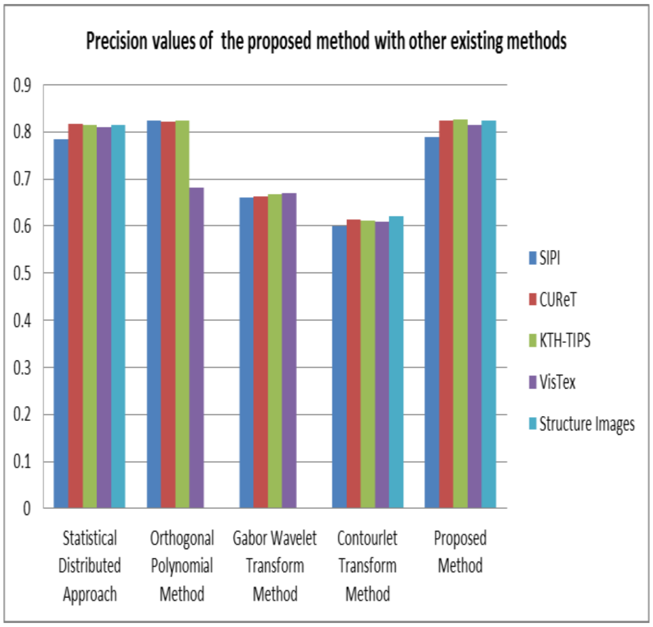

Figure 2: Precision values of the proposed method with other existing methods

A comparative study is performed with the existing methods such as Orthogonal polynomial [19], Gabor wavelet transform [20] and the Contourlet transform method [27] methods and Statistical distributional approach [28], and the obtained results are presented in Table 1. The results reveal that the proposed method outperforms the existing methods. It is observed from the results that there is no significant difference between the proposed method and the statistical distributional approach. Though both parametric and non-parametric tests yield almost same results; there are some difficulties to employ parametric tests. Since some type of images may not be distributed to Gaussian, at that situation the parametric tests cannot be applied. Thus, the necessity arises to use appropriate non-parametric tests instead of parametric tests.

VI. CONCLUSION

Block-wise sampling technique proposed in does not yield good results for the rotated and scaled color images, because the corresponding blocks of query (actual) and target (transformed) images do not match spatially, while the target image is rotated in any direction or scaled. Hence, the technique proposed in fails to match and retrieve the right images in the existing technique. The proposed system avoids this problem, because it uses the global distributional differences of both query and target images; in the case of structured images, these features are extracted from the shapes in both query and target images, and those are compared shape-wise, it compares the number of shapes with different pixels between the images. The orthogonal polynomial based methods retrieve only textured images with gray scale, and the Gabor features based method retrieves only the textured images in both color and gray-scale. The proposed system retrieves both textured and structured color images of different image databases downloaded from the Internet, and it is robust for scaled and rotated images. Most of the other methods retrieve a set of similar images, from which the user has to select the required images. But the our proposed system facilitates the user to retrieve the required image only by fixing the level of significance at a desired level.

The proposed system is invariant for rotation and scaling, since the query image is treated as either a sample or population of the target image. First, the test for equality of variation between the query and target images is performed; the query and target images pass the test, viz. the two images are same or similar, then the test for equality of mean vectors is performed, i.e. testing the spectrum of energy on the same images. The proposed system provides hundred percent accuracy and precision, even if either the target or query image is rotated or scaled.

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