A review on"Aspects of Texture analysis of images"

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ABSTRACT

Texture analysis is a major step in texture classification, image segmentation and image shape identification tasks. Analysis of texture is a useful way increasing the information obtainable from medical images. Texture analysis methods have been utilized in variety of application domain. This paper reviews the different aspects of texture analysis in medical images based on available literature. Paper includes different approaches for texture analysis as structural method; transform method, statistical approach and model based method

Key words:- texture, Structural method, Model based method, Statistical approaches, Transform method, histogram

1.INTRODUCTION

Texture analysis refers to the branch of imaging science that is concerned with the description of characteristics image properties by characteristic features. Generally speaking, textures are complex visual patterns composed of entities, or sub patterns that have characteristics. Image texture is an important surface characteristics used to identify and recognize objects. Texture may be informally defined as a structure composed of large number of more or less ordered similar pattern or structures. Texture provides an idea about the perceived smoothness, coarseness or regularity of surface. Texture analysis is the major step in texture classification, image segmentation and image shape identification task. Texture classification involves deciding what texture category an observed image belongs to

2.ISSUES IN TEXTURE ANALYSIS

There are four major issues in texture analysis:

Feature extraction: to compute a characteristic of a digital image able to numerically describe its texture properties;

Texture discrimination: to partition a textured image into regions, each corresponding to a perceptually homogeneous texture (leads to image segmentation);

Texture classification: to determine to which of a finite number of physically defined classes (such as normal and abnormal tissue) a homogeneous texture belongs;

Shape from texture: to reconstruct 3D surface geometry from texture information.

3.APPROCHES FOR TEXTURE ANALYSIS

Approaches for texture analysis are usually categorized in

1. Structural method
2. Model based method
3. Statistical approaches
4. Transform method

- **The structural method**

  This represents the texture by well defined primitives (micro-texture) and a hierarchy of spatial arrangements (micro-structure) of those primitives. In structural methods, texture is viewed as consisting of many textural elements (called texels) arranged according to some placement rules. A human observer can strongly perceived the structural properties of some textures. This leads to many structural texture analysis methods. The structural properties of these elements have been successfully applied to characterize the texture by many authors. Commonly used element properties are average element intensities, area, perimeters, eccentricities, orientation, elongation, magnitude, compactness, moments, etc. structural analysis methods are better for texture synthesis than its analysis. The theory of mathematical morphology is a powerful tool for structural analysis. These methods provide a good symbolic description of image. Extracting texels from natural image is a difficult task.

- **The model based method**

  Here attempt is made to represent texture in an image using sophisticated mathematical model such as fractal or stochastic. Texture analysis using fractal and stochastic models, attempt to interpret image texture by use of respectively generative image model and stochastic model. This method is used for texture analysis as well as texture discrimination. In practice, the computational complexity arising in the estimation of stochastic model parameter is a primary problem. It is not suitable for describing local image texture.

- **The statistical approaches**

In statistical methods, texture is described by a collection of statistic of selected features. In contrast to structural method statistical approaches do not attempt to understand explicitly the hierarchical structure of texture. Instead, they represent the texture indirectly by the non- deterministic properties that govern the distributions between the gray levels of an image. Statistics are broadly classified into first order, second order and higher order statistics. The most popular second order statistical features for texture analysis are derived from so called co-occurrence matrix. They were demonstrated to feature a potential for effective texture discrimination in biomedical images. These methods normally achieve higher discrimination indexes than structural or transform method. This approach is more general and easier to compute and used more often in practice. This method is widely used for medical applications

- **Transform method-**

Transform method of texture analysis such as Fourier, Gabor and wavelet transform represents the image in a space whose coordinate system has an interpolation that is closely related to characteristics of texture. Gabor filter provide mean for better spatial localization; however, their usefulness is limited in practice because there is usually no single filter resolution at which one can localize a spatial structure in natural textures. Compared with Gabor transform the wavelet transforms feature several advantages-varying the spatial resolution allow it to represents textures at the most suitable scale also there is no wide range of choices for wavelet function, so one is able to choose wavelets, best suited for texture analysis in specific applications. They make wavelet transform attractive for texture segmentation. The wavelet transform is most widely used because of the ease with which it may be adjusted to the problem in a question. Method based on Fourier transform performs poorly in practice, due to its lack of spatial localization. The problem with wavelet transform is that it is not translocation invariant.

