Research on image segmentation and edge detection technology based on computer vision

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Abstract. With the continuous development of computer vision technology, image segmentation technology and edge detection technology are becoming more and more mature. Firstly, this paper simulates the fixed threshold method and adaptive threshold method in image segmentation, and concludes that the fixed threshold method is applicable to images with obvious targets and backgrounds, and the adaptive threshold method is applicable to images with uneven distribution of light and dark, and secondly, the comparative experiment and result evaluation of edge detection of images by Sobel operator and Canny operator are used to conclude that the Sobel algorithm is more accurate in positioning edges, while Canny algorithm image edge information is more continuous and single edge response is better. Its edge detection is also better.

1. Introduction

Image segmentation is one of the basic problems of image processing and machine vision, the purpose of which is to divide the image into collections of disparate areas that are either meaningful to the current task or help to illustrate their correspondence with actual objects or parts of objects. Image segmentation is widely used in almost all fields of image processing and involves all types of images. For example, in remote sensing applications, the segmentation of targets in synthetic aperture radar images: The segmentation of different cloud systems and background distribution in remote sensing cloud map, etc. The division of brain tissue and other non-brain tissue regions in medical applications, etc. In traffic image analysis, the vehicle target is separated from the background, etc. In object-oriented image compression and content-based image database queries, images are divided into different object areas[1-3]. In these applications, segmentation is usually to further analyze, identify, compress the encoding of images, etc., the accuracy of segmentation directly affects the effectiveness of subsequent tasks, so it is of great significance. Edge detection technology is one of the most basic parts of machine vision technology based on image recognition, and it has been widely studied[4-5].

2. Image segmentation

Image segmentation refers to the process of dividing images into several areas of similar nature, mainly based on threshold, region, edge, clustering, graph-based and deep learning-based image segmentation methods. Image segmentation is divided into semantic segmentation and instance segmentation. The principle of segmentation is to keep the subplots with the greatest similarity internally and the subplots with minimal similarity. Extract object information in the image and the remaining part of the image area have different collections of grayscale scales, you can select 1 grayscale threshold t, object and background area division[5]. This method is called grayscale threshold segmentation. However, when extracting target information, the difference in the image is often not a
grayscale feature, in which case the difference is converted to grayscale and then processed accordingly by threshold segmentation. The basic principle of the image threshold segmentation method can be explained simply by formula (1):

$$ g(x, y) \begin{cases} 1 & f(x, y) > T \\ 0 & f(x, y) \leq T \end{cases} $$

(1)

2.1. Fixed threshold segmentation

Threshold segmentation of input single-channel matrices pixel by pixel is the definition of fixed threshold segmentation. A typical application is to obtain a binary image from a grayscale graph to eliminate noise that is too large or too small. There are five types of fixed threshold segmentation, namely, THRESH_BINARY, THRESH_BINARY_INV, THRESH_TRUNC, THRESH_TOZERO, and THRESH_TOZERO_INV. Determining an array and a threshold, and then processing according to the size of each element in the array relative to a given threshold, is the rationale for this function[7-9]. In this experiment, the threshold is set to 120 by the method of dualization of the THRESH_BINARY, and the setting of the element in the image greater than 120 is 255, that is, all white, and the setting of less than 120 is 0, that is, all black. This article selects THRESH_BINARY functions to implement:

$$ \text{dst} \begin{cases} \text{maxval} \text{ arc} (x, y) > \text{thresh} \\ 0 \text{ otherwise} \end{cases} $$

(2)

Threshold (InputArray src, OutputArray dst, double thresh, double maxval, CV_THRESH_BINARY), for the pixel value of the current point, maxval is the maximum value set, arc (x,y) is the image to be processed, thresh is the split threshold, InputArray src and OutputArray dst is the input and output matrix[10].

The experimental results are shown in Figure 1 below, where (a) the figure is the original figure and (b) is the processed image.

