Unsupervised Segmentation using Fuzzy Logic based Texture Spectrum for MRI Brain Images

G.Wiselin Jiji, L.Ganesan

***Abstract*—**Textures are replications, symmetries and combinations of various basic patterns, usually with some random variation one of the gray-level statistics. This article proposes a new approach to Segment texture images. The proposed approach proceeds in 2 stages. First, in this method, local texture information of a pixel is obtained by fuzzy texture unit and global texture information of an image is obtained by fuzzy texture spectrum. The purpose of this paper is to demonstrate the usefulness of fuzzy texture spectrum for texture Segmentation.

The 2nd Stage of the method is devoted to a decision process, applying a global analysis followed by a fine segmentation, which is only focused on ambiguous points. The above Proposed approach was applied to brain image to identify the components of brain in turn, used to locate the brain tumor and its Growth rate.

***Keywords*—**Fuzzy Texture Unit, Fuzzy Texture Spectrum, and Pattern Recognition, segmentation.

I. Introduction

TEXTURE analysis is an important task in many computer applications of Computer image analysis for classification, detection or segmentation of images based on local spatial patterns of intensity. Textures are replications, symmetries and combinations of various basic patterns, usually with some random variation [8]. The major task in texture analysis is the texture segmentation of an image, that is, to partition the image space into a set of sub regions, each of which is homogeneously textured.

In texture segmentation the goal is to assign an unknown sample image to one of a set of known texture classes. Texture segmentation process involves two phases: the learning phase and the recognition phase. In the learning phase, the target is to build a model for the texture content of each. Texture class present in the training data generally comprises of images with known class labels. The texture content of the training images is captured with the chosen texture analysis method, which yields a set of textural features for each image. These features, which can be scalar numbers or discrete histograms [1] or empirical distributions, characterize given textural properties of the images, such as spatial structure, contrast, roughness, orientation, etc. In the recognition phase the texture content of the unknown sample is first described with the same texture analysis method. Then the textural features of the sample are compared to those of the training images with a classification algorithm, and the sample is assigned to the category with the best match. Optionally, if the best match is not sufficiently good. According to some predefined criteria, the unknown sample can be rejected instead. The basic assumption in this approach to texture classification is based on a discrimination function using several texture characteristics. The frequency of occurrences of these texture numbers is called texture spectrum, which is used to globally describe the texture image. In case of a texture unit, the intensity of center pixel is compared with those of 8 neighbor pixels. Based on the result of comparison like <, = or >, they are coded correspondingly as 0, 1 or 2. The equivalent decimal number for these 8 digit ternary number is called texture number. We propose a fuzzy logic based approach has been proposed in this paper because of the following reasons.

- The texture number scheme is unable to distinguish between > and far > or < and far <. For example, the central pixel is 50, the neighboring pixels are 55 and 250 in both cases, and they are encoded as 2. in the earlier scheme.
- The total number of texture units range from 0 to 6560, which is high and need high time complexity for processing.

These two drawbacks are easily avoided by employing the fuzzy logic based approach by introducing more levels of comparisons. Based on the total number of levels used for comparison, these methods are called either base 5 (as shown in Figure 2) or base 7 methods. This paper demonstrates Base5 method to texture segmentation.

II. Fuzzy Texture Unit and Fuzzy Texture Spectrum

In a square raster digital image, each pixel is surrounded by eight neighboring pixels. The local texture information for a pixel can be extracted from a neighborhood of 3X 3 pixels, which represents the smallest complete unit.

