Assessment of Accuracy of IKONOS Image Map, Traditional Orthophoto Map and Conventional Line Map of Kathmandu Valley : A Pilot Study

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Abstract

IKONOS image mapping is being considered a possible replacement to the traditional mapping in many countries due to their ease of access to current data and their potential high resolution. Survey Department of His Majesty's Government completed traditional orthophoto mapping of all urban and semi-urban areas of the country. The 1:5000 monochrome orthophoto maps of Kathmandu Valley were completed in 2003. In 2002, as a test, production of a near natural colour Image Map at 1:5000 scale of a part of Kathmandu Valley based on IKONOS data was carried out. A conventional line map plotting of the same area at 1:5000 was also prepared. The objective of the pilot project was to assess the geometric accuracy and the information content of these maps. The details of the study and their results are underlined. The findings of the study helps to explain whether IKONOS image map can replace conventional orthophoto map at 1:5,000 for urban areas of Nepal like Kathmandu.

Keywords: *Orthophoto, Rectified image map.*

Introduction

Digital ortho-image maps based on satellite imagery are becoming one of the major sources of data for various GIS application especially in urban sector due to availability of high resolution imagery and related software. Also geo-referenced image maps may be used, because of short processing time required in producing an image map. The trend now is on the rise towards using such ortho-image if possible and also image maps (georeferenced but not ortho corrected) in certain context e.g. in plain areas.

Several studies are reported on the assessment of the spatial accuracy of IKONOS imagery. One such study indicates the suitability of IKONOS imagery for preparation of large scale (1:4800) topographic maps in terms of spatial accuracy, while the information content of such ortho rectified image maps is found to be slightly inferior to conventional line maps [2]. Considering the spatial accuracy and the spatial information content, it is indicated that IKONOS ortho rectified images conforms to 1:10000 scale topographic maps [3].

The purpose of this study is to assess the suitability of such image maps compared to conventional line maps and traditional orthophoto maps based on aerial photograph in terms of spatial accuracy and information content. The study however does not include the case of ortho-imagery. In addition the paper reports the accuracy test on traditional orthophoto map and line map both at 1:5000 scale.

Orthophoto and Traditional Line Map

Monochrome orthophoto maps at 1:5000 scale based on the aerial photographs of December 1998 at 1:15000 scale for urban areas of Nepal [7] were completed in 2003. Similarly, a vector map of a part of study area was compiled photogrammetrically at the scale of 1:5000 based on the same 1:15000 aerial photographs.

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The Study

In the given context, the study looks into the spatial accuracy of rectified (not ortho rectified) IKONOS image map only of a nearly plain area, to see if avoiding orthorectifications in such area does not entail serious degradation in the spatial accuracy.

IKONOS Image Map

An IKONOS Geo product (10km x 10km) in UTM projection, WGS84 datum was rectified using existing GCP points. The nominal accuracy of the image was considered to be of 15 m on the ground without including the effects of terrain effects (90% confidence in circular error) [5]. The root mean square error (rmse) of the rectification was 1 m (1 pixel). The image was then resampled to obtain a rectified image in Modified UTM projection, Everest Spheroid 1830, the datum being used in Nepal.

The resulting image map along with the orthophoto map and the line map at 1:5000 scales were then tested by comparing against a set of 40 coordinate pairs of well defined points spread evenly in the map area (Fig. 1) measured in analytical plotter. The accuracy of the control

Fig. 1. Control points

The Result

Before analyzing the result, it should be noted that pointing the position of control points over the image map were found to be inferior to that over the orthophoto map owing to the resolution of the image. We estimated that the pointing accuracy was about three pixels. The pixel size of the IKONOS image map was 1 metre whereas that of the orthophoto map was of 0.5 metre.

The topography of the study area was partly hilly (approximately 25% of the area towards the northwest) and the elevation in the remaining areas ranged from 1280 metres to 1300 metres.

IKONOS Image Map

Considering all 40 points, as expected, the rmse was calculated to be 5.4 m which was significantly higher than the permitted value of 4.25 m for 1:5000 scale mapping [1].

Consequently, testing was done by removing nine points lying in and around the hilly areas in the north west part of the map and the resulting rmse was found to be 2.63 m (Table 1), which is within the permitted value.

This has suggested that the simple rectification process is not suitable for the areas having significant topographic variations; however, the process may be good enough for areas having little topographic variations. But considering the difficulty in pointing the control points as well as extracting the features from the image due to spatial resolution, the image map do not meet the expectation as from the conventional line or orthophoto map of the same scale. Nevertheless, the image map of plain areas thus produced may be of wider acceptance in the GIS community as against costly orthophoto generation using aerial photographs, owing to the ease in producing them and using them at least as a backdrop for further analysis and presentation.

