House Detection from High Resolution Satellite Image by Using Double Window

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Abstract: Double window is introduced for detecting the houses from high resolution satellite image. Many researchers conducted the effort for improving the classification accuracy of satellite image. Most of the study has used optical spectrum information of each pixel for image classification. By applying this method for high resolution satellite image, number of class becomes increase. This situation is remarkable for house, because the roof of house has variety of many colors. Even if the classification is carried out for many classes, roof color information of each house is not necessary. Most of the case, we need the information that object is house or not. In this study, we propose the method for detecting the houses by using double window.
Keywords: Detection, High Resolution, Classification, Window Operation

1. Introduction

Many researchers conducted the effort for improving the land cover classification accuracy of satellite images. Most of the study has used optical spectrum information of each pixel for land cover classification. By applying this method for high resolution satellite images, the number of the classes becomes increase. This situation is remarkable in the housing area, because the roofs of the houses have the variety of many colors. Even if the land cove classification is carried out for many classes, roof color information of each house is not important in the classified result. Most of the case, we need the information that the object is house or not.

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

2. Concept of Double Window

The window is designed according to the size of target house. We will prepare a window whose size is almost same as the size of target houses. If target house is almost entered in the window, we can recognize the size of target house. The problem in this case is how to decide whether the size of the target house is almost same as that of the window. This decision becomes easy if the situation of the target house expansion to the outside of the window. Therefore, large window was set around the window. We call double window 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 house. In order to avoid such situation, training data is taken for most of the land cover except houses. Supervised land cover classification is carried out for the center pixel of each window. The shape of window is rectangular or circular. Inside window and outside window are called as core window and peripheral window respectively. Inside pixel value of core window is set positive value depend on the distance from the boundary of the core window. Central pixel has largest value. The pixel value between the boundary of peripheral window and core window depend on the distance from the boundary of core window. These values are set negative values.

3. House Detection Algorithm

House detection algorithm is as follows.

(1) Supervised land cover classification is carried out for central pixel in the window.
(2) If classified result is not unclassified, the window is moved.
(3) If classified result is unclassified, 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) Convolution between double window and obtained result in step (3) is carried out.
(5) If the convolution result is less than threshold value, the window is moved.
(6) If the convolution result is larger than or equal to threshold value, convolution result between core window and obtained result in step (3) allocates to central pixel.

Such procedure is carried out for each pixel by moving double window. Center pixel of house area has relatively large value. We can detect the central position of the house by using above algorithm. After detecting the house position, we can find out the boundary of each house easy.

4. Experiment

House detection experiment was conducted by using the double window.

A. Object Image Used in This Experiment

The proposed house detection algorithm was applied for QuickBird multi spectral image. The object image is shown in Fig. 1.

Fig.1 QuickBird image used in this experiment

This image is obtained on 7 June 2002. This area is included in Tokorozawa city that is located at the south west of Saitama prefecture in Japan. There are many houses, many roads, many bare grounds and many glass lands in this area. These houses have the variety of roof colors that include red, blue, gray and so on. There is a small river in north area. There is a small pond in east area. Forest area is located in southwest and in west. Image size is 205 pixels by 197 lines.

B. Double Windows Used in This Experiment

The size of ordinary house in Japan is about 10m x 8m area which is correspond to 4 pixels by 3 pixels area in the object image. Each house is surrounded by one mixture pixel in actual image shown in Fig.1. Therefore each house corresponds to 5 pixels by 5 pixels area in actual image. The size of core window should be 5 pixels by 5 pixels. Peripheral window size is selected 9 pixels by 9 pixels. There are two types for window shape, circular and rectangular.

Rectangular case is shown in Fig.2. The values in core windows shown a, b and c should be set positive value for example a=3, b=2 and c=1. The value in peripheral window shown d and e should be set negative value for example d=-1 and e=-2.

C. Supervised Land Cover Classification

Maximum likelihood classification method is applied for the multi spectral image. Ordinary land cover classes except roof of house are set for classification classes.

e	e	e	e	e	e	e	e	e
e	d	d	d	d	d	d	d	e
e	d	c	c	c	c	c	d	e
e	d	c	b	b	b	c	d	e
e	d	c	b	a	b	c	d	e
e	d	c	b	b	b	c	d	e
e	d	c	c	c	c	c	d	e
e	d	d	d	d	d	d	d	e
e	e	e	e	e	e	e	e	e

Fig. 2 Example of double window

These classes consist of bare ground, glass land, road, pond, river, forest etc.. Some subclasses are set for each class. Especially, many subclasses are created for bare ground and glass land.

Normal distribution is used in the maximum likelihood method. We truncated this distribution at twice of standard deviation. Outside pixels of twice of standard deviation classified to unclassified class. Most of the roof of houses will be classified to unclassified class.

There are some problems in this classification. Some gray color roofs were classified into road. There are many variety of bare ground. The color of bare ground depends on the content of water. The color of ground also depends on the percentage of glass.

5. Conclusion

New method was proposed for detection of house position and boundary of roof. This method is combined supervised land cover classification and double window. The experiment was not finished. We could not confirm 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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Reference

[1] Hosomura, T, 2005, Object Detection from High Resolution Satellite Image by Using Genetic Algorithm, Proc. of ISRS2005, Jeju