ON FIELD RECONNAISSANCE SYSTEM USING RTK-GPS AND FM WAVE

Kazuya NAKANO, Kosuke TSURU, Akira OHTA
AERO ASAHI CORPORATION, Japan
Kazuya.Nakano@aeroasahi.co.jp

Working Group V/1

KEY WORDS: Mobile mapping, GPS, Image transfer

ABSTRACT

It has been already passed more than decade since the Digital Mapping started in Japan. During this period, the system was improved to construct the fundamental system from stereo plotting to standard map format, structurized data for GIS or traditional paper map for human use. However these processes are just only the later half of the whole process of Digital Mapping. Hereafter it becomes necessary to integrate process of leveling, control point surveying and field reconnaissance on digital network. In particular, field reconnaissance is important for Digital Mapping, because almost expressions concerning the Digital Mapping are included in the field reconnaissance results. Generally, map vector data are acquired from aerial photographs using stereo plotter. Operators are required with field reconnaissance results when we determine map expression or classification in plotting. In formerly field reconnaissance, Field surveyors go to field and draw reconnaissance data on enlarged photographs with ink pen. If field reconnaissance results can be directly digitized, the Digital Mapping will be much more efficient. This investigation describes method of field reconnaissance using digital image and RTK-GPS with FM wave.

1 INTRODUCTION

Field reconnaissance is important for Digital Mapping, because almost expressions concerning the Digital Mapping are included in the field reconnaissance results. Generally, map vector data are acquired from aerial photographs using stereo plotter. This process is called as plotting. Figure 1 shows the plotting scenery. Operators are required field with reconnaissance results when determine map expression or classification in plotting. Figure 2 shows the field reconnaissance results.

Figure 1. Former plotting

Figure 2. Field reconnaissance result

Following cases are necessary to the field reconnaissance results.
+ Part of object is hidden in shadow.
+ Object is difficult to specify by photo-interpretation.
+ Object is symbolized.
+ Cartographic annotations are determined.

In formerly field reconnaissance, Field surveyors go to field and draw reconnaissance data on enlarged photographs with ink pen. This method has following weak points.
+ It is difficult to correct mistakes. Sometimes ink is blotted to influence of sweat or rain.
+ It is impossible to input the result directly in digital map file.
+ Operator must refer reconnaissance results and stereo-model at plotting separately.

Therefore, if these reconnaissance results can be directly digitized, the Digital Mapping will be much more efficient.

2 DIGITAL FIELD RECONNAISSANCE SYSETM

The authors have developed a field reconnaissance system. The components of the field reconnaissance system are GPS receiver, GPS antenna, FM antenna, D-GPS corrector, battery and a hand held computer. GPS antenna has received spatial data from GPS satellites and FM antenna has received differential correction data. Some of Japanese FM radio stations are presenting this information using the multi-channel broadcasting whole country area. Positional accuracy is improved using correction data from FM wave.
Figure 3 shows the configuration of field reconnaissance system.

