# EVALUATION OF POSSIBILITY OF ORTHO IMAGERY PRODUCTION USING SPOT5 SINGLE IMAGE

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**Commission IV, WG IV/9**

**KEY WORDS:** Ortho Imagery, Digital Map, Accuracy Analysis, Layer, SPOT5

**ABSTRACT:**

As availability of high-resolution satellite imagery increases, the interests on the image maps using satellite imagery have been focused the production of thematic maps or accuracy improvement of digital maps. This research evaluated accuracy of the ortho images by comparing ortho imagery generated from SPOT5 single image with existing digital map by Korea National Geographic Information Institute. In this research, ortho imagery was produced using single image of SPOT5 satellite imagery. The accuracy analysis with 10 check points of respective layers of roads, streams, and structures was conducted. Although the research showed that ortho imagery acquired by single image had lower accuracy, it was evaluated to be more effective considering the economical effectiveness and applicability. With satellite imagery of higher spatial resolution, it can be effectively applied in production of larger scale ortho imagery maps.

## 1. INTRODUCTION

Recently according to supplying high resolution satellite imagery, we take much interest in the update and the revision of digital map and thematic map based on the satellite images. The ortho imagery mapping on the existing method extracted DEM(Digital Elevation Model) using stereo satellite images and used it for correction of satellite images. However, it is true that stereo image is not only expensive but also difficult to acquire images which were corresponded with an objective region and time.

Thus, in this research, ortho imagery using single image of SPOT5 satellite imagery and existing digital maps to overcome restriction of objective images acquirement was produced and accuracy analysis for utilization assessment of it was performed. And a scale 1 to 5,000 digital map which was produced National Geographic Information Institute of Korea for the orthorectification was used. The accuracy analysis for ortho imagery generated from SPOT5 single image was performed on the basis of a scale 1 to 25,000 digital map produced by National Geographic Information Institute of Korea. It would be presented the utilization possibility in the production and a revision of the digital map using SPOT5 single image.

## 2. SUBJECT MATTER AND METHOD

Observation images from the earth observation satellite generally have geometric distortions. These distortions mainly were caused by the earth curvature and rotation, satellite attitude and altitude, geometric characteristics of sensor and etc. Therefore satellite images with geometric distortions showed a different topography from reality.

In this research, we will attempt to evaluate the utilization possibility of ortho imagery generated from SPOT5 single image for the mapping and a map revision. For this, precise geometric correction using ground control points were performed to remove these distortions. And digital elevation model was generated from elevation data of 1 to 5,000 scale digital map produced by the National Geographic Information Institute of Korea. The accuracy analysis for ortho imagery generated from SPOT5 single image was performed on the basis of 1 to 25,000 scale digital map produced by National Geographic Information Institute of Korea. Then the existing regulations and the law of mapping which was notified by the National Geographic Information Institute of Korea were used as a reference data.

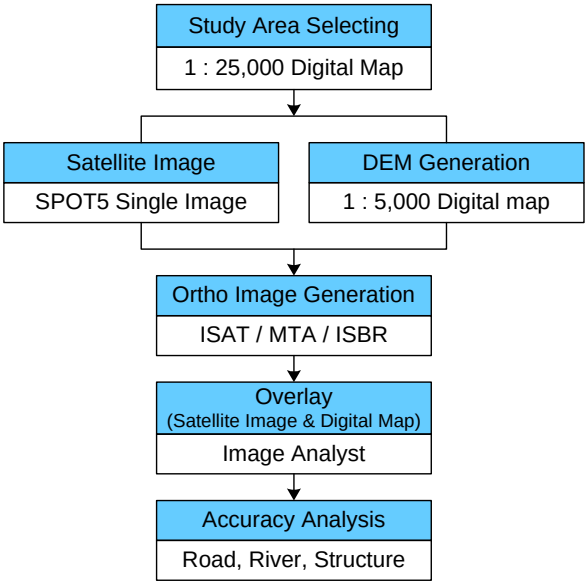


Figure 1. Research flowchart

## 3. IMAGE PROCESSING AND ACCURACY ANALYSIS

### 3.1 Image Processing

In this research, ISAT, MTA, ISBR and IA software which was related Image Station Z of Intergraph Corporation was used for image processing of SPOT5 satellite image. Especially ISBR(Image Station Base Rectifier) software was used for generation of ortho image from SPOT5 single image. Table 1 shows the program which was related Image Station Z. Figure 2 shows the system of Image Station Z and figure 3 shows a part of ortho image generation process from an SPOT5 image by ISBR software.

| Item | Program | Function |
|---|---|---|
| Composition of Project & Model | ISAT | . Data composition related project |
| Orientation | | . Execution of orientation |
| Triangulation | | . Auto triangulation |
| Display and Mapping of 3D Stereo Model | ISSD, ISFC | . Generated stereo model display<br>. Generation & editing of vector components |
| DEM Generation | MTA | . Generation of DEM |
| Data Processing | IA | . Image processing and analysis |
| Ortho Image Production | ISBR | . Ortho image production |

