Wavelet Transform in Image Regions Classification

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Texture segmentation and classification form very important topics of the interdisciplinary area of digital signal processing with many applications in different areas including analysis of microscopic images, biomedical image processing or detection of satellite image components. The paper presents selected mathematical tools for pattern recognition [1] applied in crystalography (Fig. 1) to detect individual objects, to analyze their properties and to find the percentage of desired individuals.

The initial part of the paper presents selected mathematical methods of image segmentation [2] using distance and watershed transforms (Fig. 2) to find image ridge lines. Proposed algorithms include also the application of the preliminary image denoising to reduce problems of their oversegmentation in the preprocessing stage and to enable homogenous cluster features estimation.

The main part of the paper is devoted to extraction of image segments features necessary for their classification. Image components features definition is based both upon the analysis of their boundary signals (Fig. 3) and their textures as well. To find features invariant to image components rotation, translation and scale both the complex wavelet transform [3] and Radon transform are used. Proposed methods include both the analysis of these methods and their application for processing of observed microscopic images.

The final part of the contribution presents results of image segments classification using self-organizing neural networks. Results of image segment classification are numerically compared using distances of individual feature vectors and corresponding cluster centers as a measure of classification results. Both numerical and graphical results are presented for analysed images.

The paper presents possibilities of multiresolution approach to image segmentation and feature extraction. Proposed methods have been verified for simulated structures and then used for analysis of microscopic images of crystals of different shapes and sizes. Further applications include analysis of structure of metals and detection of specific components in biomedical magnetic resonance images.

Key words: Image processing, pattern recognition, time-scale analysis

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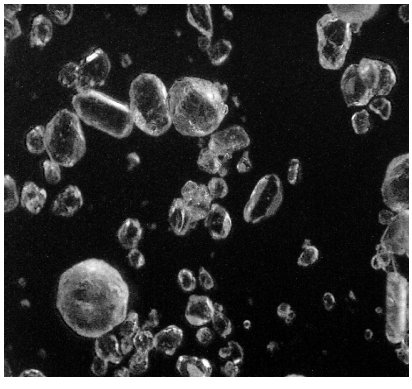

Fig. 1. Microscopic image of illuminated crystals having different shapes, textures and sizes

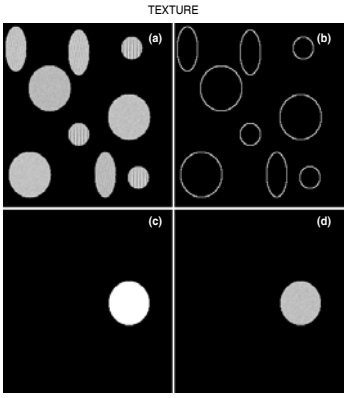

Fig. 2. Image segmentation presenting **(a)** an image containing different simulated structures, **(b)** results of its watershed segmentation, **(c)** selected image segment area, and **(d)** its texture

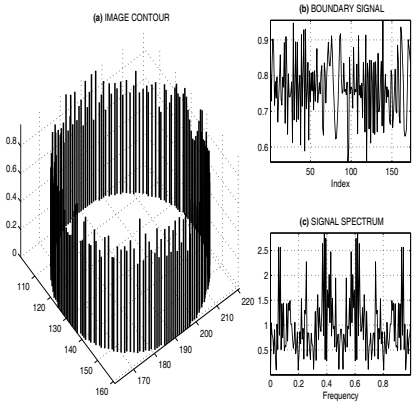

Fig. 3. Selected image segment analysis presenting **(a)** 3D image segment boundary signal, **(b)** 2D image boundary signal, and **(c)** its discrete Fourier transform