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COMPOSITE MORPHOLOGICAL STRUCTURAL ELEMENT IN THE EDGE DETECTING

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Summary. Edge detection is an important step in image analysis. Using mathematical morphology and individual structural elements can detect certain types of edges. But much remains undetected. This paper proposes edge detection algorithm based on the structural element made up of many individual structure elements. The experimental results are showing.

Key words: mathematical morphology, edge detection

Introduction

Edge detection is one of the major operations performed on the image. In today's image-analysis systems it is used very often. The correct edge detection is very important for the next steps of image analysis. This article proposes a method based on morphological operations. Existing methods based on erosion and dilation used the structural element (SE) of various shapes (cross, diamond, etc.), and therefore their use is not always gave satisfactory results. The use of a structural element of a complex structure is an alternative approach that could give better results.

Edge extraction using morphological operations

Mathematical Morphology is very frequently used to solve various problems in image processing. The basic morphological operations are erosion, dilation, opening, closing [1, 4]. In this paper, morphological operations are used to detect edges. These operations are:

- edge of image using erosion denoted by G_e defined as a difference between the domain A (input set) and erosion of domain A

$$G_e = A - (A \Theta B) \qquad (1)$$

where B is an structural element SE

- edge of image using dilation denoted by G_d defined as a difference between dilation of domain A and domain A (input set):

$$G_d = (A \oplus B) - A \qquad (2)$$

- morphological gradient (M_{grad}) is defined as the difference between dilation and erosion input set A:

$$M_{grad}(A) = (A \otimes B) - (A \Theta B) \qquad (3)$$

Composite morphological structural element SE

Typically, the edge detection is used symmetrical structural elements. However, in many cases, such an approach does not guarantee the detection of all edges. The proposed method enables more accurate detection of edges [2]. The final result also depends on the shape and size of the structural element. Therefore, it is appropriate to submit a structural element of many individual shapes.
Let $\{F(m,n)\}(m,n \in Z)$ is digital image, (m,n) is its centre. Structure elements in (2N+1) x (2N+1) square window can be denoted by:

$$A_i = \{F(m+m_0, n+n_0), \phi_i = i * \alpha, -N < m_0, n_0 < N\} \qquad (4)$$

where i=1,2,…4N-1, α=180/4N, ϕ_I is the direction angle of structure element.
If N=1 then square window is 3x3 size and the direction angle of structure elements are $\phi=0^o$, 45^o, $90^o$and 135^o (Fig. 1).

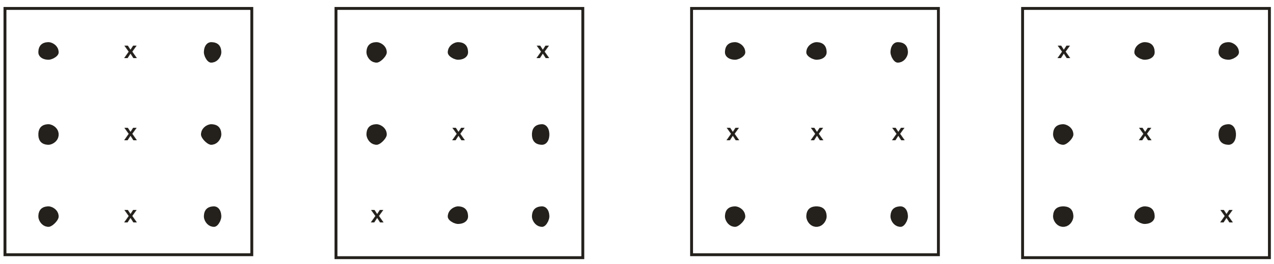

Fig. 1. Four different structure elements in 3x3 square window.

For N=2 square window is 5x5 size and the direction angle of structure elements are $\phi=0^o$, $22,5^o$, 45^o, $67,5^o$, 90^o, $112,5^o$, 135^o and $157,5^o$.

