Smooth Edge Images Based on a Multilevel Morphological Filter

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Abstract Edge detection is an important problem in computer vision and image understanding. Because the threshold is difficult to properly determine, edge images gained by the usually gradient-based segmentation methods are often tend to have many disjoint or overlapping boundaries, which makes the edge images spinous. In this paper, a practical multilevel morphological filter is presented for smoothing spinous edge images. The experimental results show that the method is effective in dealing with the images of a target in the sky.

Key words Multilevel Morphological Filter, Smoothing Edge Images

1. Introduction

The computer vision branch of the field of artificial intelligence is concerned with developing algorithms for analyzing the content of an image. As the usually first phase to understand image, image segmentation or object isolation has attracted many scientists' interest, but the existing algorithms of segmentation are often lead to spinous edge images[1].

As the photoelectric trackers are widely used in various fields, target detection from the images of sky captured by the trackers is becoming an important problem. In this paper, a practical morphological filter is proposed to smooth the spinous edge images for isolating the target from the sky background. The experimental results show that the method is effective in dealing with the images of a target in the sky. Our work lays the foundation of target detection and recognition for a photoelectric tracker.

2. Morphological filter

Morphological filtering way is a kind of new nonlinear filtering method[2], which has been developed based on mathematical morphology. It describes the basic feature and structure of image by using the geometrical relation among all pixels or subsections of images. It has the special transforms or operations, and possesses an integrated system of theory, method and algorithm, and has achieved great success in the applications to image restoration, noise suppressing, edge extraction and pattern recognition.

The fundamental operations of Morphological Filter are defined as follows:

Let $f_{(n)}$ be a discrete function on the tow-dimensions space Z, and structure element B the finite subset of Z. Then dilation and erosion of $f_{(n)}$ with respect to B are

$$erode(f,B) = (f\Theta B)_{(n)} = \min\{f_{(n+m)} / m \in B\}, \quad (2.1)$$

$$dilate(f,B) = (f \oplus B)_{(n)} = \max\{f_{(n-m)} / m \in B\}. \quad (2.2)$$

Morphological open and close of $f_{(n)}$ with respect to B are

$$open(f,B) = (f \circ B)_{(n)} = [(f\Theta B) \oplus B]_{(n)}, \quad (2.3)$$

$$close(f,B) = (f \bullet B)_{(n)} = [(f \oplus B) \ominus B]_{(n)}. \qquad (2.4)$$

Morphological open and close are usually used in morphological filter. They smooth signals by the different ways. Morphological open may remove the peak of signal (positive impulse), and morphological close do the valley of signal (negative impulse). In order to remove positive and negative impulse of signal, the multistage of morphological open and close is adopted.

3. Multilevel Morphological Filter

Usually, the background of the sky is greatly different from the target. The clouds in the sky are fractal with many crease edges, but the target often produced artificially is not fractal and has many linear boundaries. Therefore, in order effectively to smooth the spinous edges and meanwhile be able to save the characteristics of the target, we should choose several linear structure elements. The structure elements as illustrated in Fig.1 are selected.

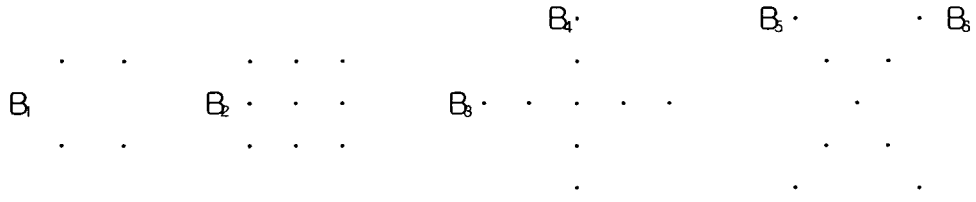


Fig. 1 structure elements.

Although the target has many linear boundaries, it also has crease edges, which makes one morphological operator not be able to fulfill the task of smoothing the edges and save the characteristics of the target. Here, a multilevel morphological filter that is composed of many parallel-series morphological operators is proposed.

Let f(n) be the input image, Y(n) the output image, and then the Multilevel Morphological Filter is illustrated in Fig.2.

