AIRPLANE DETECTION BY USING PSEUDO GROUND RESOLUTION IMPROVEMENT FOR MULTIBAND IMAGE

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Abstract: This research aims to detect airplanes from high resolution satellite image. Generally, high resolution satellite image consists of panchromatic image and multiband image. Ground resolution of panchromatic image is higher than that of multiband image. For example, the former of QuickBird is 0.61m, the latter of QuickBird is 2.44m. We applied the classification algorithm for the combined image of QuickBird panchromatic and multiband image. However, obtained result was unsatisfied for the purpose of airplane detection. Figure of airplane was not smooth. In order to detect airplane by using classification algorithm, the ground resolution of multiband image should be improved. We tried to create high ground resolution multiband image by referencing panchromatic image. Created high resolution multiband image was useful for the detection of airplane by using classification algorithm.

1. INTRODUCTION

Many methods[1],[2],[3] were proposed for objects detection from high resolution satellite images. High resolution satellite image has two mode, multi spectrum mode and panchromatic mode. Multi spectrum mode has optical spectral information. Panchromatic mode has advantage of high ground resolution compare with that of multi spectrum mode. These two mode images can be combined by HIS transformation. Pansharpened image can be created by using HIS transformation. We can classify these images by ordinary classification method. Classification result for pansharpened image was compared with that for multi spectral image with panchromatic image. This result showed that classified accuracy of both methods were almost same. Classification method using only optical spectrum information cannot be obtained sufficient accuracy. In this study, we propose a classification method using created high ground resolution multiband image by referencing panchromatic image.

2. AIRPLANE DETECTION ALGORITHM

2.1 Clustering

Clustering algorithm was used for multi spectral image. After classifying the multi spectral image, we divided the classified result image into two groups. One group corresponds to airplane classes, another group corresponds to the classes without airplane.

2.2 Ground resolution improvement

Ground resolution of classified image is less than panchromatic image. We improve ground resolution of classified image by referencing panchromatic image. Ground resolution of panchromatic image is 4 times higher than that of classified image. One pixel of classified image correspond to 16 (=4x4) pixels of panchromatic image. Difference of ground resolution is too large. Therefore, we decrease the ground resolution of panchromatic image to 1/2. As the result, difference of the ground resolution becomes small. One pixel of classified image becomes to correspond to 4 (=2x2) pixels of panchromatic image. Size of classified image enlarged to two times for both horizontal and vertical direction. If four pixels of panchromatic image have almost same value, adjustment of classified image is not necessary. If the difference of the values of four pixels is large, adjustment of classified image is necessary.

2.3 Geometric feature

Geometric feature parameter is very useful for the extraction of objects from image. Representative geometric feature parameters are center of gravity, bounding box, area, perimeter, roundness, Euler number and moment feature. Roundness is the most effective parameter for the airplane extraction. However, we cannot detect the airplane by using roundness only. We used other parameters also. Airplane extraction algorithm consists of five steps. First step is labeling. Second step is contour tracking. Third step is calculation of geometric feature parameters. Fourth step is extraction of airplane. Fifth step is drawing a circle on the successfully extracted airplane.

2.3.1 Labeling

Labeling algorithm assign the sequential number on each connected component by using lookup table.

2.3.2 Contour Tracking

Contour tracking is to find the boundary of connected component. In this study, we used the contour tracking algorithm by using raster scanning.

2.3.3 Calculation of Geometric Feature Parameter

We used area, perimeter, roundness, center of gravity, ratio of vertical and horizontal size.

2.3.3.1 Area

Area S can be calculated by counting the number of pixels in each connected component.

2.3.3.2 Perimeter

Perimeter can be calculated by counting the number of pixels on the boundary of each connected component. In this case, we used 8-connection. Distance between two pixels connected vertically or horizontally denote C_1. Distance between two pixels connected corner denote C_2. Perimeter L can be calculated following equation.

$$L = C_1 + \sqrt{C_2} \quad (1)$$

2.3.3.3 Roundness

Roundness shows the degree of resemble to circle. Roundness F can be calculated by following equation.

$$F = \frac{4\pi S}{L^2} \quad (2)$$

where S:area, L:perimeter

2.3.3.4 Center of gravity

Center of gravity shows the average position of pixels contained in connected component. Center of gravity can be calculated by following equation.

$$\left(\frac{\sum_{i=0}^{n-1} x_i}{n}, \frac{\sum_{i=0}^{n-1} y_i}{n}\right) \qquad (3)$$

Where n: area, (x_i, y_i): position of each pixel.

