AN ACCURACY ADJUSTMENT BY FUSION METHOD WITH GIS DATA AND REMOTE SENSING DATA

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ABSTRACT:

The Department of Construction in Kochi prefecture, Japan established and shared a bridge database without accuracy information. When the data overlay with a commonly used GIS data, some errors appeared. To adjust the accuracy of the bridge database, the intersections of roads and rivers of the National Land Digital Information (NLDI) of Japan were used in the accuracy adjustment, and 64% of bridges over rivers obtained accuracy adjustment (Jong Hyeok JEONG, Masataka TAKAGI, 2001). In the adjustment, 36% bridges could not be adjusted because of the limitation of the NLDI. The NLDI did not have enough information for the adjustment. To cover the limitation of the NLDI in the accuracy adjustment of the bridge database, an IKONOS satellite image was used. Expected bridges were extracted from an ISO unsupervised classification of the IKONOS image and edge detection of the IKONOS image, and then the extracted bridges were converted to polygons. Each bridge polygon in the bridge database matched with the nearest extracted bridge point to make a one-to-one relationship. Then the attribute data of each bridge in the bridge database added to the coordinate of the nearest polygon. In the test area of this study, 23 bridge points existed, 15 bridge points of them were adjusted by the extracted bridge position from classified image, 19 bridge points of them were adjusted by the extracted bridge position from the edge detection of the IKONOS image. In this study, the edge detection method provided reliable result of accuracy adjustment.

1. INTRODUCTION

GML was established by Open GIS Consortium and G-XML was established by Data Promotion Center in Japan. They are XML based GIS data format, and were adapted as a standard GIS format. Nowadays, major GIS softwares support the XML based GIS data. XML based GIS data format provides various channels for GIS users to access a GIS data, and it enables to use various GIS. Since the advantages of XML based data format, companies, governments and organizations started to convert their GIS data into XML based GIS data. Currently, various GIS data are based on different scales. When those GIS data are overlaid with other GIS data in different scales, many problems will be encountered in the accuracy domain.

The Department of Construction in Kochi prefecture, Japan established and shared a bridge database without accuracy information and a metadata. When the bridges on river in the bridge database overlaid with road data and river data in a commonly used GIS data, the bridge points did not matched with the intersections of them.

To adjust the positional accuracy of the bridge database, the attribute data of each bridge point added to the coordinate of the nearest intersection of a road data and a river data in a reference GIS data (Jong Hyeock JUNG, Masataka TAKAGI, 2001). But in the result of the accuracy adjustment, 36% bridges could not be adjusted. The reason came from the low accuracy of the bridge database and the limitation of the reference data. In case of used reference data based on a 1:25000 scale map, narrow river streams and roads were not described. Therefore enough intersections were not generated. The objective of this investigation is positional accuracy adjustment for the bridge database using a high-resolution satellite image.

2. DATA

In this study, following four data were used. The test area is Tosayamada in Kochi prefecture, Japan.

The bridge database: this data was established by the Department of Construction in Kochi prefecture, Japan. It was shared without accuracy information and a metadata, therefore this data was assumed as an uncertain GIS data. 23 bridge points of the bridge database existed and used on the test area.

The National Land Digital Information (NLDI): this data was established by the Ministry of Land, Infrastructure and Transport, its data type is line, and it based on a 1: 25000 scale map, used as a reference data in this study, the intersections of roads and rivers of the NLDI were used.

The Disaster Prevention Information (DPI): Kochi prefecture government in Japan established this data, and it based on a 1: 2500 scale map, its data type is polygon, road and river data were used for generating training area for land cover classification and image processing.

The IKONOS image: This image was composed of 4 spectral bands including infrared band, and it was used for extraction of bridge positions. The coverage of this image is the test area in this study.

3. METHODOLOGY

For the accuracy adjustment, a data fusion method was used. The data fusion method is combining the bridge database with a high accuracy reference data. In this study, bridge positions in the bridge database were adjusted by following three methods.

- To extract expected bridge positions by intersecting of the roads and rivers of the NLDI.

- To extract expected bridge positions from ISO unsupervised classification of the IKONOS image

- To extract expected bridge positions from the edge detection of the IKONOS image.

