

The Study on Features Shape Extraction in High-Resolution Remote Sensing Image

WANG Run-fang

*Institute of Surveying Engineering, Sichuan College of Architectural Technology, Deyang, China
pangwawa668@126.com*

Abstract: In this paper, features shape extraction were studied in high-resolution remote sensing image which starting from their geometry. Up to now, most methods study focused on the typical features shape, such as: rectangular and round, however, these methods are not suitable for other types of shape extraction. For the universality of Features shape, a new method is proposed.

Keywords: high-resolution remote sensing image; features shape; edge detection; extraction; merge

1. Introduction

In the last few years, High-resolution remote sensing imagery has become progressively more abundant along with the launch of commercial remote sensing satellites successfully, such as IKONOS, QUICKBIRD etc^[1]. Due to large amount of information, well timeliness, reasonable economic cost, it play an increasingly important role in the national economic activities. Transformate the remote sensing image data into useful information with a variety of topics through analysis and interpretation so that provide better decision making for managers. Features is the most important image primitives, so accurate construction of features shape has important significance.^[5]

2. Edge Detection

Because edges are the basic elements in the image shape, edge detection will have a direct impact on the subsequent higher-level processing^[2]. The edge information is

an important basis for features shape extraction in the high-resolution remote sensing images. Therefore, how do detect features's edge is an important factor which affecting the outcome of the extraction. Edge refers to the most significant local part of the image intensity changes, it mainly between the objectives and objectives, or between objectives and background, or between region and region. Generally, it believed that dramatic changes in gray point shall be the edge of the image, and the image edge detection is to identify the location of dramatic changes in the gray^[3]. Commonly used edge detection algorithms are the following:

1) Roberts edge detection operator: Roberts edge detection operator is an operator which use partial differential operator to find the edge. When looking for edge, it calculate its gradient vector operator for each pixel, and then to the threshold operation. And it is very sensitive to noise in general case, and often have some isolated points

$$g(x, y) = \sqrt{[f(x, y) - f(x + 1, y + 1)]^2 + [f(x, y + 1) - f(x + 1, y)]^2}$$

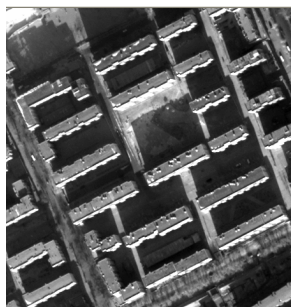


Fig.1. Original image

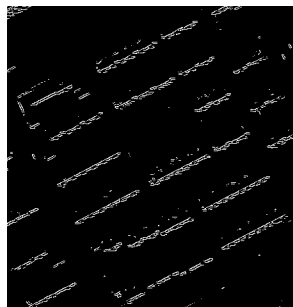


Fig.2. Roberts edge detection

2) Sobel edge detection operator: Sobel edge detection operator consists of two convolution kernel, and do the convolution for every Pixel with these two convolution kernel: The one to the vertical edge is usually the largest response, while the other to horizontal edge is the maximum. Two convolution as the point of maximum output values, operation result is a edge amplitude of the image. Sobel operator to use pixels from top to bottom, left and right neighboring points, the gray-weighted al-

gorithm, based on extreme edge of this phenomenon points to reach the edge detection. So Sobel operator has a smoothing effect to noise. However, it will also detect many of the pseudo-edge, and edge positioning accuracy is not high enough. When accuracy is not very high, that is a commonly used edge detection method.

$$g(x, y) = \sqrt{g_x^2 + g_y^2}$$

$$\left. \begin{aligned} g_x &= \{f(x+1, y-1) + 2f(x+1, y) + f(x+1, y+1)\} - \\ &\quad \{f(x-1, y-1) + 2f(x-1, y) + f(x-1, y+1)\} \\ g_y &= \{f(x-1, y+1) + 2f(x, y+1) + f(x+1, y+1)\} - \\ &\quad \{f(x-1, y-1) + 2f(x, y-1) + f(x+1, y-1)\} \end{aligned} \right\}$$

