Extended abstract of J. You, H.A. Cohen, *Use of Fuzzy Set in Textured Image Segmentation*, Proc. Int'l Conf Signal Processing Applications, ISSPA, Gold Coast, Aug 26-28, Vol 2, pp 585-588.

Use of Fuzzy Set in Textured Image Segmentation

J. You^1 H.A. Cohen^2

^1 School of Computing $\&$ Information Technology
Griffith University, Brisbane, Qld., Australia 4111
Phone: +61 7 875 5402 Fax: +61 7 875 5051
you@bilby.cit.gu.edu.au

^2 Dept. of Computer Science \& Computer Engineering}
La Trobe University, Bundoora, Vic., Australia, 3083}
Phone: +61 3 9479 2596 Fax: +61 3 9479 3060}
Email: harvey@latcs1.lat.oz.au

This paper presents an approach to texture segmentation by thresholding based on compactness measures of fuzzy sets to determine thresholds of an ill-defined image. The extension of fuzziness in the texture feature space provides more meaningful results than by considering fuzziness in gray scale domain. The effectiveness of the algorithm is demonstrated by comparison with other traditional nonfuzzy methods or the controversial fuzzy method in gray scale alone. In addition, the efficiency of our algorithm is further improved by parallel implementation using distributed shared memory workstations.

An important component in image analysis is segmentation of the image into meaningful regions with certain properties. During the past decades, various image segmentation techniques have been proposed [1]. Thresholding is a technique extensively studied and widely used as a tool in image segmentation. A number of approaches to thresholding, including global, local and dynamic methods have been proposed in the past. However, when the regions in an image are ill-defined (i.e., fuzzy), some ideas based on fuzzy set have been proposed by assuming the segments to be fuzzy subsets of the image. Fuzzy geometric properties defined by Rosenfeld [2] are useful for such analysis. Pal [3] proposed a method to extract the fuzzy segmented version of an ill-defined image by minimizing compactness and fuzziness of the image in both the intensity and spatial domain. The advantages of such an algorithm has been demonstrated by considering the ambiguity in grey level through the concepts of index of fuzziness[4], entropy [5] and index of nonfuzziness (crispness) [6]. Nevertheless, this method cannot be applied directly to textured image because texture is characterized by its local features over some neighbourhood rather than a pixel gray scale.

In this paper we extend the fuzzy compactness approach to segment textured images by incorporation of fuzziness in texture feature domain. Here, our emphasis is on the so called `spatial-statistical' measurement of texture features, which involves the computation of statistics of various local image functions. These measures are spatial because they depend upon local window functions rather than single pixels. They are statistical in the sense that statistical moments of an image window are invariant to relative pixel positions. In our test, Skewness and Laws' texture energy are used as texture measurements[7] in determining the fuzziness in a textured image.

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In contrast to the conventional measurement of fuzziness in an gray scale image detailed by Pal[3] in his pioneering work, we extended this approach by applying the distance measurement to texture feature image rather than the texture image in gray scale. In the work reported here, both Skewness and Law's texture energy are calculated and mapped to different levels for the measure of index of fuzziness in the feature domain. In addition, our optimization of fuzziness for textured image segmentation is implemented in parallel using a workstation cluster.

We adopt a divide-and-conquer policy, where a complex task is divided into a number of sub-tasks and those sub-tasks are mapped to computers for simultaneous implementation. In order to reduce the communication overheads, we conduct our experiment of parallel computing on networks of workstations using the TreadMarks distributed shared memory (DSM) system.

We conclude that the extended thresholding scheme by optimization of fuzziness provides more meaningful results for textured image segmentation. Furthermore, the parallel computing on networks of workstations using distributed shared memory is powerful to attain real-time performance. Our investigation shows that distributed shared memory computing can meet the high computational and memory access demands in real-time imaging.

Key words: Texture segmentation, thresholding, fuzzy sets, fuzziness, fuzzy compactness, parallel implementation.
Topic category: Image and Multidimensional Signal Processing

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