In addition eight elements may be ordered differently. If the eight elements are ordered clock-wise as shown in the

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figure1, fewer than eight different ordering ways (from a to h) as shown in Figure.1

a	b	c
h		d
g	f	e

Fig. 1 Ordering of elements in 3x 3 matrix

The previously defined set of fuzzy texture units describes local texture aspects of a given pixel, which is, the relative gray level relationships between the central pixel and its neighbors. Thus the statistics on frequency of occurrence of the entire fuzzy texture unit [3] over a large region of an image should reveal texture information. Fuzzy texture spectrum is the frequency of distribution of all fuzzy texture unit, with abscissa indicating the fuzzy texture unit, $N_{TU\ and}$ the ordinate representing its occurrence frequency of regions for a texture image in a fuzzy texture spectrum is shown in Figure.5

TU: {E_1, E2…E8} Where E_i is determined by the formula

$$FT_{mu5} = \sum_{I=1}^{8} EI * 5^{(I-1)/2}$$

It is represented in Figure 4.

$$E_i = \begin{cases} 0 & \text{if } vi < v0 \text{ and } vi < x \\ 1 & \text{if } vi < v0 \text{ and } vi > x \\ 2 & \text{if } vi = v0 \\ 3 & \text{if } vi > v0 \text{ and } vi < y \\ 4 & \text{if } vi > v0 \text{ and } vi > y \end{cases} \qquad \text{For } i = 1,2,3..8$$

Where x,y are user-specified values

Fig. 2 Texture Unit Values Range

$$\begin{pmatrix} 90 & 130 & 145 \\ 160 & 140 & 200 \\ 100 & 140 & 250 \end{pmatrix} \Rightarrow \begin{pmatrix} 0 & 1 & 3 \\ 4 & & 4 \\ 0 & 2 & 4 \end{pmatrix}$$

Base 5 Method

Fig. 3 Sample Data

Texture Unit is calculated for the sample sub image in Figure3 by using the formulae as N_{TU}=1392

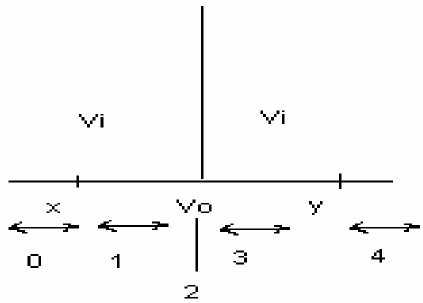

Fig. 4 Diagrammatical Representation of Texture Unit values

As each element of TU has one of three possible fuzzy number values, the combination of all the eight elements results in 2030 possible texture units in total.

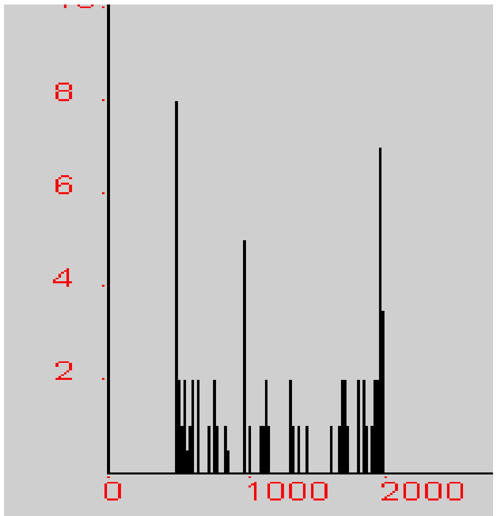

Fig. 5 Texture Spectrum

III. Texture Segmentation

The most important problem in Texture Segmentation is to extract powerful features, which best characterize the texture aspect of image. In order to evaluate the discriminating performance of texture spectrum, segmentation has been performed over color texture images. To demonstrate the original property of fuzzy texture spectrum, we use the simplest discrimination method and carry out as few as possible mathematical operations over the texture spectrum. The evaluation was performed using a supervised classification over the four-color texture images. The algorithm of segmentation is described below.

1. Select randomly a sample sub image of 15*15 pixels from each texture image.
2. Calculate Fuzzy Texture Spectrum for first window, by moving the 3*3 matrix across the sample with overlap.
3. Neighbour window is calculated with 15*15 pixels with overlap and calculate fuzzy texture spectrum of that window.
4. Calculate the absolute difference between the texture spectrum of first window and neighbor texture spectrum.