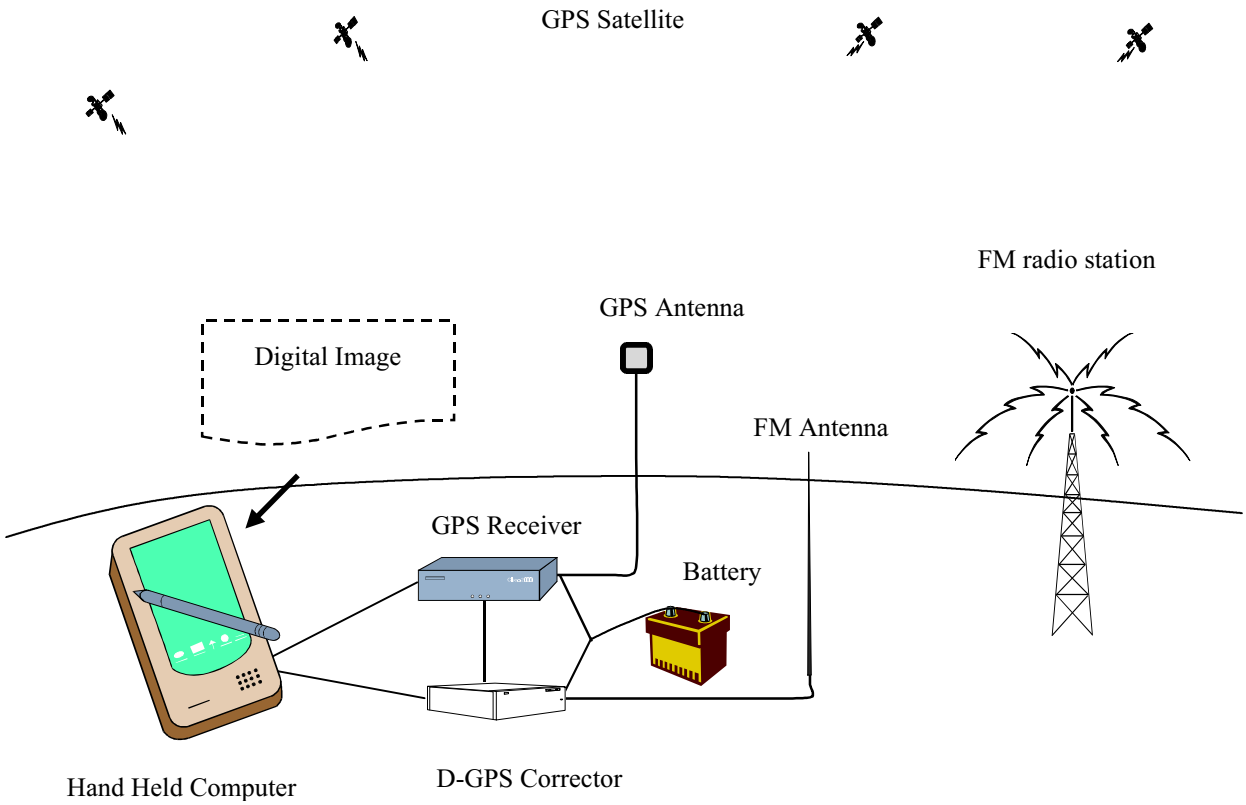

Figure 3. Field reconnaissance system configuration

3 IMAGE TRANSFER

For field reconnaissance data directly input on digital image, the image should be transferred with relation to spatial data. Image transfer procedures developed in this paper are as follows:
1. Digital images are scanned from aerial photographs.

2. Spatial data as control points are acquired at terrain feature place using GPS and differential correction data.
3. Spatial data of WGS-84 coordinate system are transformed into Japanese coordinate system (rectangular plane coordinate system).
4. Field surveyor select a point corresponds to terrain feature place on the digital image.
5. First selected point determines the position to attach digital image on the Japanese coordinate system.
6. Second selected point determines the rotation and the scale of digital image.
7. If numbers of point are more than 3 points, TIN-model is generated and digital images are geometrically corrected by each triangle using these points on the field.
8. Digital image is re-corrected, when spatial data acquire other terrain feature place.

Positional accuracy of digital image can be improved without stereo orientation or ortho rectification on the field. These procedures are shown in Figure 4.

Therefore, field surveyors input field reconnaissance data on the corrected digital image using hand held computer instead of drawing on analog photographs with ink pen. The map symbols and cartographic annotations from the field reconnaissance are directly digitized on the corrected image. As a result, Operators can be checked with field reconnaissance results without compare with enlarged analog aerial photographs at plotting.

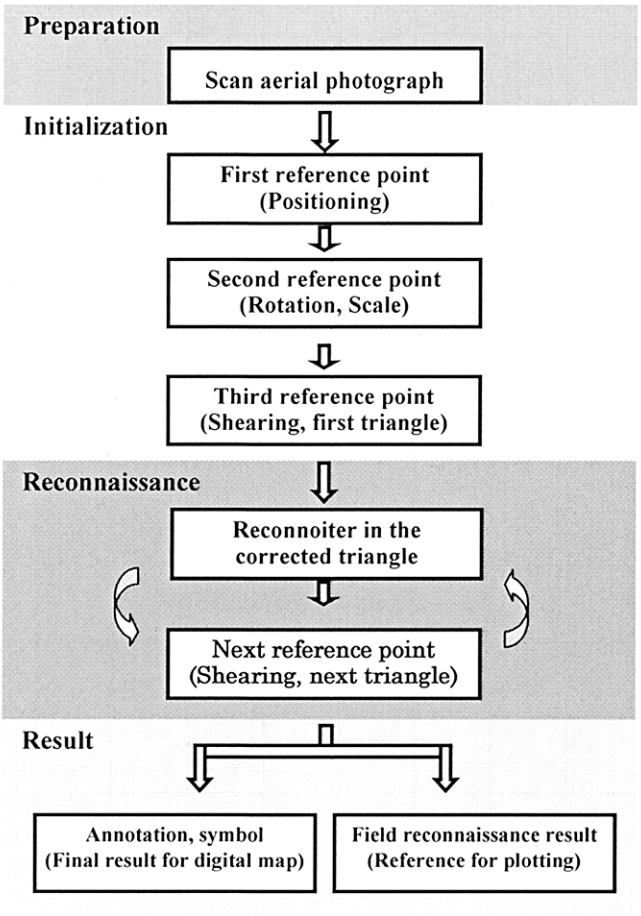

Figure 4. Processing procedure

4 EXPERIMENT

In order to confirm a basic field reconnaissance system, Experiment were performed to check positioning accuracy using control point. Test field is Kawagoe in Saitama prefecture.

Table 1 shows the difference between two measured coordinates from transformed image and existing map. We note the points of the aimed investigation result.

