

ROAD EXTRACTION FROM HIGH RESOLUTION SATELLITE IMAGE BY USING CIRCLE AREA

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ABSTRACT:

Many researchers conducted efforts for improving the accuracy of road extraction from satellite images. Many studies have used optical spectrum information of each pixel for road extraction. By applying this method for high resolution satellite image, some problems occurred. This situation is remarkable for urban area. Most of the case, we need the information about land use. In this study, we propose the method for detecting the road intersection by using a double circle. After detecting the road intersection position, we can find out the road network easy. This algorithm was applied for QuickBird image.

1. INTRODUCTION

Many researchers conducted efforts for improving the road extraction accuracy of satellite images. Most of the study has used optical spectrum information of each pixel for road extraction. By applying this method for high resolution satellite images, some cars or center lines on road are also extracted. This situation is remarkable in the urban area. Even if the land cover classification is carried out for many classes, color information of each car is not important in the classified result. Most of the case, we need the information that the object is road or not.

In this study, we propose the method for detecting the roads by using the size and the shape. Double circle is introduced for detecting the size and the shape of road.

2. CONCEPT OF DOUBLE CIRCLE

The circle is designed according to the size of target roads. We will prepare a circle whose size is almost same as the size of target road intersection. If target road intersection is almost entered in the window, we can recognize the size of target road intersection. The problem in this case is how to decide whether the size of the target road intersection is almost same as that of the circle. This decision becomes easy if the situation of the target road intersection expansion to the outside of the circle. Therefore, large circle was set around the center circle. We call double circle for such structure. If this decision is carried out by using only the size of target area, other classes for example bare ground or grassland are also recognized as road intersection. In order to avoid such situation, training data is taken for most of the land cover except road. Supervised land cover classification is carried out for the center pixel of each circle. Inside circle and outside circle are called as core circle and peripheral circle respectively.

3. ROAD EXTRACTION ALGORITHM

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Road intersection detection algorithm is as follows.

- (1) Supervised land cover classification is carried out for pixels in the core circle.
- (2) If classified results of some pixels in core circle are not road, the circle is moved.
- (3) If classified results of all pixels in core circle are road, the pixel whose value is almost same as that of central pixel and connected with central pixel is allocated "1". Other pixels are allocated "0".
- (4) Directional lines are drawn in all directions from the central pixel to the peripheral circle.
- (5) Run length of "1" on the directional line is calculated.
- (6) If many lines that run length is the same size of the radius of the peripheral circle are gathered in one group, this direction correspond to road.
- (7) If above line group exist at least 3, this central pixel is recognized as road intersection.

Such procedure is carried out for each pixel by moving double circle. Central pixel of road intersection area satisfy above (7) condition. We can detect the central position of the road intersection by using this algorithm.

4. EXPERIMENT

Road intersection detection experiment was conducted by using the double circle.

4.1 Object Image Used in This Experiment

The proposed road intersection detection algorithm was applied for QuickBird image. The object image is shown in Figure 1.

This image is obtained on 7 June 2002. This area is included in Kodaira city that is located at the west of Tokyo in Japan. There are many houses, many roads, many bare grounds, many trees and many grass lands in this area. These roads have the variety of width.



Figure 1. QuickBird image used in this experiment

4.2 Double Circle Used in This Experiment

The size of main road in target image is about 12m width which is correspond to 20 pixels in the object image. Main road intersection is surrounded by pedestrian crossing in actual image shown in Figure 1. The radius of core circle should be 10 pixels. Peripheral circle radius is selected 20 pixels. Proposed double circle is shown in Figure 2.