2.3.3.5 Ratio of vertical and horizontal size

Horizontal size corresponds to the difference of maximum position and minimum position in horizontal direction. Vertical size also corresponds to the difference of maximum position and minimum position in vertical direction. This ratio can be calculated by vertical size / horizontal size.

2.3.4 Detection of Airplane

Previously extracted template image was examined. Geometric feature parameters of template airplane were calculated. Connected components in a binarized image were extracted. Geometric feature parameters of those connected components were also calculated. As roundness is the most effective parameter, the value of this parameter should be examined at first. The value of other parameters were examined successively.

2.3.5 Drawing a Circle

A circle was drawn on the successfully extracted airplane. Center of this circle corresponds to the center of gravity of the airplane. Radius of this circle is the maximum distance of pixel included in this airplane + 5 .

3. EXPERIMENT

Airplane detection experiment was conducted by using combined algorithm of clustering and geometric feature.

3.1 Object image used in this experiment

The proposed airplane detection algorithm was applied for QuickBird image. The object image is shown in Figure 1. This image is obtained on 2 May 2002. This area is included in Haneda airport that is located at the south west of Tokyo in Japan. Multi spectral image in Quickbird image has 4 band images that are composed of 3 visible band images and one infrared band image. The ground resolution is 2.44m. Panchromatic image in Quickbird image has 0.61m ground resolution. Quantization level of original image is 11 bits. In this study, we quantized from 11 bits to 8 bits. QuickBird natural color image used in this experiment is shown in Figure 1.

Figure 1. QuickBird Natural Color Image Used in This Experiment

QuickBird color infrared image used in this experiment was shown in Figure 2.

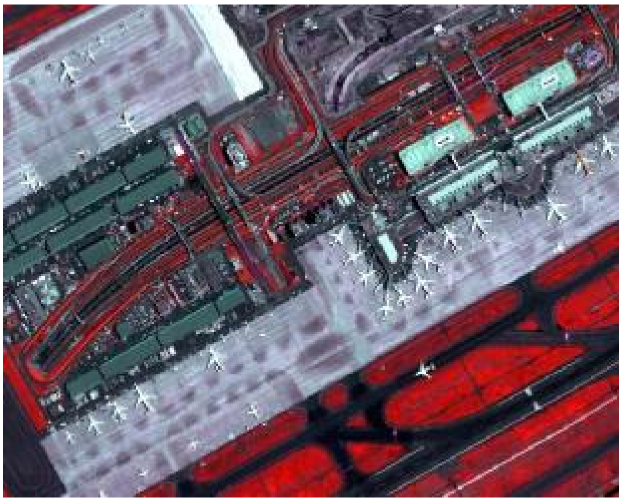

Figure 2. QuickBird Color Infrared Image Used in This Experiment

3.2 Clustering

Clustering algorithm was used for multi spectral image. ISO-DATA method was used as clustering algorism. Number of class was selected 24 classes. After classifying the multi spectral image, we divided the classified result image into two groups. One group corresponds to airplane classes, another group corresponds to the classes without airplane.