Table 1. Planimetric accuracy of field reconnaissance system

No.	Coordinates(X,Y)				Discrepancy		
	Reconnaissance system [m]		Existing map [m]		DX [m]	DY [m]	Distance[m]
1	-12354.91	-34311.48	-12360.31	-34309.36	-5.40	2.12	5.80
2	-12391.31	-34075.72	-12402.26	-34073.30	-10.95	2.42	11.21
3	-12479.95	-33920.23	-12488.76	-33920.53	-8.81	-0.30	8.81
4	-12544.73	-34271.60	-12548.14	-34266.52	-3.41	5.08	5.68
5	-12502.95	-34098.29	-12509.77	-34091.77	-6.82	6.52	9.43
6	-12712.75	-34132.40	-12715.59	-34125.28	-2.84	7.12	7.66
7	-12716.96	-33876.55	-12726.91	-33877.61	-9.95	-1.06	10.00
8	-12816.53	-34274.80	-12819.94	-34271.50	-3.41	3.30	4.56
9	-12892.70	-33959.93	-12896.61	-33956.29	-3.91	3.64	5.34
10	-12953.10	-34217.24	-12954.53	-34213.30	-1.43	3.94	4.19
11	-12990.21	-33874.17	-12995.61	-33871.74	-5.40	2.43	5.92

As a result, RMSE for 11 control points are $\sigma_x = \pm 6.71$ m, $\sigma_y = \pm 4.20$ m, $\sigma_{xy} = \pm 5.46$ m.
Figure5 shows reconnaissance area, orientation triangle and points confirming the difference of the reconnaissance result

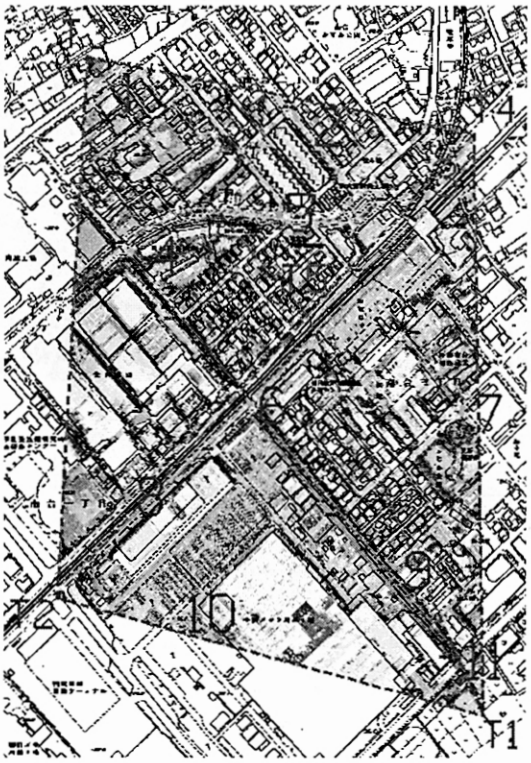

Figure 5. Transferred image

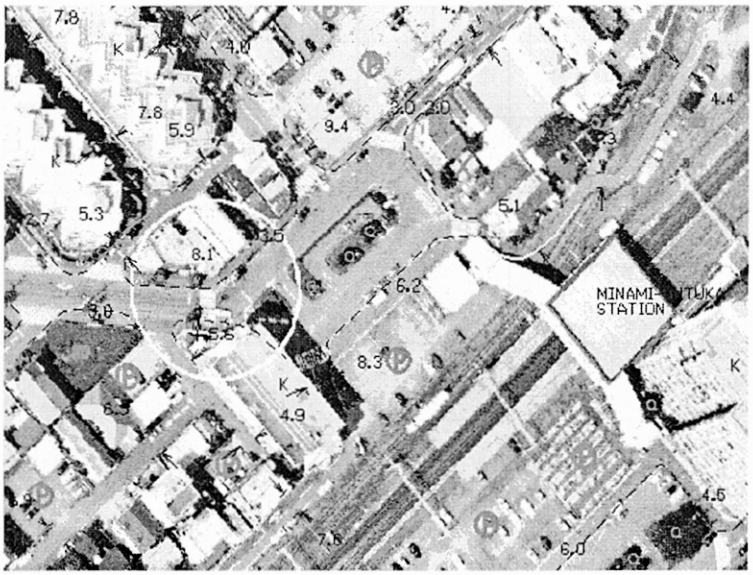

Figure 6. Overlapping, the image and field reconnaissance result

5 CONCLUSION

Method of field reconnaissance using digital image has been described in this paper. The effectiveness of the field reconnaissance system was demonstrated. There are issues, however, for further work. These problems are as follows. The service areas are restricted to acquire FM multi-channel waves in fact. The system is heavy. Hand held computer is powerless to process of huge data. However, it is concluded that the field reconnaissance system is a useful tool in Digital Mapping domains.

REFERENCES

Fuse,T., Shimizu.E., 1998. A study on geometric correction of historical maps. In: International Archives of Photogrammetry and Remote Sensing, Hakodate, Japan, Vol. XXXII, Part 5