3.1 Bridge Extraction with The NLDI

In the case of accuracy adjustment of the bridge database with the NLDI, the intersections of roads and rivers were used. Figure 1 shows the flow chart of the accuracy adjustment of the bridge database with the NLDI.

Firstly, the intersections of roads and rivers in the NLDI were generated. The intersections were assumed expected bridges. Not all bridges on the test area recorded in the bridge database. Because the only bridges managed by government were recorded. The number of intersection was larger than the number of bridges in the bridge database. So one-to-one relationship between bridge points and the intersections were needed.

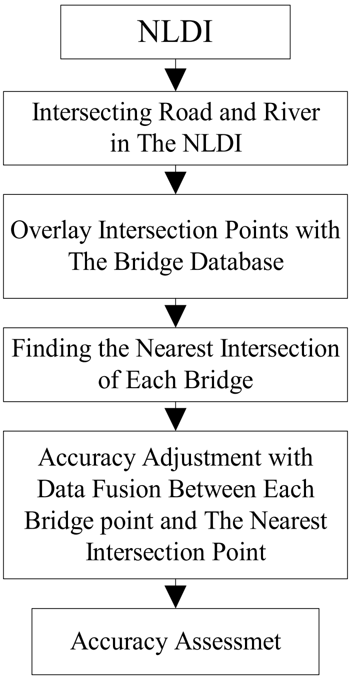

Figure 1. The flow chart of the accuracy adjustment of the bridge database with the NLDI

To make one-to-one relationship between bridge points and the intersections, the nearest intersection of each bridge point was searched. The attribute of each bridge added to the coordinate of the nearest intersection, and then they were considered as expected bridge position.

3.2 Bridge Extraction with ISO Unsupervised Classification of The IKONOS Image

The ISO unsupervised classification method was used to classify the land cover of the test area on the IKONOS image that was composed of four spectral bands including infrared band. After the classification, 256 classes were generated (Figure 2).

The classification result overlaid with polygon of road and river data in the DPI. Then the histogram of classified categories on roads and rivers were generated to find unique categories of bridges in the IKONOS image. In this study, category number 82,83,84,85,92 could be used as unique categories on road. Then classified roads on rivers were filtered with median filter (3x3) to eliminate small noises. The out sides of rivers were masked by the river data of the DPI to consider only classified roads on rivers. The classified roads on rivers were assumed expected bridge positions. The expected bridges converted to polygons (Figure 4). After that, the polygons of expected bridges overlay with the bridge points in the bridge database (Figure 4).

Figure 5 shows the flow chart of the accuracy adjustment of the bridge database with the ISO unsupervised classification of the IKONOS image.

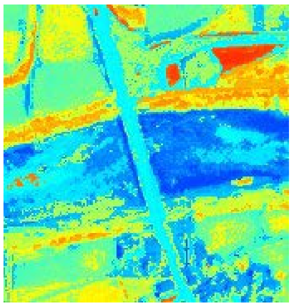

Figure 2. An example of ISO unsupervised classification result

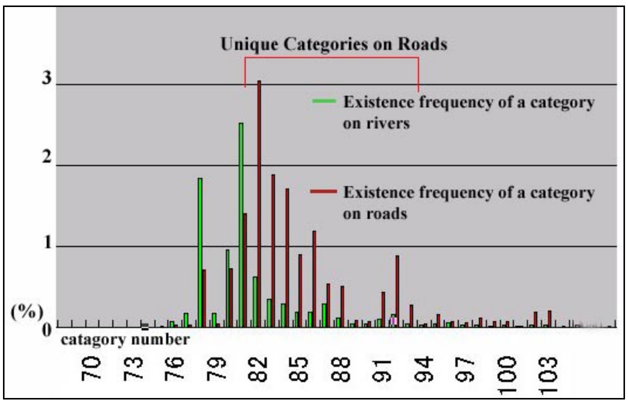

Figure 3.Histogram of classified categories on road and river

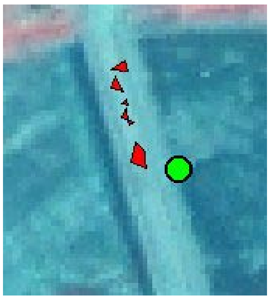

Figure 4. An expected bridge from the ISO unsupervised classification result (red polygons) and a bridge point (green point) in the bridge