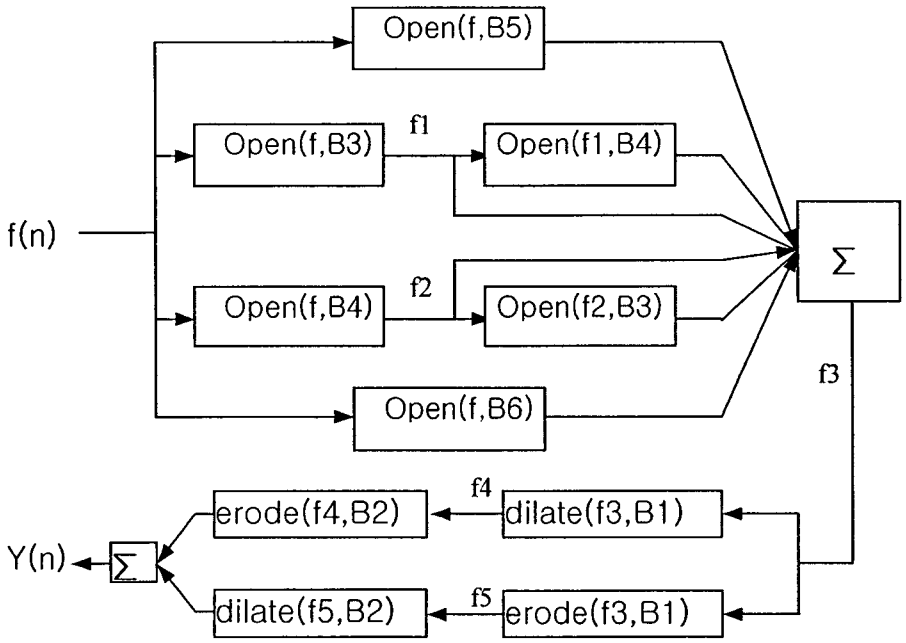
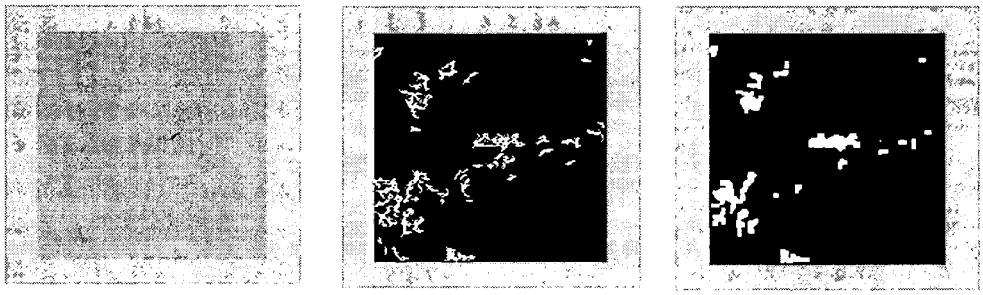


Fig.2 multilevel morphological filter

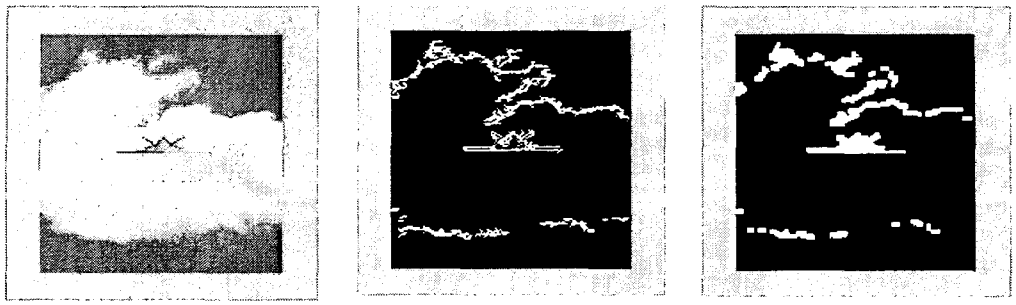
4. Computer Simulations and Discussion

The edge image with many spinous boundaries will be processed for confirming the effectiveness of the algorithm presented in this paper. In figure 3 and figure 4, (a) is the original image (161×161×3Bits), (b) is the edge image gained by the fuzzy method[3] and (c) is the result using the multilevel morphological filter to smooth the image (b). The processing result shows the algorithm presented in this paper can not only effectively smooth the spinous edge but also preserve the geometrical features of the target in images Our method has great practical value.



(a) (b) (c)

Fig. 3 A plane in the sky with many clouds



(a) (b) (c)

Fig. 4 A plane in the sky with one cloud

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Shao-qing Yang , received the Ph. D. degree in automatic control engineering in 2000 from Harbin Institute of Technology. Now he is an postdoctoral candidate at Dalian Maritime University. His research interests are primarily in the area of chaotic signal analysis, computer vision and image understanding, data fusion and target recognition.

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