SELECTION OF THE MOST SUITABLE SIZES OF GROUND CONTROL POINTS IN THE SATELLITE IMAGES

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ABSTRACT:

Nowadays, satellite images have been used for many applications intensively. Using of the digital satellite images in relevant approaches may give more accurate ideas about the researched fields. Besides, different methods could be used for derivation of maps from relevant digital data in many scientific disciplines. One of these methods is to use satellite images. The most important reason of using the maps, which are derived from satellite images, is accuracy of data. To obtain maps from satellite images or use satellite images as map, the satellite images required certain rectification. For a rectification process, ground control points are plotted in field. In the present study, the most suitable ground control point sizes were investigated for multi-spectral images from IKONOS satellite of one-meter resolution. The present study showed that the most suitable size of ground control point was 2.5 m diameter points.

1. INTRODUCTION

High resolution satellite images, as less than 1 m. resolution are used in many fields. For example, updating existing maps, land use mapping, urban planning, disaster monitoring, and so on. To use high resolution satellite images in such fields, they had to be rectified. Rectification process is done by points, which coordinates are known in both land and image. The selected points may indicate either measured points in the field or/and can be designated as visible points in images. These points may represent; building corner, road cross, panting objects, etc. Points which are set up in the field are either acquired from existing maps or from image matching the research site. The main purpose of the present study is to identify the most suitable size of the field points, which might be marked in land by using ground control points for rectification.

2. IMPORTANT OF CONTROL POINTS

Acquisition of ground control points (GCPs) is particularly important for geometric correction of high resolution satellite images. The commercial high resolution satellite image can be accurately rectified using the combination of bias-corrected rational polynomial coefficients (RPCs) and ground control points (GCPs). With a few precisely measured GCPs accurate three dimensional measurements can be made from the base level Ikonos data product. However, the accuracy of the results is dependent on the precision of the GCPs (Dare et al., 2002).

There are two approaches in geometric correction of high resolution satellite images. One of them is the bias-correction procedure for rational polynomial coefficients (RPCs), which requires a minimum of only a single GCP, but it gives of course require RPCs. The other is affine model that requires a minimum of four GCPs per scene, though six as practical minimum would be recommended (Fraser, 2002).

The control points could be acquired by three different methods for geometric correction in two and three dimensional of high resolution satellite images. These are; GCPs from existing maps, GCPs set up in land, GCPs from image matching.

Kadota and Takagi (2002) had used above mentioned methods in acquisition of GCPs for geometric correction of high resolution satellite image. They had achieved to best result with surveyed GCPs.

Dial and Grodecki (2003) had tested Ikonos stereo accuracy without ground control. They had achieved to absolute accuracy at 6.2 m. horizontal, 10.1 m. vertical, and found out the most relative accuracy results for points more than 3 meters.

Hanley and Fraser (2001) had used ground surveyed GPS points and ground control measured from the orthomosaic for two dimensional geometric correction of high resolution satellite images. They had achieved to similar results from both surveyed GPS points and orthomosaic points .

Dare et. al., (2002) had used ground surveyed GPS points and orthomosaic GCPs for three dimensional correction of high resolution satellite images. They had also achieved to similar results from both surveyed GPS points and orthomosaic points.

The above mentioned study showed that the geometric corrections by using GCPs surveying in land may give most accurate results.

3. IKONOS SATELLITE

The world's first high-resolution commercial satellite, IKONOS, was launched by Lockheed Martin for Space Imaging in September 1999. The IKONOS satellite contains both; a 1-meter 11-bit panchromatic sensor; and a 4-band 4-meter 11-bit multi-spectral sensor. After launch a detailed On-Orbit Product Verification, program was conducted to verify the IKONOS satellite and ground station products met all design specifications. The sensor of satellites can generate one-meter panchromatic and four meter multi-band images with off-nadir viewing up to 60 degree in any azimuth for better revisit rate and stereo capabilities [Cook et all, 2001; Behdinian, 2002]. Due to its superior geometric accuracy characteristics, IKONOS satellite imagery is particularly well suited for large scale mapping applications [Dial and Grodecki, 2002], [Grodecki et. al., 2003]. As for geometric correction of high-resolution satellite imagery, acquisition of ground control points is important [Kadato and Takagi, 2002].

4. CASE STUDY FOR IKONOS SATELLITE IMAGERY

In this study, IKONOS was used as high resolution satellite imagery (Table 1). It was the digital geo-image, which was corrected distortion by the roundness of earth. The present case study includes application of IKONOS satellite imagery in particular area covering Aksaray city, at Central Anatolian part of Turkey. Image covers surface area of about 11 km x 11 km.