![Figure 1 SAR image fixed threshold segmentation](image1.png)

Figure 1 SAR image fixed threshold segmentation

Here's a comparison of the image processing results for the five segmentation types of fixed threshold segmentation, as shown in Figure 2 below:
Figure 2 Five fixed threshold segmentation methods compare the results

It can be seen that fixed threshold segmentation works well when dealing with images with obvious foreground and background distinction, which is suitable for the processing of simple single image "one size fits all", but when there are more elements in the image, this method is no longer applicable, and the adaptive threshold method should be applied.

2.2. Adaptive threshold method

In the actual image processing process, the grayscale value of the background is not a specific constant, in this case, the fixed threshold method can not be used, it is necessary to introduce the adaptive threshold method. In order to solve this problem, a fixed threshold may have different segmentation effects in different areas of the image, and in order to solve this problem, it is necessary to take the threshold value as a function value that varies with the position of the image area, that is, the adaptive threshold. The adaptive threshold method processes a small portion of the image each time it is processed and calculates its threshold, making the thresholds different for different regions[11]. Adaptive threshold algorithm is implemented by the function cvAdaptiveThreshold in OpenCV, and the binary threshold type of THRESH_BINARY is selected in this paper. The effect is shown in Figure 3 below:

Figure 3 Fixed threshold segmentation vs. adaptive threshold segmentation
Figure Origin is the source image and Figure Global is a fixed threshold method processed after the image, you can see the effect is very poor. Figure Adaptive Mean is the use of mean adaptive method to process the image, Figure Adaptive Gaussian is using Gaus formaldehyde adaptive image processing. After repeated experiments, the effect is obvious when the area of adaptive small area is set to 11. The extraction effect of adaptive threshold segmentation is better than that of fixed threshold segmentation, and the adaptive threshold method has a better effect on images that are not easily split by fixed threshold, and has strong noise resistance, but the time space complexity of this algorithm is relatively large[13].

3. Image edge detection

Edge detection algorithms have matured, and researchers have come up with many classic algorithmic models, such as Sobel, Roberts, Prewitt, Canny, and so on. In order not to lose the generality, this paper adopts the classical method of gradient operator theory: Sobel operator and Canny operator[12]. The Canny operator is a method of smoothing and then deriving derivatives. John Canny studied the characteristics of the optimal edge detection method and gave three indicators to evaluate edge detection performance: 1 the probability of judging non-edge points as edge points is low, the probability of judging edge points as non-edge points is low; Here's how:

- Color image converted to grayscale image (read in as grayscale single channel map)
- Gaussian blur (denoise) on the image
- Calculate the image gradient, calculate the image edge amplitude and angle according to the gradient
- Non-extreme value suppression in the direction of gradient (edge refinement)
- Double threshold edge connection processing
- The output of the binary image.

The effect is shown in Figure 4 below:

Figure 4 The canny algorithm edge extraction is performed on the lena diagram

In the results of the operation on the left, the lower threshold is 80, the upper threshold is 150, the kernel size is 3 x 3, the middle and lower thresholds on the right are 50, the upper threshold is 100, and the kernel size is 5 x 5.

For each pixel of a digital image, the weighted difference of grayscale between its upper and lower neighbors is examined, and the proximity of the neighbors is large. Accordingly, the Sobel operator is defined as shown in Figure 5 below:
Figure 5 The sobel algorithm edge extraction is performed on the lena diagram

Edge detection results can be seen: the classic Canny algorithm has information loss when detecting the edges of the hat part of Lena images, and there are more edges; Sobel operator detection is slightly better than the classic Canny algorithm, but at the complex edges of the image such as Lena image character hair (the detection effect is cluttered, some lines are blurry, but better than the classic Canny algorithm edge line continuity).

4. Conclusion
This paper compares and analyzes the fixed threshold method and the adaptive threshold method, as well as the sobel operator and the canny operator, and simulates these algorithms and analyzes their advantages and disadvantages. It is of reference value to improve the adaptability of image segmentation and edge detection algorithm in practical application.

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