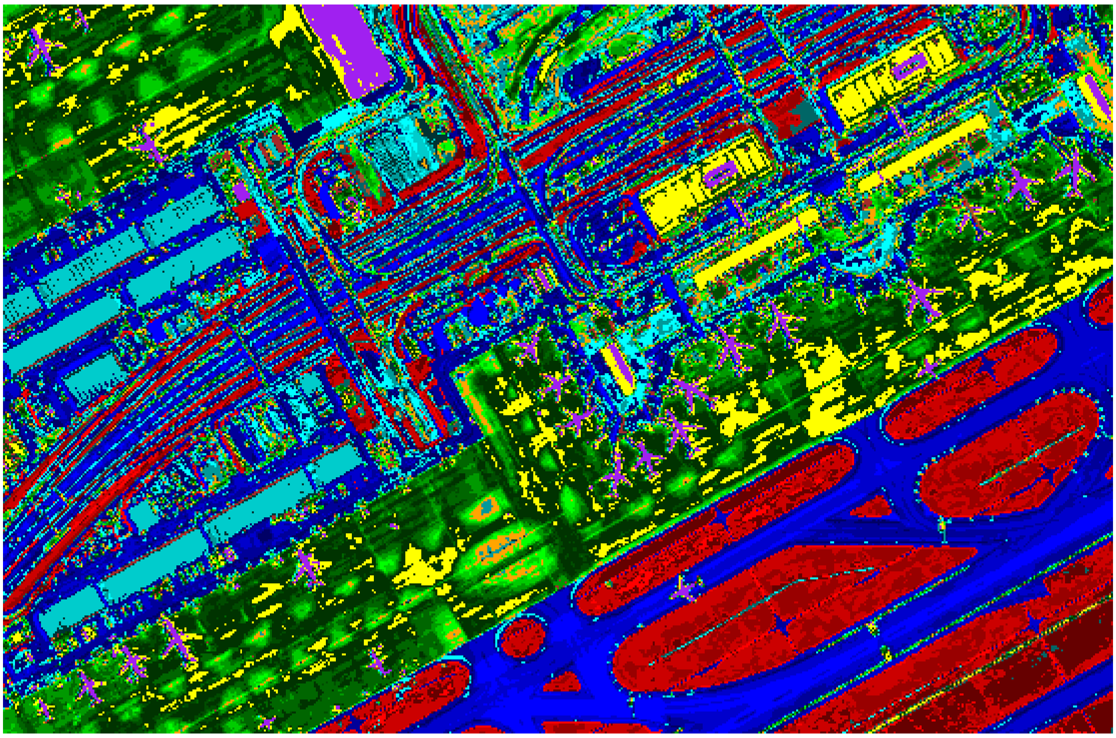

Figure 3 Classified Image by Using Clustering Algorithm

3.3 Airplane detection

After executing the classification, airplanee classes were unified into one class. The other classes were also combined to one class. Figure 3 shows the binarized image by using above method. There are many small white objects and some large buildings. We improve ground resolution of classified image by referencing panchromatic image. Figure 4 shows the binarized image by using above method. There are many small white objects and some large buildings. These objects become obstacles for extraction of airplane. We must eliminate these objects. Some objects were actually not airplane. But those objects were classified into airplane. Those objects were divided into three groups by the object size. Small objects can be eliminated by using the perimeter of object.. Other type objects could be eliminated by following methods.

Previously extracted template image was examined. Geometric feature parameters of template airplane were calculated. Connected components in a binarized image were extracted. Geometric feature parameters of those connected components were also calculated. We compared these parameter values of connected components with that of the template airplane. If this value is near the value of template airplane, target connected component was recognized as airplane. As roundness is the most effective parameter, the value of this parameter should be examined at first. The other parameters were examined successively.

