A Case Study on Accuracy Adjustment of Uncertain Bridge Positional Data by GIS Data Fusion Method

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Abstract*: Nowadays, many companies and local governments have produced many kinds of GIS data. But most of them were shared without a specification or a metadata. Usually an uncertain GIS data cannot be used with a high accuracy GIS data, so accuracy adjustment and assessment should be carried out. To adjust accuracy of coordinate for an uncertain bridge positional data by various GIS data fusion, intersection data of bridges and river streams will be helpful. After that, low accuracy uncertain bridge coordinates can be replaced with high accuracy coordinates of intersection data, which was generated by GIS data fusion. In this case study, 59 percent of the uncertain bridges' accuracy could be succeeded to adjust by GIS data fusion.*

Keywords: GIS, accuracy, fusion, assessment

1. Introduction and Research Objective

Department of construction in Kochi prefecture established a bridge database which includes coordinates, address, name, the uses of bridges and the code number of bridges information. In this research, the bridge database was used as the uncertain data because the accuracy information was unknown. When the uncertain data overlaid with officially used GIS data, positional errors were appeared in coordinates and attribute data. Within the uncertain bridge position data, the bridge types can be divided into three types according to crossing objects which are river, sea, road, rail way and steep slope. In this research, only the bridges on rivers were selected to adjust positional accuracy of the uncertain bridge database. Because bridges on rivers are usually located on the intersection of rivers and roads. Therefore, bridge's positional accuracy could be adjusted when high accurate river and road data are used. So high accurate GIS data fusion will be helpful. Objectives in this study are to estimate the possibility of accuracy adjustment and assessment by GIS data fusion method.

3. Data Set

In this research following data set were used;

1. **The bridge database**: this data set was established by Department of construction in Kochi prefecture, and used as an uncertain data. Bridges were described as points, and there are 1,240 points.
2. **National Land Digital Information (NLDI)**: N.L.D.I was established by National Land Agency. This data set was based on the 1 to 25,000 paper map. In this data set, road and river features are described as line feature and 2,778 intersection points of them were generated (Figure. 1).
3. **Disaster Prevention Information (DPI)**: D.P.I was established by Kochi prefecture, which was based on 1 to 2,500 paper map. In this data set, rivers and roads features are described as polygons, Center points of the polygons were used in this study, and 3,400 intersection points of them were generated (Figure. 2).
4. **Differential GPS Surveying data**: This data set was generated by surveying. The positional precision is about less than 1m. 130 bridges were surveyed ourselves.

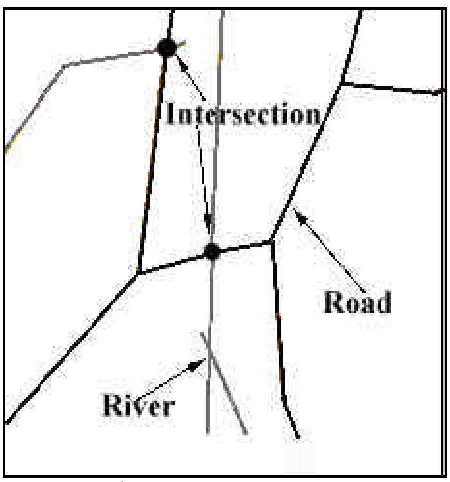

Figure. 1. NLDI

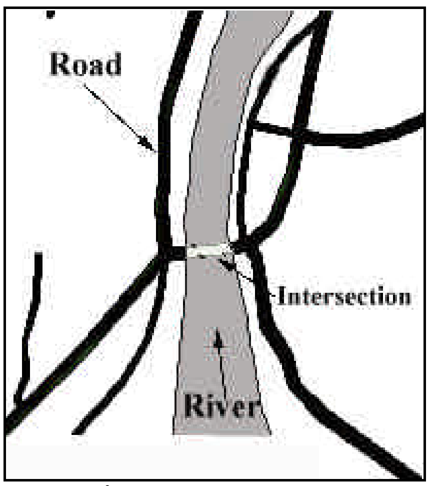

Figure. 2. DPI

4. Preprocessing

In this study, only the bridges on rivers were treated, so the following data arrangements were necessary before main process. The use of bridges field was included in the uncertain bridge databases, which are overhead bridges, pedestrian overpasses and so on. Such kinds of bridges were eliminated by database query. Some bridges which located on steep slope area were also eliminated by DEM.

