A METHOD OF HIGH-RESOLUTION REMOTE SENSING IMAGES BUILDING ON EDGE EXTRACTION

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Commission VII, WG VII/5

KEY WORDS: Aerial Images; Building Contour; Building Recognition; Edge Extraction; Edge Extraction; Semi-Automatic

ABSTRACT:

This paper proposes a method of high-resolution remote sensing image of buildings on semi-automatic edge extraction. The first, pre-process remote sensing image and detecting all the edge; the second, tracking the edge and extracting linear feature, extracting the main direction line of the buildings; then using the model to judge the relations of line, segmentation and regional growth; lastly, merge regions and extract the building contour. The paper use this method to experiment on high-resolution Quick Bird satellite images, the result shows that this method has a higher recognition level, a better accuracy of a certain practical value.

1. INTRODUCTION

As an important element of topographic map, Buildings, whose recognition and extraction directly affected the automatic level of terrain feature survey. Because the building has obvious characteristics of position, it's recognition and precise positioning for feature extraction, the feature matching, the image understood, the mapping and regarded as reference body to other targets have the vital significance. From the point of view of practical application, the realization of remote sensing images to identify buildings need to satisfy the remote sensing image mapping, GIS data acquisition and automatic updates; From the point of view of research, because of the high diversity and complexity, the successful automatic identification system of buildings will provide a general understanding of guiding significance of the theory and methods. Therefore, how to identify and extract the buildings from remote sensing images is the one of the most important researching topics of objective recognition.

The paper studied the computer vision, image understanding, as well as the method of information extraction, then put forward a semi-automatic extraction method of buildings and solved the problem of extraction of flattened rectangular buildings.

2. METHODS OF REALIZING

Rectangular buildings or that combinations, whose obvious characteristics in the images, is mutual orthogonal of neighbour edges. Based on this structural characteristics of buildings, carried out statistics to the edge of lines, obtained the main direction of buildings, according to main line direction to get rid of some interference, processed the main direction and its vertical line with model, divided the image to different regional blocks with the extension of line, chose the blocks of buildings, merged them with adjacent regions in accordance with certain criteria, then extracted the outside edge of combination region and implemented linear approximation, the final outcome was got.

2.1 Preprocessing of remote sensing image

There are a variety of influencing factors present on accessing the remote sensing images, due to the image including quantization noise, channel transmission noise, thermal noise and other types of noise, and influencing the following work of information extraction. In order to solve this problem, we need to carry out the smoothing filter to remove the noise, however, during the process of smoothing, the filter which requires good ability of smoothing, at the same time , should keep the details of images, and maintains the accuracy of marginal position. In this paper, use adaptive smoothing method to pre-proceed the image.

2.2 Edge detection and linear feature extraction

Building recognition and extraction on the high-resolution remote sensing images, building top edge information is a most important means of judge. Therefore, how to extract the top edge of building is one of the important factors influencing the result of extraction. In image processing, generally considered grey changed dramatically which is the edge points. In the frequency domain shows high-frequency component, the process of edge detection is to locate the grey dramatic changes in image, which is also a high-frequency enhanced process.

Compared to other classic edge detection operator(Robert, Sobel), Canny edge detection has good continuity and integrity, moreover has obvious effect, after the detection, it's necessary to process threshold segmentation and refinement to get BW images, easily process followed.

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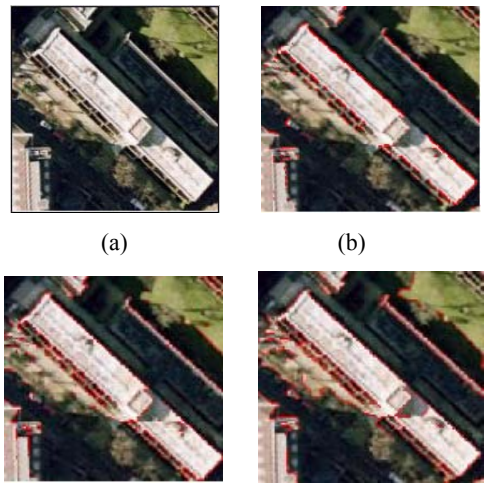