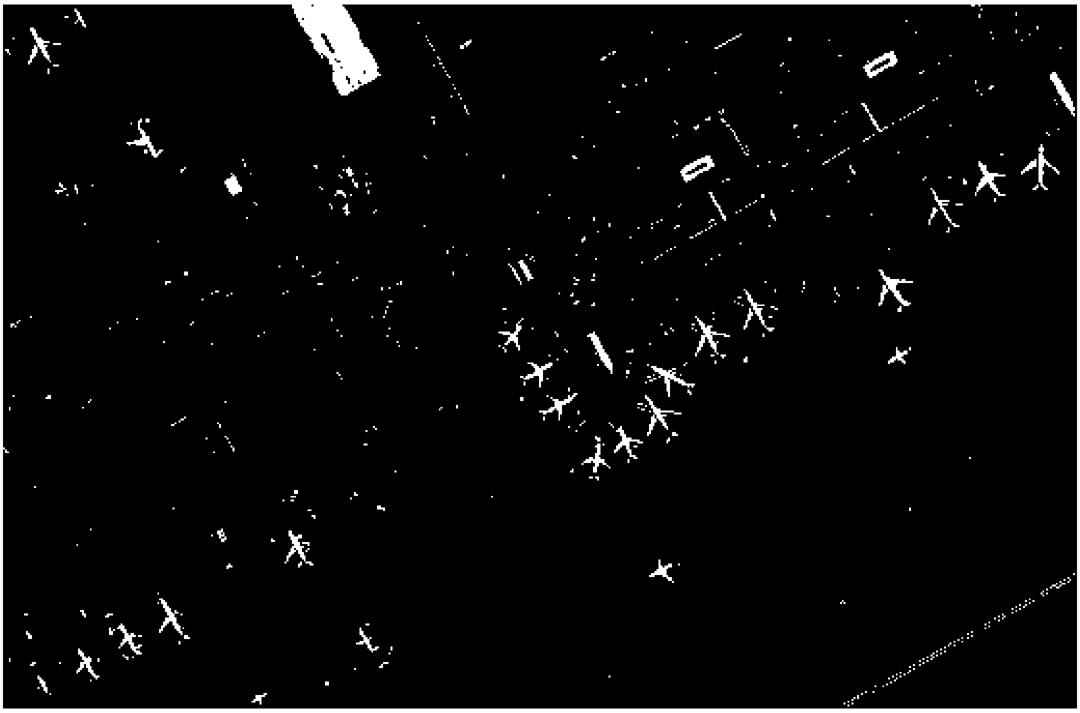

Figure 4 Binarized Image

Extracted airplanes are shown in Figure 6. A circle was drawn on the successfully extracted airplane. Center of this circle corresponds to the center of gravity of the airplane. Radius of this circle is the maximum distance between the pixel included in this airplane and the center + 5 pixels.

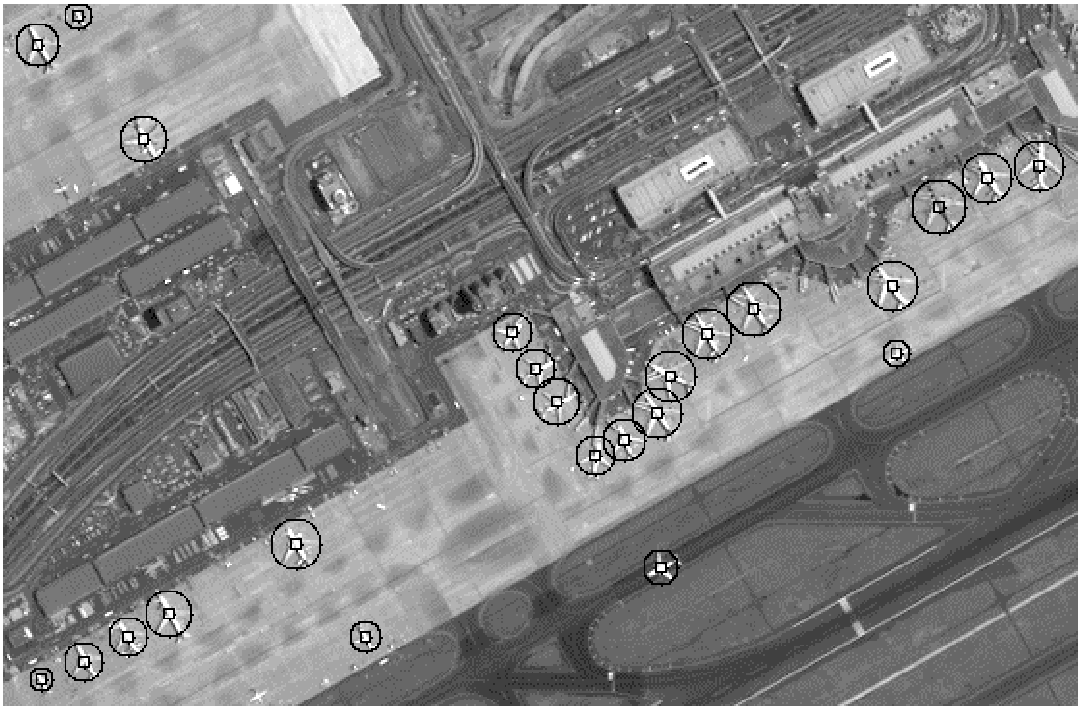

Figure 5 Successfully Extracted Airplane

4. CONCLUSION

New method was proposed for detection of airplane. This method is combined classification and geometric feature. We could show the effectiveness of this method.

References

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