Uncertain bridge positional data were replaced by GPS surveying. So this data can be referred as correct data. Figure3 shows histogram of distance between uncertain bridge positional data and GPS surveying.

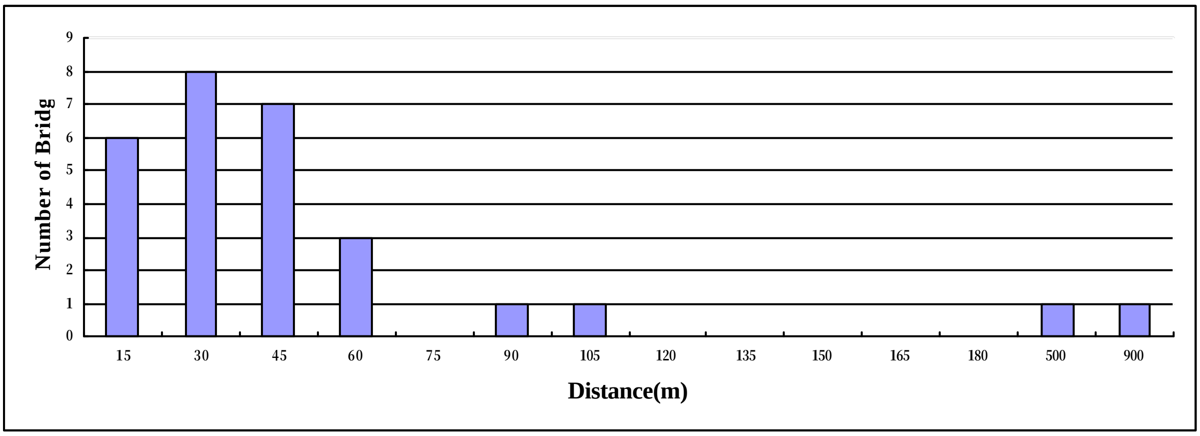

Figure. 3. Histogram of distance from GPS surveying data

5. Accuracy Adjustment by GIS data fusion

Process 1 (using NLDI): Intersection points could be generated by using river line and road line data in NLDI. Each nearest bridge in reference data was matched and linked each other. Then its coordinate can be replaced. Distance from the intersection points to reference points can be calculated (Figure. 4). After that, the accuracy-adjusted bridge will be eliminated if the distance indicates longer than 150m.

Process 2 (using DPI): Intersection polygon could be generated by using river polygon and road polygon data in DPI. In the distance calculation, center points of polygons were used. Following process is same as "process 1" (Figure. 5).