4.FEATURE SELECTION

- Choosing most effective features for class separability
- Strongly skewed features are rejected; strongly correlated features are rejected. Discriminatory analysis is used to select the most discriminating features
- The most desirable line of approach is to pay a lot of attention in choosing image features so that the classes are linearly separable. In other words, careful feature selection followed by a simple classifier is much more preferable than a quick feature selection stage followed by a carefully designed classifier.

5.TEXTURE DISCRIMINATION AND SEGMENTATION

The reported segmentation methods are based on

- estimation theory
- split-and-merge
- Bayesian classification
- probabilistic relaxation – iterative approach for using context information to reduce
- local ambiguities
- clustering
- artificial neural network

The techniques for texture segmentation can be classified to be either supervised 1989a, or unsupervised based on whether the number of textures contained in the image is known in advance or not.

6.TEXTURE PARAMETER

1. Histogram (statistical class)
2. Absolute gradient (statistical class)
3. Run length matrix (statistical class)
4. Co-occurrence matrix (model class)
5. Auto-regressive model (transform class)
6. Wavelets

1. Histogram

The histogram of an image is the count of how many pixels in the image possess a given grey-level value. From the histogram many parameters may be derived, such as its mean, variance and percentiles. The mean of the histogram gives us the mean grey-level value of the image. The variance is a measure of how far from the mean the grey-level values in the image are distributed.

2. Absolute gradient

The gradient of an image measures the spatial variation of grey-level values across the image. Examples of texture parameters that may be computed from the absolute gradient are, again, its mean and its variance. The absolute gradient mean will thus be a measure of the mean grey-level variation across the image, and its variance a measure of how far from the mean these variations are.

3. Run length matrix

The run-length matrix is a way of searching the image, always across a given direction, for runs of pixels having the same grey-level value. Many different run-length matrices may be computed for a single image, one for each chosen direction. In practice normally 4 matrices are computed, for the horizontal, vertical, and two diagonal directions. Some parameters that may be computed from the run-length matrix are the fraction of image in runs and the short-run emphasis. The fraction of image in runs is a measure of the percentage of image pixels that are part of any of the runs considered for the matrix computing, and the short-run emphasis is a measure of the proportion of runs occurring in the image that have short length.

4. Co-occurrence matrix

The co-occurrence matrix is a technique that allows for the extraction of statistical information from the image regarding the distribution of pairs of pixels. Since the co-occurrence matrix analyzes the grey-level distribution of pairs of pixels, it is also known as the second-order histogram. Examples of parameters computed from the co-occurrence matrix are the contrast and the entropy.

5. Auto-regressive model

The auto-regressive model assumes a local interaction between image pixels in that the pixel grey-level value is a weighted sum of the grey-level values of the neighboring pixels. In simpler words it is a way of describing shapes within the image, by finding relations between groups of neighboring pixels. The auto-regressive parameters are simply the set of weights used to establish these relations.

7.WAVELETS

Wavelets represent a technique that analyzes the frequency content of an image within different scales of that image. This analysis yields a set of wavelet coefficients corresponding to different scales and to different frequency directions. When computing the wavelet transform of an image, we associate to each pixel a set of numbers (the wavelet coefficients) which characterize the frequency content of the image at that point over a set of scales. From these coefficients we can compute texture parameters. An example of a wavelet-derived parameter is the wavelet energy associated with a given scale and direction, so this parameter measures the frequency content of the image on a given scale and in a given direction The effect of external factors on some texture parameters must be taken into consideration before using texture analysis techniques

8.APPLICATION

Texture analysis has played an important role in several medical applications. In general, the applications involve the automatic extraction of features from the image which is then used for a variety of classification tasks, such as distinguishing normal tissue from abnormal tissue. Applications of texture analysis may include segmentation of anatomical structures, diagnosis of skeletal muscle dystrophy, Differentiation between healthy and pathological tissue in human brain, cervix lesions classification, etc.

9.CONCLUSION

I have described here the aspects of texture analysis in medical images. Although many papers have been published on texture analysis, the definition of texture is still an open issue. The definition of texture will strongly affect the choice of texture analysis methods.

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