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Store D (i) value.

$$D(i) = |W(j) - A(i)| \quad i = 1,2,3,4.$$

Where, D (i) : absolute difference between the fuzzy texture spectrum of a window and the texture spectrum of neighbour window W(j) : the occurrence value of texture unit j in the texture spectrum of the window considered. A(i): the occurrence value of texture unit j in the texture spectrum of the next window considered. The occurrence
5.Repeat steps 2 to 5 until full image covers.

The second decision step is devoted to the classification of the ambiguous points. The above proposed method is used in considering a neighborhood around each non-classified Pixel. The ambiguous pixel is set according to the number of occurrences of classified pixels in the neighborhood. If all the neighbors are ambiguous, then the pixel is unchanged. This procedure is repeated until all pixels have been classified. By statistical analysis of Brain tumor, we can easily identify the growth of Brain tumor.

IV. RESULTS

Using the above-described method, Figure 6 (left hand side) Brain images are processed and segmented; the important components in Brain as well as tumor (right hand side image in Figure 6).

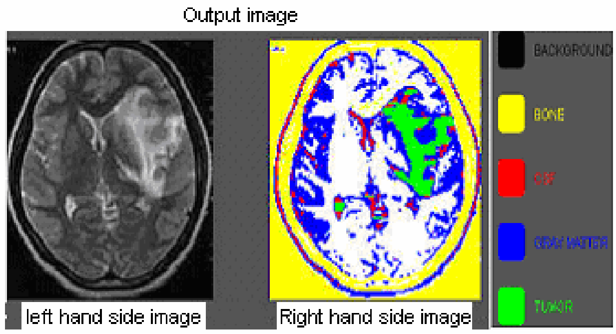

Fig. 6 Segmented Output image

V. CONCLUSION AND DISCUSSIONS

The Texture Spectrum has been calculated from the discriminating performance. It segments the components of Brain and it identifies the Brain tumor also and is shown in Figure 4. The discrimination method was simple and the number of mathematical operations applied to texture spectrum was small while promising results have been obtained.

The Fuzzy Texture Spectrum method has been proposed for texture Analysis. The work presented in this paper is just a preliminary study to evaluate the performance of the fuzzy texture spectrum in the discrimination of textures. The features derived from the fuzzy texture spectrum, used to segment the Brain image.

REFERENCES

[1] Rosenfield and A.C.Kak," *Digital image processing*", 2nd edition.
[2] L.N., Wang F.Z., Mapps D.J., Robinson P., Jenkins D., Clegg W.W., "*Nano-scale positioning for magnetic recording*". European Journal of Sensors and Actuators, Vol. A81, Nos. 1-3, April 2000, pp 313-316.
[3] F. Liu and R. W. Picard. *Periodicity, directionality, and randomness: Wold features for image modeling and retrieval*. Technical report, MIT Media Laboratory and Modeling Group, technical Report No.320, 1994.
[4] S.-F. Chang. *Compressed-domain techniques for image/video indexing and manipulation.* In International Conference on Image Processing, Special Session on Digital Library and Video-On Demand. I.E.E.E., October 1995.
[5] Wang,"*A new statistical approach for texture analysis*".
[6] P.Brodatz texture –A photographic Album for arucs and designers, renhold.
[7] Shifeng Weng, Changshui Zhang and Zhonglin Lin. *Exploring the structure of supervised data by Discriminant Isometric Mapping*. Pattern Recognition, 38(4), Pages 599-601, 2005.
[8] Lee, J. S, 1981, *Refined filtering of image noise using local statistics, Computer Graphics and Image Processing*, vol. 15, pp. 380-389.
[9] He, D. C. and W. Li, 1991, *Texture features based on texture spectrum, Pattern Recognition*, vol. 24, no. 5, pp. 391-399.
[10] Ulaby, F. T., F. Kouyate, B. Brisco, and T. H. L. Williams, 1986, *Textural information in SAR images*, IEEE Trans. Geosci. Remote Sensing, vol. GE-24, no. 2, pp. 235-245

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