Table 1. Discrepancy in x and y in metres

NR_	dx_I	dy_I	dx_O	Dy_O	dx_m	dy_m
1			0.72	0.31	0.30	-0.43
2			0.07	0.30	0.77	0.53
3	-3.90	0.07	-0.16	1.34	-0.52	1.18
4			-0.11	0.96	-0.51	0.02
5			1.26	1.49	0.84	-0.13
6	0.25	2.02	0.09	1.96	1.52	0.72
7	0.57	0.53	0.88	1.16	0.31	1.88
8	0.74	0.37	0.17	0.97	0.17	0.19
9	3.52	-0.83	1.56	0.76	1.34	0.26
10	4.38	-0.21	0.93	0.20	0.25	0.04
11	-0.35	-0.95	0.49	1.64	0.64	1.10
12	2.27	0.20	0.49	1.52	2.11	1.81
13	3.67	0.53	0.40	1.25	0.03	1.88
14	1.68	0.82	-0.11	1.14	0.62	0.41
15	3.67	-0.78	0.84	2.56	-0.25	2.37
16	0.34	0.25	0.00	1.21	0.71	0.32
17	0.70	1.07	-0.03	0.57	-0.39	0.32
18	0.55	0.25	-0.65	1.11	-0.30	1.27
19	1.00	-1.37	-0.14	0.61	0.55	0.77
20	0.32	-0.60	-1.00	0.73	-1.55	-0.78
21	-1.02	-0.42	0.41	0.77	-0.23	0.31
22	-0.80	0.50	-1.27	-0.13	-1.27	-0.95
23	-1.11	-0.39	-0.04	1.36	0.67	-1.12
24	-1.68	1.32	-0.43	0.71	-0.43	0.71
25	0.50	0.50	0.67	0.97	1.17	-1.36
26	-0.63	2.40	0.30	0.30	0.71	-0.66
27	-3.55	0.76	-0.92	1.09	-0.70	-0.02
28	-2.92	1.87	1.37	1.17	0.24	-1.27
29	-4.73	0.46	-0.28	0.48	0.39	-0.30
30	-2.50	2.59	-1.16	-0.05	0.46	-1.94
31			0.40	0.63	1.07	-0.53
32			-1.67	0.42	0.47	-1.44
33			-0.88	0.47	0.78	0.80
34	-1.74	2.84	1.10	1.63	1.10	1.63
35	-2.34	-0.44	-0.12	1.23	-0.12	1.85
36	-4.04	2.19	-0.45	0.87	0.69	0.58
37			-0.30	0.42	0.24	-2.42
38	-0.62	1.53	0.33	1.15	0.18	-1.26
39	0.36	1.33	0.58	1.77	-0.87	1.39
40			0.53	0.73	-0.15	0.73
	rmse=	2.63	Rmse=	1.32	rmse=	1.39

Orthophoto Map

One orthophoto map of the same area was also tested using the same procedure and the result was found to be much better. The rmse of 1.32 m (Table 1) suggested that the orthophoto map conforms to the standards [1].

Line Map

Similarly, the result (rmse 1.39 m) of the test in case of line map (Table 1) was also found to be at par with the accepted standards.

Conclusion

Though orthorectification yields a better result in terms of spatial accuracy, the findings of the pilot study showed that in plain areas a simple rectification with carefully selected GCP also resulted in a suitable image map which could be useful for many GIS applications as it was found to meet the geometric accuracy standards. But, the information content may not be up to the requirement of 1:5000 conventional mapping compared to the orthorectified photo mapping at the same scale, as the latter possesses a superior quality in terms of geometry as well as information content. In spite of the reduced quality of such image in information content, rectified IKONOS image could still be a useful information source owing to ease with which such product could be generated at a lower cost and in a shorter time. Furthermore, when applications require a recent image or of a particular date, this is much easier and cost efficient compared to obtaining aerial photography.

The study also indicated that the conventional orthophoto map production and photogrammetric compilation of maps at 1:5000 scales as per the standard procedures established at the Survey Department; both conformed to the geometric accuracy standards of similar products.

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References

[1] Guptill, S. C., J. L. Morrison (eds.), 1995. *Elements of Spatial Data Quality,* ISBN 0 08 042432 5.

[2] Karsten J. 2002. Generation of Orthophotos with Carterra Geo Images without Orientation Information, *Proceedings of the XXII FIG International Conference and ACSM/ASPRS Annual Conference, 2002.*

[3] Konecny G. 2002. Mapping from Space, *Proceedings of 23rd Asian Conference on Remote Sensing, Kathmandu, 2002.*

[4] Lee D.S., Shan J., Bethel J. 2002. Classification-guided building extraction from IKONOS imagery, *Proceedings of the XXII FIG International Conference and ACSM/ASPRS Annual Conference, 2002.*

[5] www.spaceimaging.com/products/ikonos/geo.htm

[6] www.usgs.gov

[7] Chhatkuli R.R. 2002. Orthophoto Mapping: A Fundamental Data Layer for Urban GIS in NGII in Nepal, *Proceedings of 23rd Asian Conference on Remote Sensing, Kathmandu, 2002.*