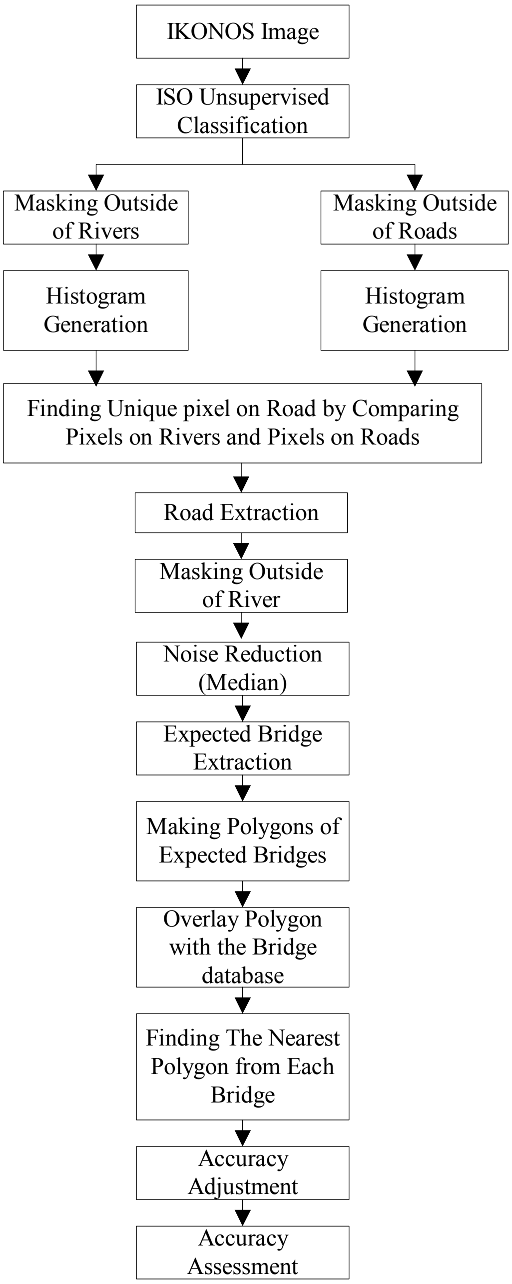

Figure 5. The flow chart of the accuracy adjustment of the bridge database with the result of ISO unsupervised classification of the IKONOS image

3.3 Bridge Extraction with The Edge Detection of The IKONOS Image

Figure 6 shows the flow chart of the accuracy adjustment of the bridge database with the edge detection of the IKONOS image. To extract the edges, the spatial filter (Table 2) was used because the most bridges on the test area are located from north to south and from northeast to southwest. Figure 7 shows an example of edges around a bridge. After filtering the IKONOS image, the linear feature of edge extracted clearly (Figure 8). After that, the edge detection image on rivers was filtered with median filter to reduce small noises. Then the outsides of the rivers of test area on the IKONOS image were masked to consider only linear feature position on rivers from the edge detection of the IKONOS image. Then the expected bridges were extracted. And they were overlaid with the bridge points of the bridge database (Figure 9).

Table 2. The spatial filter to edge the IKONOS image

0	1	1
0	0	0
-1	-1	0

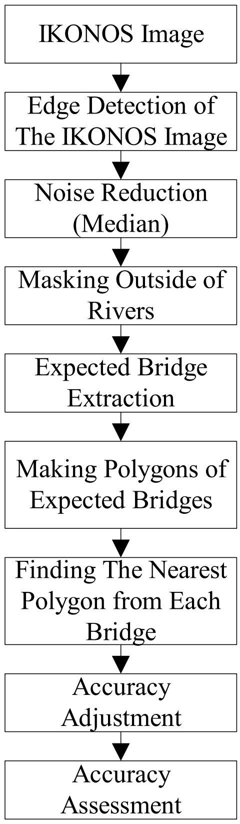

Figure 6. The flow chart of the accuracy adjustment of the bridge database with the edged IKONOS image