To determine the most suitable size of ground control points, nine groups of ground control points were established in the study area. The selected points were plotted in circle-shaped of diameters of 1 m, 1.5 m, 2 m and 2.5 m, respectively (Figure 1). The points had been painted by lime in soil or sandy ground and by plastic paint in asphalt ground. Coordinates of the points had been measured by geodetic method in WGS 84 coordinate system. Planimetric errors of the selected point coordinates had been calculated as m_x= ± 1.31 cm. and m_y= ±1.23 cm. Satellite images were evaluated in ERDAS IMAGINE 8.5 software and coordinates of points were measured in WGS 84 coordinate system.

Item	Detail
Cross Scan (m)	0.88
Along Scan (m)	0.94
Scan Direction	Forward
Nominal Collection Azimuth (degree)	13.2053
Nominal Collection Elevation (degree)	67.92448
Sun Angle Azimuth (degree)	147.7188
Sun Angle Elevation (degree)	65.89241
Acquisition Date/Time	2003/05/0808:48 GTM
Imagery Area	Aksaray/TURKEY
Area (km^2)	219.70
Product Level	Digital-Geo Image
Sensor Type	Pan-Sharpen 4 Bands
Map Projective Method	Transverse Mercator
Ellipsoid	International
Datum	Ankara

Table 1, Specifications of used IKONOS

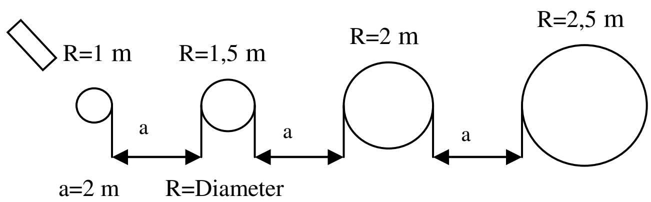
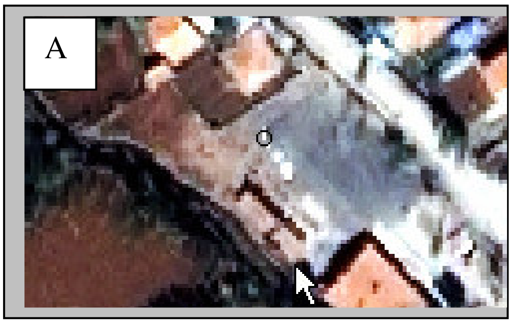


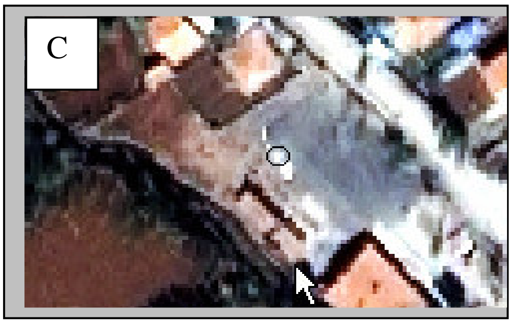
Figure 1, Location and sizes of ground control points

During measurements, the ground control points of 1m diameter were not almost visible. However, ground control points of 1.5 m diameter were not visible enough, the 2 m diameter ground

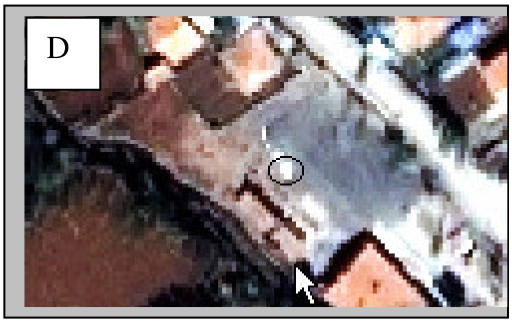


1m diameter GCP

1.5 m diameter GCP



2 m diameter GCP



2.5 m diameter GCP

Figure 2, Views of ground control points in satellite image.

control points became more visible. The 2.5 m diameter ground control points were clearly seen and easily measured (Figure 2).

Table 2 shows the mean errors that were obtained from the differences between ground coordinates and measured coordinates of the selected points on the satellite image.

Ground control point size (m)	RMS Average Errors (m)		
	m_x	m_y	m_p
1,0	0,89	0,51	1,03
1,5	0,68	0,68	0,96
2,0	0,71	0,48	0,86
2,5	0,59	0,55	0,81

Table 2, Average errors in ground control points

5. CONCLUSION

Rectification process could be done without ground control points. But, accuracy of rectification with ground control points is higher. Certainly, using ground control points of bigger size than satellite image resolution may increase visibility of these points. Therefore, size of the control points is an important factor during analysis of images. Time of measurement, cost and accuracy are also important factors in map productions. Selection of an optimal size of ground control points may decrease both cost and consuming time of application. Moreover, some application errors may take place as results of using big size ground control points as it in small ones. The contrast of ground’s color and differences between points color are also important factors in visibility of points. Image interpreting and coordinate readings are related to operator’s ability, eye sensitivity, image’s quality and resolution directly. The present study showed that the most suitable size of ground control point was 2.5 m diameter points. But, in order to get a standard of required ground control point sizes, ground control points should be investigated in stereo, gray-scale and different resolutions images.

6. REFERENCES

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