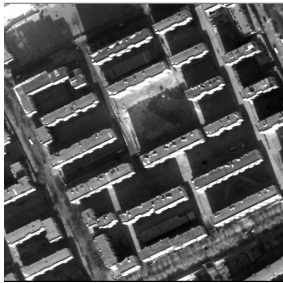


Fig.1. Original image

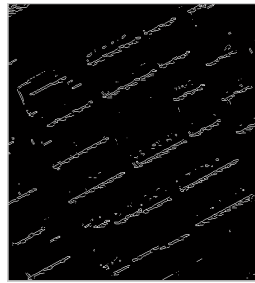


Fig.3. Sobel edge detection

3) Prewitt edge detection operator: Using the Prewitt operator same as the Sobel operator, Each image pixel is carried out by two convolution kernel, and taking the maximum as the output. Prewitt operator and Sobel operator is good or bad depends on the image noise, If the noise of the each pixel is same, Prewitt operator is better; If the noise is close to the edge of the sides which along the edges, Sobel operator is better.

$$g(x, y) = \sqrt{g_x^2 + g_y^2}$$

$$\left. \begin{aligned} g_x &= \{f(x+1, y-1) + f(x+1, y) + f(x+1, y+1)\} - \\ &\quad \{f(x-1, y-1) + f(x-1, y) + f(x-1, y+1)\} \\ g_y &= \{f(x-1, y+1) + f(x, y+1) + f(x+1, y+1)\} - \\ &\quad \{f(x-1, y-1) + f(x, y-1) + f(x+1, y-1)\} \end{aligned} \right\}$$

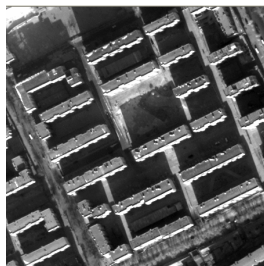


Fig.1. Original image



Fig.4. Prewitt edge detection

4) Laplacian edge detection operator: Laplacian operator using the second derivative zero-crossing point, First derivative edge detector which through the desired first derivative is above a threshold to determine the edge point, it would be too much edge point in output. A better approach is to seek local maxima of the corresponding point of the gradient, and assert that they are edge points, first derivative of the local maximum corresponds to the second derivative zero-crossing point. Thus, by looking for the second derivative zero-crossing point of the image intensity will be able to find the exact edge point.

$$\begin{aligned} \nabla^2 f = L(x, y) &= f(x+1, y) + f(x-1, y) \\ &\quad + f(x, y+1) + f(x, y-1) - 4f(x, y) \end{aligned}$$

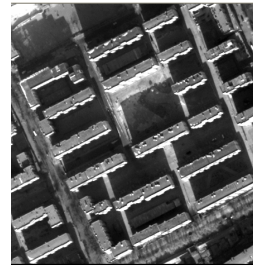


Fig.1. Original image

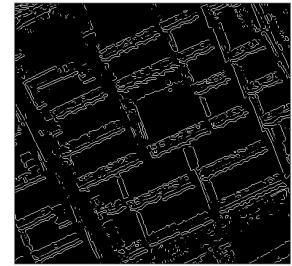


Fig.5. Laplacian edge detection

5) Canny edge detection operator: Canny edge detection algorithm's basic idea is Canny's Criteria. [4] ① Optimal detection. The real edge is not undetected and non-edge points is not detected, which called for output the largest SNR. ② The best detection accuracy. Location of edge points which detected away from the actual point recently. ③ The points which detected are correspondence with the edge point. Each one actual edge point and the points which detected are one-to-one Correspondence.

Canny expressed the above criteria in mathematical form, and got the best edge detection template by using the numerical optimization methods. The algorithm steps are: First, selecting smooth filter -Gauss filter to smooth the image. Second, using the Non-maxima Suppression technology process the smoothed image. Third, using dual-threshold algorithm to detect edge point and connect them. Thus, the final edge image would be obtained.

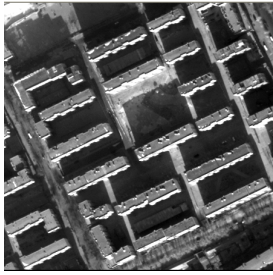


Fig.1. Original image

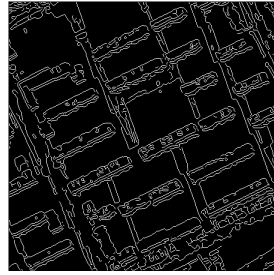


Fig.6. Canny edge detection

3. Shape Extraction

Based on the above detected results, this paper proposes a method which suitable for multi-class features in the extraction. The basic idea is: First, broking the complex surface features down into simple closed polygons, such as triangle, quadrilateral and circle. Second, extracting these simple closed polygons in turn. And finally, merging these simple closed polygons. In this method, the most critical step is how to extract these simple closed polygons. Extraction of them is divided into two parts: the first part is extract. It should extract the detected results in the effective points, and connect it into a small straight line segments. The second part is merger. It would merge the small straight line segments which according with the conditions.