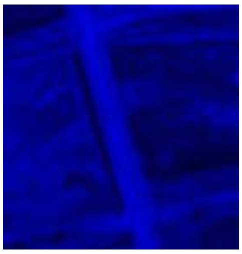

Figure 7. Band1 of the IKONS image

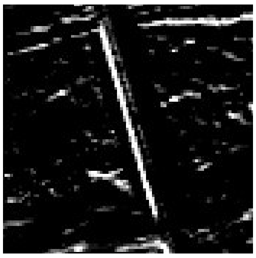

Figure 8. The edged image of IKONOS band1 image

Figure 9. An expected bridge polygon (dark blue) from the edge detection of the IKONOS image, and a bridge point of the bridge database

3.4 Accuracy Adjustment

After extracting expected bridges with the three methods, the attribute data of the bridge database added to the coordinate of expected bridge positions. If a bridge length of a bridge points in the bridge database plus the positional accuracy of NLDI (12.5m) is longer than the distance between a bridge point and the nearest expected bridge position, it was assumed that the accuracy of the bridge was adjusted correctly. The positional error of NLDI is 12.5m because it based on a 1: 25000 scale map (Shunji Murai, GIS Work Book, 1997).

4.RESULTS

Total 23 bridge points in the bridge database were used, and table 3 shows the result of accuracy adjustment.

Table 3. Accuracy Adjustment Results by Each Reference Data on The Test Area

Reference Data	**Number of Adjusted Bridge**
NLDI	**16/23**
Classified IKONOS image	**15/23**
Edged IKONOS Image	**19/23**

In the result of accuracy adjustment by the three methods, 19 (83%) bridge points on the test area adjusted by the edge detection method. This method provided the most reliable reference data among the three methods.

In the result of the ISO unsupervised classification, bridge and gravel were classified in the same category (Figure 10), therefore bridges on gravel area in a river stream were not extracted.

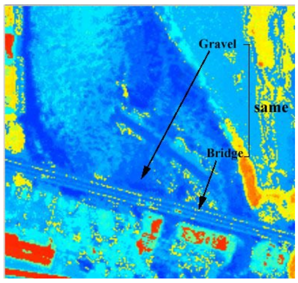

Figure 10. The ISO unsupervised classification of a bridge on a gravel area

On the other hands, bridges are not on a gravel area (Figure 11) in a river stream, they were extracted clearly by the classification method (Figure 12).

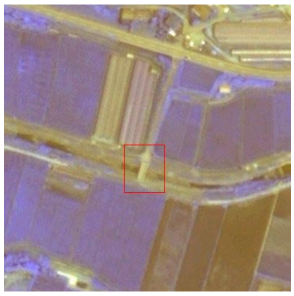

Figure 11. A bridge not on a gravel area in a river stream

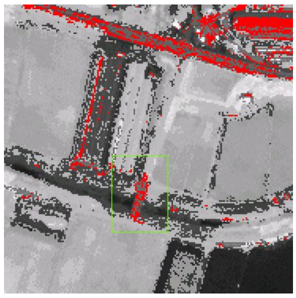

Figure 12. An extracted bridge not on a gravel area in a river stream

5.CONCLUSIONS AND FURTHER STUDY

From this study, the accuracy adjustment of the bridge database by using a high-resolution IKONOS image was successfully achieved, and the method of the edge detection of the IKONOS image provided most reliable reference data among the three methods. Although the result of ISO classification provided low quality of a reference data, bridges were not on a gravel area, they were extracted clearly in a river stream. In the result of extraction, many noises existed in the result of extraction of the expected bridges, and they prevented us from extracting clear bridge positions from the classified IKONOS image and the edge detection of the IKONOS image. As a further study, to extract more clear linear feature of bridges from the edge detection of the IKONOS image, Hough transform will be used. And the result will be compared with the results of other methods.

REFERENCES

Shunji Murai, 1997.GIS Work Book. Japan Association of Surveyors, Japan, p. 35.

Jong Hyeok JEONG, Masataka TAKAGI, *An Accuracy of Uncertain GIS Positional Data by Data Fusion Method,* The proceedings of ACRS 2001, Volume 2, pp.1498-1500.