(a) (b)

(c) (d)

Figure.1 Several edge detection algorithm comparison (a) Removal noise Image (b) Robert operator processing image (c) Sobel operator processing image (d) Canny operator processing image

2.3 Boundary Tracking

From the edge of the target tracking features can be divided into two steps: Firstly, extract the basic unit-Edge reflecting the grey changes, secondly, connect these edges to meaningful goal, called edge tracking, that is, one searching process that is used to determine the contour images (Filtering refers to the image). Edge tracking is a method of border examining. Generally speaking, includes three processes:

1. Determine the start point of search, which is strongly depended on this algorithm.
2. Take an approximate data structure and search mechanism, determine the next border points on the basis of founding the starting point
3. Termination of the search conditions. Carrying through edge tracking, first of all, find the edge of starting point. Making an edge point as a starting point, which have eight adjacent points. The central of edge point has the structure in Figure 2, can be as starting point of search.

Search method:

1. Choose a starting point of search and note the coordinates;
2. Change it to 0, avoid duplication;
3. Judge the present point of its eight neighbourhood in order, if there is 1, then set it as present point, output the direction this point, turn the step 2;
4. Until there is no 1 in the eight neighbour regions to the current point, finish the track.

Figure.2 The sketch of staring point for tracking border

Edge tracking takes 8 neighbour templates, which is a method of record chain memorizing edge point, and regulate the required direction from current point to the next, because there are eight possible directions, which can be marked from 0 to 7 and Figure 3 shows the coding schemes of the direction of an eight directions. Figure4 shows the border tracking results.

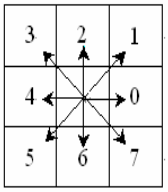

Figure.3 Eight direction coding scheme

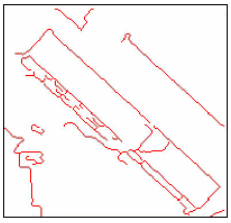

Figure..4 Border track results

2.4 Extraction of linear feature

Before the interpolation, firstly, use the iterative algorithm of border demarcation to meet the fitting line of a straight line. Figure 5 is below.

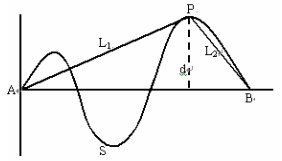

Figure.5 straight line split fitting Sketch

While is splitting, the first, take the starting and ending points of connection as reference, in the range AB of curve, process the point-by-point search, get the P point of largest distance from AB, P's distance equal to d, set threshold T, if $d \leq T$, the line AB can be used as fitting straight line. If $d>T$, P will be a split, and take AP and PB as new reference line, and repeat the process until there is no longer appearing the reference point of a straight line distance of more than T.

In the sequence of broken line after splitting, a connecting credit line is composed of a straight line split in accordance with paragraph from the first to the end, beginning search from the first broken line, with the linear least squares fitting above mentioned, if the standard deviation between the next adjacent line less than a certain threshold value ofφ,then merge the two broken lines. Then combine the third broken line to judge, if the standard deviation between them less thanφ,can be carry out the merge down, if more thanφ,only merge the first and the second broken line, and then start search from the third broken line, process Ibid. Until the final sequence of broken lines, this can get the sequence of merge, each of which is from the fitting form of a straight line. In this paper , compared with other algorithm and on the basis of multiple experiments, choose T=3, Φ=2 and get the desired results. For example Figure 6.

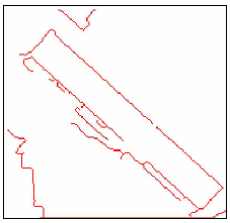

Figure.6 Linear Feature Extraction results

2.5 Extract the main direction of buildings

Extracted the main direction with main direction and its vertical line segment, excluded some segments that have nothing to do with the building edge, which can rule out some features of the surrounding buildings interference; extracted the main direction of buildings that is easy for searching the edge lines in this direction, improve the computing speed and enhance the stability of extraction.