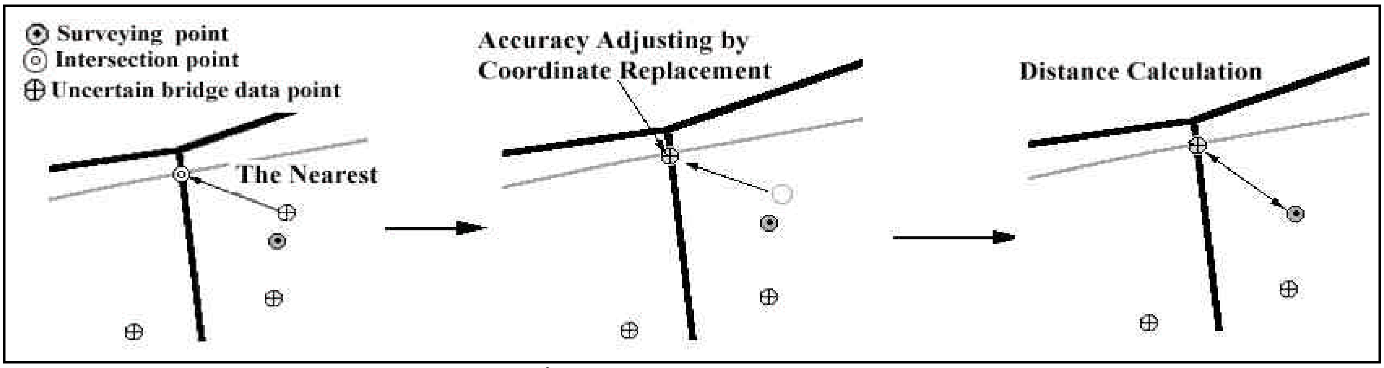

Figure. 4. Process 1

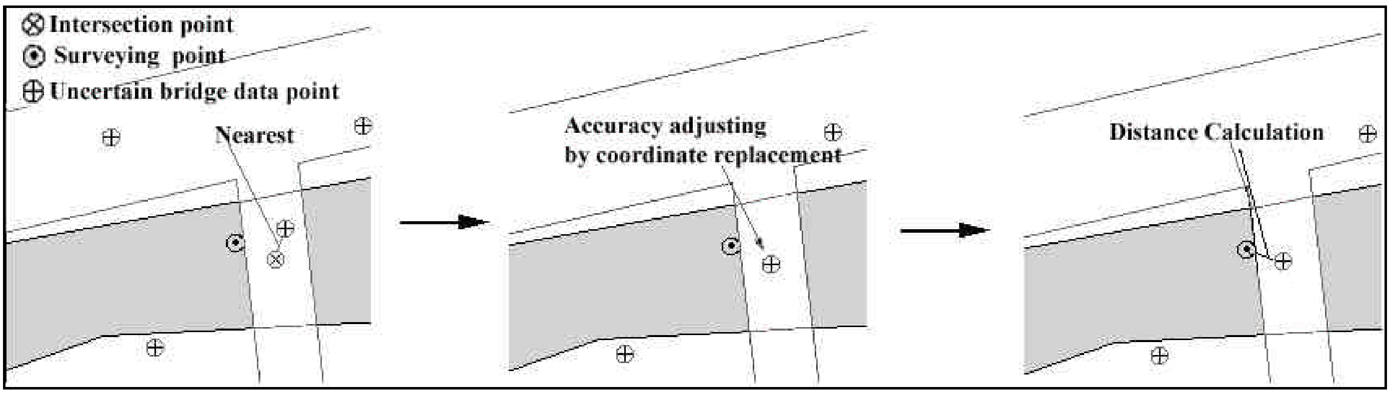

Figure. 5. Process 2

6. Results

In this study, 82 bridges are selected as reference data by GPS surveying. 72 points were adjusted in "process 1" and 34 points of them were indicated less than 150m from reference data (Figure. 6). Therefore, the 47 percent of the matched uncertain bridges' accuracy was adjusted. In "process 2", the accuracy of 73 points was adjusted and 43 points of them were indicated less than 150m (Figure. 6). Therefore 59 percent of the matched uncertain bridges' accuracy was adjusted. Figure. 7 shows distance from reference data in each bridge. Distance by process 1 indicates almost longer than process 2. Figure. 8 shows histogram of distance from reference data. Process 2 indicates shorter distance than process 1. So, DPI has reliable for accuracy adjustment.