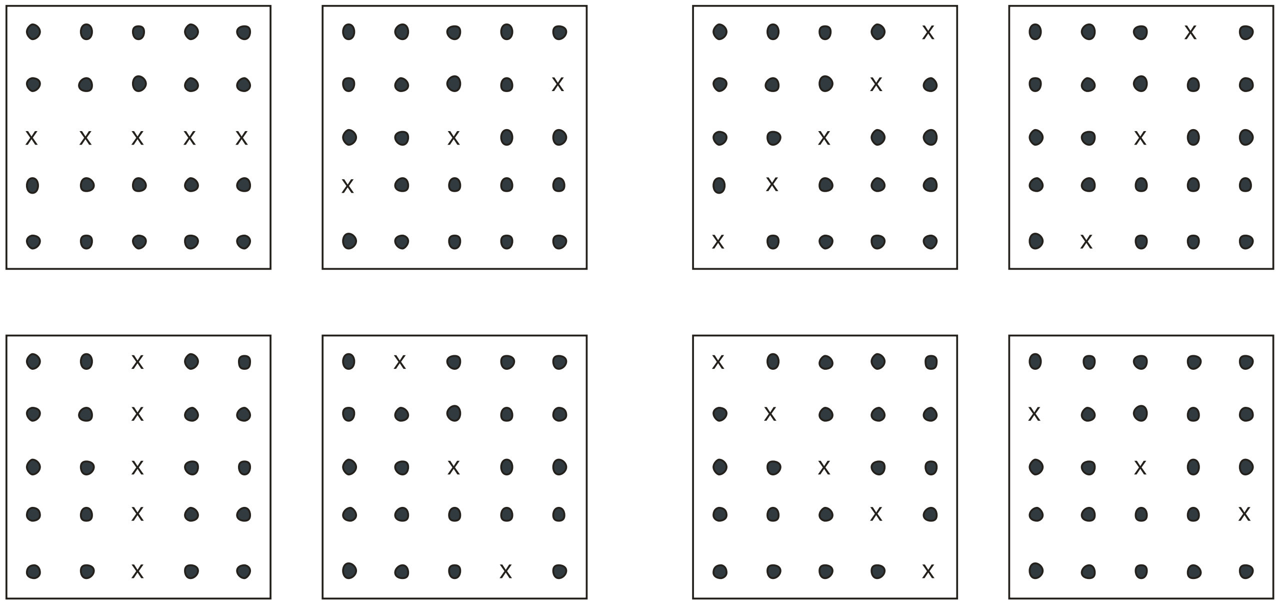

Fig. 2. Eight different structure elements in 5x5 square window.

Use of the structural elements prepared according to the expression (4) can detect edges in the image. For this purpose can be used morphological gradient expressed by (3). For each of the direction angles will be determined edges of original digital image. Next, the results are summing and based on the weighted average will determine the final result of the edges detection (expression 5).

$$M_{grad}(A) = \sum_{i=1}^{M} k_i M_i(A) \tag{5}$$

where $M_{grad}(A)$ is final detected edges of original image, M is number of structure elements, k_i is the weight of different detected edge (in this paper be calculate by $k_i=1/M$).

Results for example image

The experiment used the image in bitmap format with a resolution of 512-512 points in 256 gray-scale levels. Figure 3 shows the original image. For comparison Figure 4 shows the detected edges by Prewitt operator, Figure 5 by Sobel operator and Figure 6 by Canny operator. Figure 7 shows the detected edges by using morphological methods (structural elements is a simple crisscross), and Figure 8 and Figure 9 show the result of the edge detection based on a composite morphological structural element, respectively, according to Figure 1 and Figure 2

Fig. 3. Original image

Fig. 4. Edge detection result by Prewitt operator

Fig. 5. Edge detection result by Sobel operator

Fig. 6. Edge detection result by Canny operator

Fig. 7. Edge detection result by 3x3 crisscross SE

Rys.8. Edge detection result by composite 3x3 morphological SE

Fig. 9. Edge detection result by composite 5x5 morphological SE

According to the results shown in Figures 4 and 5, the edges are not detected continuously, detection by Canny operator (Fig. 6) detects the edges continuously, however, as the edges sometimes detects noise. As shown in Figures 8 and 9 detecting the edges of the composite structural element is precise and constant (also in relation to edge detection result by 3x3 crisscross SE – Fig. 7).

Conclusions

The article presents a method of edge detection based on mathematical morphology with composite structural element. The results show that the use of such an element gives better results than the usually used methods based on Canny operator, Prewitt operator, Sobel operator and morphology with crisscross structural element.

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