Assuming the total number of line segments is N, static the length of each line segment, as well as the corresponding azimuth. In the range of image dealing with, the building edge lines is connected much longer, so we should focus on the long segments and give much greater weight. In this paper, adopt the square of the length acting on the azimuth. Establish cumulative matrix, which will be cumulated to the corresponding angle, then the corresponding angle of maximum in the accumulator is the main direction of buildings. Figure 7 shows the effects of line planning.

Figure.7 The effects of planning line

Deletes line segments when Satisfy the following conditions:

$$\alpha \in [0,90), |\alpha-\theta| > T \text{ and } |\alpha+90°-\theta| > T \quad (1)$$

$$\alpha \in [90\ \ 180), |\alpha-\theta| > T \text{ and } |\alpha-90°-\theta| > T \quad (2)$$

Reserve line when Satisfy the following conditions:

$$\alpha \in [0,90), |\alpha-\theta| \le T \text{ or } |\alpha+90°-\theta| \le T \quad (3)$$

$$\alpha \in [90\ \ 180), |\alpha-\theta| \le T \text{ or } |\alpha-90°-\theta| \le T \quad (4)$$

2.6 Judge of segments relation with model.

Because of noise or other buildings, the straight edge line of building may be cut off, there are many interferential segments. Which have an impact on the accuracy of building structures search. In this paper, with the method of model to judge the relationship of segments, connect the broken border line, and remove some interference surrounding the buildings.

2.7 Handling the relation between lines.

The long segment should be the main edge after connected the straight line, and there are some short line segments in the vicinity which can be considered as illusive edge line. they will be removed. First of all, sort all segments in accordance with the length, starting with the shortest straight line. Only proceed between the straight lines in the parallel. Figure 8 shows the effect of treatment.

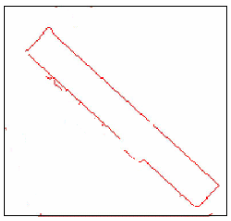

Figure 8 the effect of treating line relations

2.8 Region segmentation and growth.

Calculate the average gradient of each segment, sort the segments from the big to small according to the gradient, then extend the segments and segment the image to different region and mark each region.

Region growth is a process that pixels or sub-regions are converged to bigger region in accordance with definitional criteria. If direct making use of region growth in the buildings within the seed growth, easy access the brink of noise, the edge of extraction is not linear. However, on the basis of extracting the edge of building, and processing segmentation, which relatively easy solve the noise problem and non-linear margin.

2.9 Region merger.

Calculating the average of grey u_i and variance δ_i of each region, if the seed selection region meet $|u_i - u_o| \le \Delta u_o$ and $|\delta_i - \delta_o| \le \Delta\delta_o$,combine the growth of region. Δu_o and $\Delta\delta_o$ are u_o, δ_o linear functions, the selection of parameters of function is due to the real case of buildings.

After merging the top of buildings, extract the outer edge and track it, and now the result of tracing out at the edge is regular closed line, due to the restriction of straight line above, so that we have the rectangle between the adjacent edges, then act on straight line approximation, finally, we obtain the line on the top of buildings, which is the result of building extraction.

Figure.9 The drawing of buildings edge extraction

3. CONCLUSIONS.

The method processed the statistics of building main direction, and planned the segments in accordance with the main direction, so we can able to control the shape of the top of buildings good. Taking the straight line of detected edge as reference, it has a relative strong anti-noise capability. This method is relatively stable, high accurate. Extracting is more dependent on the effect of edge detecting, if the edge is not clear, shadow and the surrounding features and buildings are very alike, the detection result is not satisfied or the outcome is wrong. In addition, during the line extension because it is difficult to find a method of parallel extent, which can only divide region into rectangle, and there are no unique guidelines of merger, results in the extraction incomplete to the multi-angle type.

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ACKNOWLEDGEMENT

Our research project i s supported by the " National S cientific Fund Program (No. 40771159)", the " University d octor disciplines S cientific Fund Program of Ministry of Education (No. 20070 147008)" , the "Open Research Fund Program of the State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing of Wuhan University (No. WKL(07)0303)" , and the "42nd Postdoctor S cientific Fund Program (No. 20070420918)" .