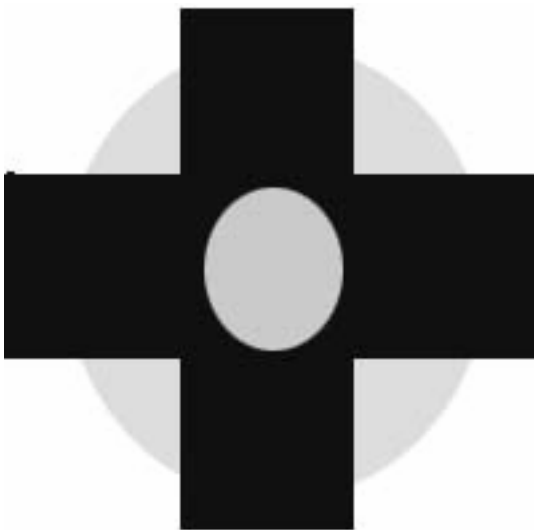


Figure 2. Example of double window

4.3 Road Intersection Extraction

Multi spectral image has 4 band images that are composed of 3 visible band images and one infrared band image. The ground resolution is 2.44m. On the other hand, panchromatic image has high ground resolution that is correspond to 0.61m. Multi spectral image can be used for land cover classification. But, resolution is not so high. Panchromatic image can be used for object detection. Road area has many land covers, for example, cars, central lines, pedestrian crossings and stop lines. Color of car has a many variety. Most of the road has characteristics of asphalt. When road is classified by using ordinary land cover classification method, cars, central lines, pedestrian crossing and so on becomes obstacles. In order to remove these obstacles, two methods are selected. One method is to calculate the NDVI. Another method is to extract the saturation image from HIS transformed image. These obstacles are removed in both images. Some roofs have same characteristics of asphalt. But, these areas do not continue to some direction. Road intersection has three or four continuous direction. By using this difference, road intersection can be detected. Peripheral circle was introduced to detect the roads from road intersection.

4.4 Generation of Mask Image

Mask image is generated from NDVI and saturation images. The image is shown in Figure 3. Black area shows removed pixels which have vegetation or high saturation. White area is candidate pixels of roads.



Figure 3. Mask Image

4.5 Supervised classification

Supervised classification method was applied masked image of NDVI, saturation Image and panchromatic image. Classified result of road is shown in Figure 4.



Figure 4. Classified result of road



Figure 6. Extracted Road Intersections from The Classified Image

4.6 Road extraction by using run length

Directional lines are drawn in all directions from the central pixel to the peripheral circle. These lines are shown in Figure 5. Run length of "1" on the directional line is calculated. If many lines that run length is the same size of the radius of the peripheral circle are gathered in one group, this direction correspond to road. If above line group exist at least 3, this central pixel is recognized as road intersection.

Such procedure is carried out for each pixel by moving double circle.

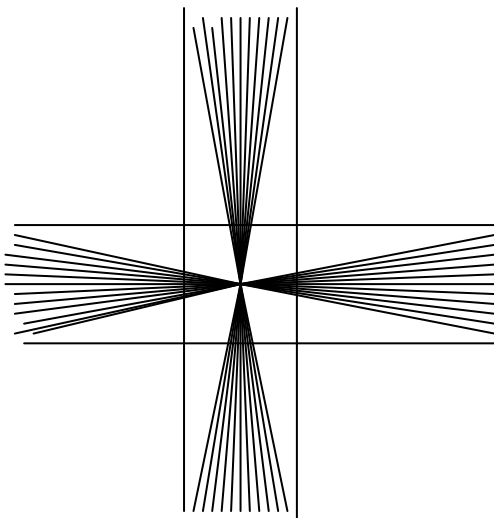


Figure 5. Directional lines

5. EXPERIMENTAL RESULTS

Extracted road intersections are shown in Figure 6. Recognized accuracy was 34%.

Some extracted errors are shown in wide roads and dotted roads. Supervised classification result does not satisfy for the road intersection extraction. We cannot find out the effectiveness of the proposed double circle. We detected roads from the object image by using visual interpretation. Double circle algorithm was applied for the obtained image. As the result, extracted road intersection shown in Figure 7 was obtained. Effectiveness of proposed algorithm is shown in Figure 7.



Figure 7. Extracted Road Intersections from The Visually Interpreted Image

6. CONCLUSIONS

New method was proposed for detection of road intersection. This method is combined supervised land cover classification and double circle. We could show the effectiveness of this method. There are some problems in the classification. We will make effort to show the effectiveness of proposed method.

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