Infrared Image Edge Detection based on Morphology-Canny Fusion Algorithm

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Abstract. Effectively extracting the contour edge of the defect in the infrared image can realize the recognition of the geometrical features of the defect. In view of the traditional Canny edge detection algorithm in the Gauss filter variance and high and low threshold selection need artificial intervention, does not have the adaptive ability, and its defects in the gradient calculation, proposed a method based on the improved Canny operator and image morphological fusion edge detection method. Using the improved Canny operator and image morphology to edge detection, the simulation results show that the algorithm has good anti-noise ability, effectively improve the accuracy and integrity of the edge detection in the infrared image, and achieve a better extraction of geometric features of the edge of the defect.

Keywords: Morphology; Canny operator; edge detection; infrared image.

1 Introduction

Edge detection is the basis of image information extraction and pattern recognition, which is an important content in the field of image processing. Image edge detection results directly affect the effect of further image processing, pattern recognition. Effectively extracting the contour edge of the defect in the infrared image can realize the recognition of the geometrical features of the defect. In recent decades, image edge detection technology has become one of the important research topics of digital image processing technology. Edge has important information characteristics, accurate and reliable edge detection method will be helpful for image feature description, image enhancement, image segmentation and pattern recognition and so on. Because of the noise and the edge of the image are high frequency signal, the general method is very difficult to effectively separate the two regions, a good edge detection method is able to filter out the noise while the edge is also to be accurate and clear. So, the accuracy and integrity of edge detection is a direct impact on the selection of the whole image, and the research on it has become one of the hot spots in image analysis and processing technology [1-3].
2 Basic Theory of Mathematical Morphology and Edge Detection Method

Mathematical morphology is a mathematical method, which is based on morphological structure elements to analyze and describe the geometry and structural properties. It is also a kind of nonlinear processing system based on geometric algebra and set theory. The basic idea of mathematical morphology is to measure the effectiveness of the method of the structural elements of a certain shape to measure the effectiveness of the method and the method of filling in the target image. Mathematical morphology can eliminate the morphological and structural properties, which is not related to the target image, while preserving the basic nature of the shape and structure, and achieve the purpose of simplifying the target image data. The most basic morphological operators include corrosion, expansion, open operation and close operation [4-6].

2.1 Morphology Expansion

A new form of structure element \( B_a \), which has a certain form of structural element \( B \) shifts distance \( a \), is obtained. If \( A \) and \( B_a \) are in the same \( A \), the \( B \) is expressed as a set of elements that satisfy the condition:

\[
D(A) = \{ a | B_a \cap A \subseteq A \} \quad A \cap B
\]

(1)

2.2 Morphology Erosion

A new form of structure element \( B_a \) is obtained by \( B \) shifts distance \( a \), which is composed of \( A \), and all the collection of elements that satisfy this condition is called \( A \) is eroded by \( B \). The formula is expressed as

\[
E(A) = \{ a | B_a \cap A \subseteq A \} \quad A \cap B
\]

(2)

2.3 Open Operation

Using the same structural elements of the image first erosion operation, and then the results of the method of expansion is called open operation, the formula is expressed as

\[
A \circ B = (A \cap B)^c \cap B
\]

(3)
Open operation can smooth the image contour, weaken the narrow part, removing the burr and the isolated spots of the long and thin protruding edges, disconnect between the target and so on., its main effect on corrosion is similar.

2.4 Closed Operation

Using the same structural elements to expand the image first, and then the results of the method of erosion operation is called closed operation, the formula is expressed as

$$A \oplus B = (A \ominus B) \ominus B$$

Close operation can also be smoothed image of the contour. Compared with open operation, closed operation is generally used to fill the small hole and crack in the target. The main function of the connection is similar to the expansion effect, but it is also the same as the size of the target.

2.5 Morphological Edge Detection Operator

The basic idea of the traditional morphological edge detection operator is to do morphological gradient processing of the original image, so that the gray level of the input image is more acute, and then the image edge is detected. With the help of the basic operations of all kinds of morphological operations, the morphological gradient $MG$ is usually expressed in the following forms:

$$MG_1(A) = (A \ominus B) \ominus A$$
$$MG_2(A) = A - (A \ominus B)$$
$$MG_3(A) = (A \ominus B) \ominus (A \ominus B)$$
$$MG_4(A) = \min \{A \ominus B, A \ominus (A \ominus B)\}$$

3 Experiment and Analysis

In this paper, the defects edge of infrared thermal image is extracted. Fig.1 shows a thermal image captured by an infrared camera SC7000. Fig.2 shows the image after gray level transformation. Fig.3 shows the edge detection result by Canny operator. Fig.4 shows the image segmentation result by morphology algorithm, after which carried out edge extraction by Canny operator, and the result is shown in Fig.5.
By comparing Figure 3 and Figure 5, it is known that the traditional Canny operator is sensitive to noise, and the morphology-Canny operator has strong noise suppression ability, and the Canny operator has a clear and coherent edge, which can improve the performance of smooth noise and suppress false edges. And the morphology-Canny operator fusion algorithm enriches the local edge details.

4 Conclusion

In this paper, we identify the edge of infrared image based on morphology-Canny operator. The simulation experiments show that the proposed algorithm can detect the edge details and more complete contour information, improve the accuracy and accuracy of edge detection, which is a valid edge detection method.
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