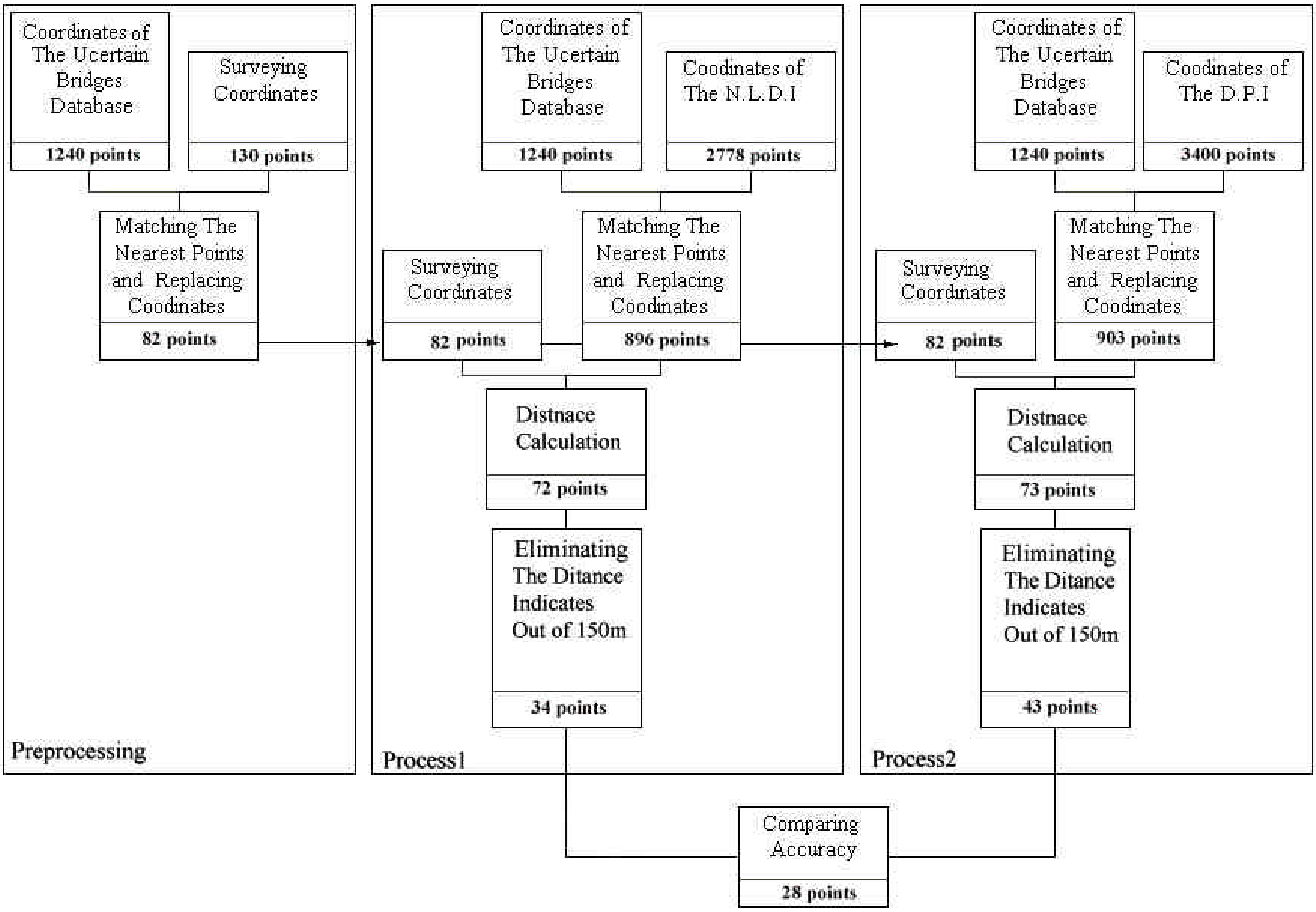

Figure. 6. Accuracy adjustment scheme

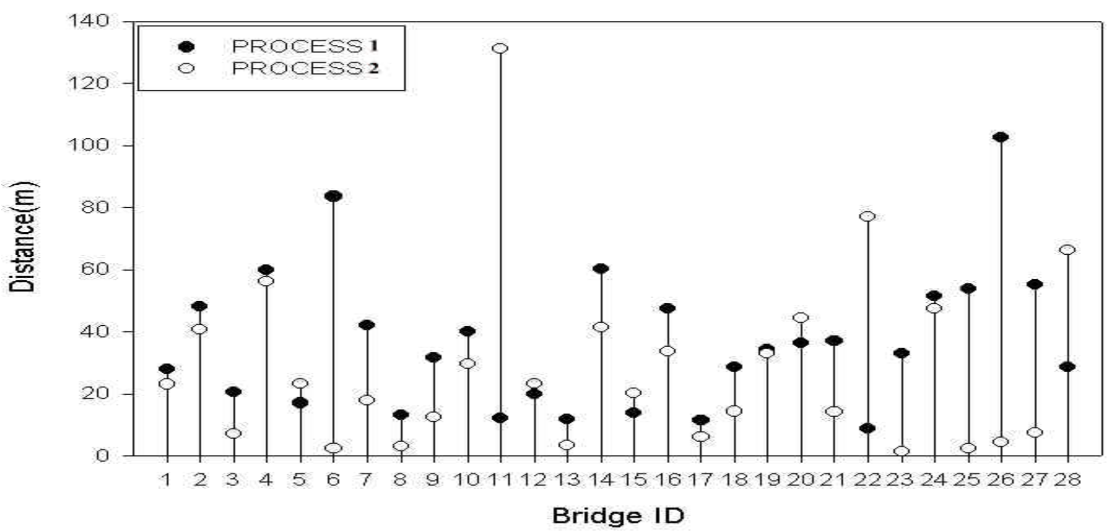

Figure. 7. Distance from reference data in each bridge

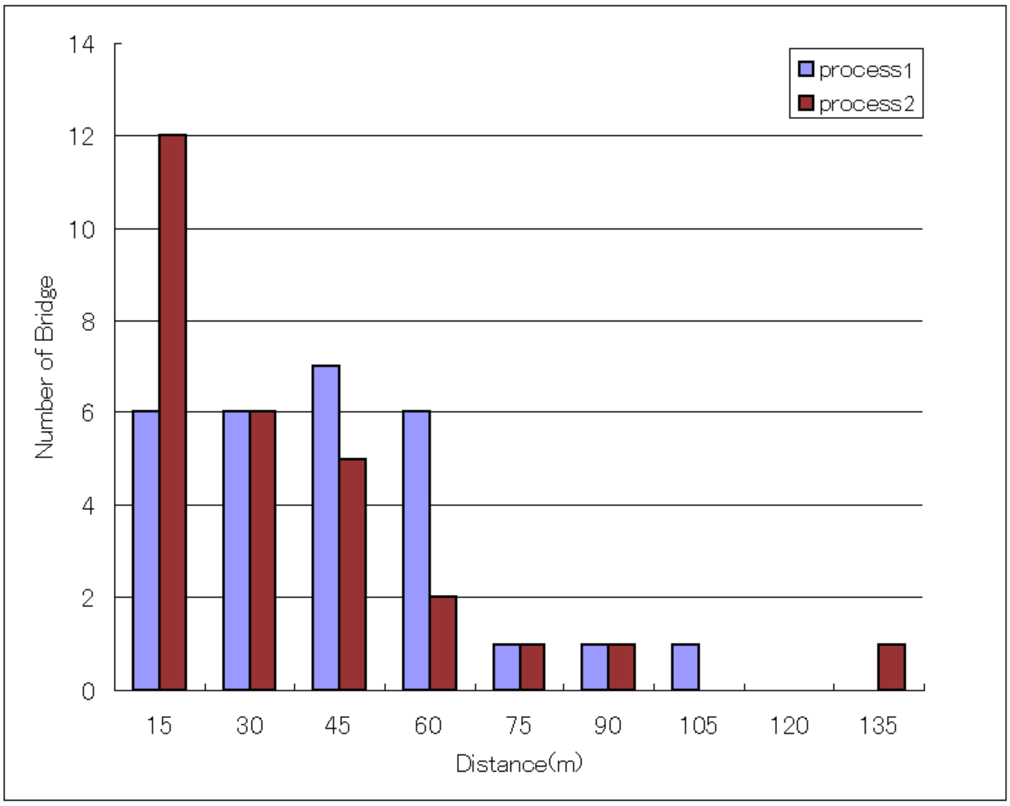

Figure. 8. Histogram of distance from reference data

7. Conclusions and future work

Accuracy of uncertain bridge positional database could be able to improve by GIS data fusion. GIS data fusion is reliable to assess the uncertain GIS data. The DPI provides more reliable and useful reference data in the accuracy adjustment. In this case study, 59 percent of bridges' positional accuracy could be succeed to adjust by GIS data fusion.

When a GIS database is established, a linking field for accuracy assessment should be added and when a GIS database is shared, a specification or metadata should be attached. As further study, accuracy adjustment with use of high resolution remotely sensed data will be investigated.