

# ACCURACY OF DTM AND ORTHO GENERATED FROM IKONOS STEREO IMAGES

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**ABSTRACT:**

DTM and orthophoto have been generated in IGiK using IKONOS along-track stereo images CARTERRA GEO Pan with B/H ratio 1:1.8 and the accuracy analysis has been performed. Orientation of stereo images has been performed with ImageStation Multi Sensor Triangulation – IKONOS. 10 GCP's have been used together with orbital orientation parameters data for the orientation of stereo images. The accuracy achieved on GCP's is as follows: RMSE<sub>x</sub> = 0.7 m; RMSE<sub>y</sub> = 0.6 m; RMSE<sub>z</sub> = 0.7 m and on the 23 independent check points: RMSE<sub>x</sub> = 0.7 m; RMSE<sub>y</sub> = 0.7 m; RMSE<sub>z</sub> = 0.9 m. MATCH-T Inpho software has been used for generating DEM with grid 25 x 25 m using both aerial photographs in the scale 1:26 000 (as reference data) and IKONOS stereo images. MGE Terrain Analyst of INTERGRAPH has been used to compare both DTM's. The analysis was performed on 1820 points representing three terrain categories (town, grassland, hilly region). After elimination of systematic errors the following results have been achieved for Ikonos data: RMSE<sub>z</sub> for towns 0.7 m; for grassland 0.5 m and for hilly regions 0.7 m. Ortho has been generated with pixel 1 x 1 m; the achieved accuracy RMS<sub>x,y</sub> from 1 to 2 m is acceptable for mapping not only in the scale 1: 10 000 but also in the scale 1:5 000.

## 1. DATA USED

IKONOS along-track stereo images CARTERRA GEO Pan have been collected by SpacelImaging on 4 May 2002 with Sun elevation 55° and collection elevation 78.5 and 60.7 degree. Base ratio B/H= 1:1.8. The data has been delivered (after almost one year from the date the order has been placed !!!) as 16-bit in GeoTiff format with ASCII meta data file. The test region is located in South East Poland, it covers an area of 80 sq. km representing three different types of terrain: hills, agricultural land and small towns. DTM with grid 25 x 25m and RMSz=0.8m has been generated with MATCH-T Inpho from 24 aerial photographs taken in scale 1:26 000 in 1988. This DTM also contains break lines and obscure areas. "Raw" DTM has been filtered. Final DTM has been used as reference data. Orthophoto images have also been elaborated from aerial photographs with pixel size 1 x 1m and were used as reference data for ortho generated from IKONOS images. Topographic maps in scale 1:10 000 have been used as additional reference information. Thirty three natural GCP's have been identified and measured in field by GPS technique with accuracy of RMS<sub>x,y</sub><0.3m and RMSz<0.4m and used for orientation of IKONOS Stereo and checking the results.

## 2. ORIENTATION OF STEREO IKONOS DATA

Orientation of stereo IKONOS data has been done on 10 GCP's with accuracy RMS<sub>x</sub>=0.7m RMS<sub>y</sub>=0.6m and RMSz=0.8m. Accuracy of orientation has been checked on 23 independent checkpoints. The results: RMS<sub>x,y</sub>=0.7m, RMSz=0.9m.

## 3. ACCURACY OF DTM GENERATED FROM STEREO IKONOS DATA

DTM from IKONOS stereo data has been generated using MATCH-T Inpho software and checked against the DTM generated from aerial photographs. The results for three different terrain types are shown in table 1.

	No of points	RMSz [m]	SD [m]	Max error [m]
Town	645	0.7	0.7	2.8
Grassland	633	1.3	0.9	3.8
Hilly region	542	2.0	1.4	12

Table 1. Accuracy of "raw" DTM

The results after elimination of systematic errors are shown in table 2.

	RMSz [m]	SD [m]	Mean [m]	Max error [m]
Town	0.7	0.7	0.5	2.8
Grassland	0.5	0.5	0.4	2.3
Hilly region	0.7	0.7	0.5	4.0

Table 2. Accuracy of DTM after elimination of systematic errors

#### 4. ACCURACY OF ORTHOPHOTO

Orthophoto image has been generated from IKONOS image with lower inclination angle and from aerial photographs taken in scale 1:26 000. Accuracy of two orthophoto images has been checked using independent checkpoints. The results are shown in table 3 and 4.

	RMSX	RMSY	Mean X	Mean Y	Max X	Max Y
Town	1.3	0.4	1.0	0.3	0.8	2.6
Grass and	1.0	0.9	0.8	0.7	1.7	1.6
Hilly region	1.3	0.8	1.2	0.8	2.1	1.4

Table 3. Accuracy of IKONOS orthoimages in [m]

	RMSX	RMSY	Mean X	Mean Y	Max X	Max Y
Town	1.4	0.6	1.3	0.6	2.4	1.1
Grassland	0.7	0.7	0.5	0.6	1.4	1.5
Hilly region	1.6	1.3	1.8	1.4	2.6	2.4

Table 4. Accuracy of aerial orthoimages in [m]

The accuracy of orthophoto generated from color aerial photographs is usually within 1 to 2 pixels. The accuracy of orthophoto from IKONOS data has been compared with orthophoto generated from aerial photographs in scale 1:26 000. The result are shown in table 5.

	RMS X	RMS Y	STDEV X	STDEV Y	Mean X	Mean Y	Max X	Max Y
Town	1.2	0.8	1.2	0.7	0.9	0.7	2.4	1.3
Grass	1.4	0.9	1.3	0.8	1.2	0.7	2.2	1.5
Hilly	1.0	1.9	0.9	1.3	0.8	1.7	2.1	2.8

Table 5. Accuracy of IKONOS orthoimage

The accuracy of orthoimages from IKONOS is very good due to narrow acquisition angle, the application of appropriate metadata as well as high accuracy of DTM. It is comparable to the accuracy achieved with the use of aerial photographs.

#### 5. CONCLUSION

IKONOS Pan stereo data with well distributed and identified GCP's can be used for generation of DTM with accuracy  $RMSz < 1m$  which is compatible with DTM generated from aerial photographs in scale 1:26 000. IKONOS pan Geo data can also be used for orthophoto elaboration in the scale 1:10 000 (pixel size 1m x 1m). The accuracy  $RMS_{x,y} < 2$  pixels.

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