I The steps of the extract:

1) Storing the edge of the detected results into a address which contains the key messages : gray value, location information: line number and column number (M_i, N_i) ;

2) Scanning the detected results from the first pixel, and taking it as center, d as radius to make a circle;

3) Finding the furthest points which away from the center in different directions in the template, recording these location information (M_i, N_i) , and connecting the furthest points and the center respectively ;

4) Calculating the quadrant angle of each connection.

$$\theta_i = \arctan \frac{N_i - N_1}{M_i - M_1}$$

5) Calculating the angle between these connection.

$$\beta_{ij} = \theta_i - \theta_j ;$$

6) Extracting the connections which meet the user' requirements ,and deleting the other connections

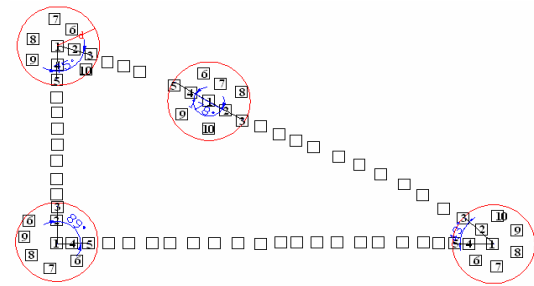


Fig.7. Extract

In the Fig.7, it draws a circle which taking point 1 as center, d as radius, and then finds the furthest point that away from piont 1. It would be point 3, point 5, point 6, point 7, point 8, point 9, point 10 in the found result, and connects the these points and point 1 respectively. Calculating the quadrant angle of line segment 1 3, line segment 1 5, line segment 1 6, line segment 1 7, line segment 1 8, line segment 1 9, line segment 1 10. Finally, using these quadrant angle to calculate the angle between these line segments. The definition of the angle value are $(73^\circ \sim 77^\circ)$ 、 $(178^\circ \sim 182^\circ)$ 、 $(43^\circ \sim 47^\circ)$ 、 $(88^\circ \sim 92^\circ)$ in the Fig.7. If the angle of the value satisfy user-defined conditions, the line segment will be retained, and deleting the other line segments. Line segment 1 3 and line segment 1 5 would be retained in the Fig.7. Repeating the above steps until all of the points scanned

II The steps of the merger:

1) Finding the endpoints of the line segments which in the above results, and recording their location information (X_i, Y_i)

2) Calculating the distance between two adjacent endpoints.

$$D = \sqrt{(X_i - X_{i+1})^2 + (Y_i - Y_{i+1})^2}$$

3) Defining a threshold T, if $D > T$, deleting the end-points, if $D < T$, merging the two endpoints.

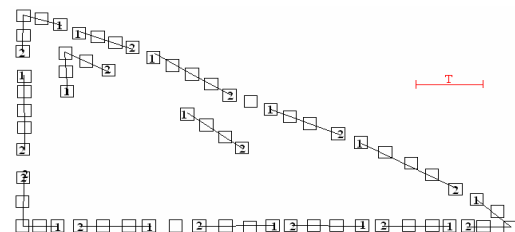


Fig.8. merger

In the Fig.8, It finds the endpoints of the line segments which in the above results, and recording point 1 and point 2 respectively, Calculating the distance between point 1 and point 2. Users define a specific threshold value T , if $D < T$, merging point 1 and point 2, or deleting them. And finally, it forms a single simple closed polygon.

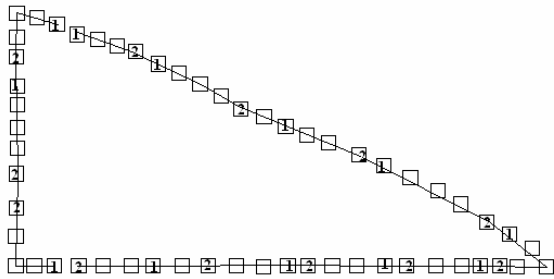


Fig.9. Outcome

4. Conclusion

For the diversity of features shape, this paper proposes

an method of the extraction which based on the results of edge detectio, and it has strong applicability. The results of the extraction is good or bad depending on each parameter which users determined, so when the method is used, the choice of the parameters should be cautious.

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