Table 1. Related programs

Figure 2. Image Station Z

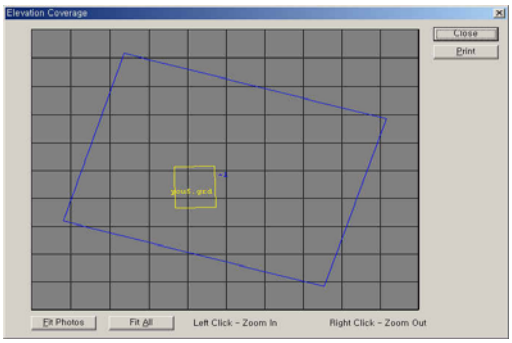


Figure 3. A part of ortho image generation

Ortho rectification was necessary to achieve ortho image from finished image of geometric correction. DEM(Digital Elevation Model) of research area was generated by MTA(MGE Terrain Analyst) software using 3D contours data of 1:5,000 scale digital map produced by National Geographic Information Institute of Korea. Resolution of grid model arranged 5m which was contour interval of digital map. Figure 4 and figure 5 shows respectively grid model and shaded relief model of research area.

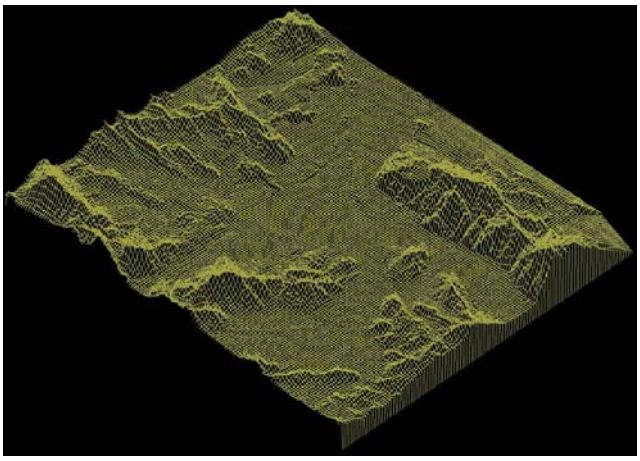

Figure 4. Grid model

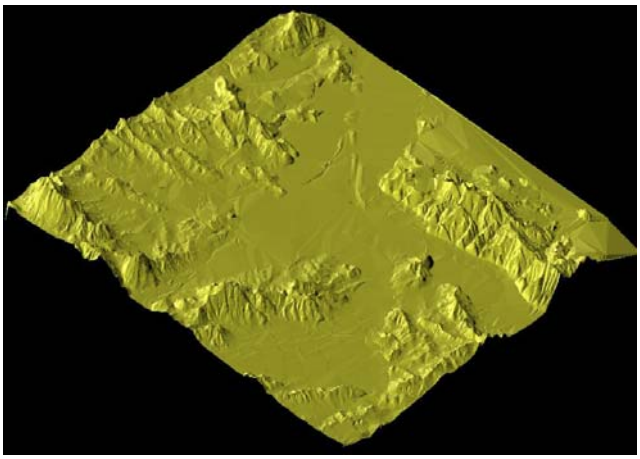

Figure 5. Shaded relief model

### 3.2 Accuracy Analysis

In this research, 1:25,000 scale digital map produced by National Geographic Information Institute of Korea was used to analyze accuracy for ortho imagery generated from SPOT5 single image. And the existing regulations and the law of mapping which was notified by the National Geographic Information Institute of Korea were used as a reference data. The accuracy analysis for 30 check points which were selected in satellite image of the research area was performed. And these works with respectively 10 check points of layer of roads, streams, and structures was conducted. Table 1~3 indicates the results of the accuracy analysis of positioning for respective layers of roads, streams, and structures.

| Point | Digital map(m) | | Ortho image(m) | | Deviation(m) | |
|---|---|---|---|---|---|---|
| | X | Y | X | Y | X | Y |
| 1 | 343966.500 | 4026510.340 | 343961.850 | 4026503.020 | 4.650 | 7.320 |
| 2 | 350274.940 | 4025638.050 | 350269.900 | 4025633.180 | 5.040 | 4.870 |
| 3 | 352860.740 | 4025026.120 | 352858.400 | 4025018.330 | 2.340 | 7.790 |
| 4 | 348970.890 | 4022716.690 | 348972.820 | 4022706.710 | -1.930 | 9.980 |
| 5 | 352047.300 | 4020630.140 | 352047.760 | 4020623.700 | -0.460 | 6.440 |
| 6 | 346456.560 | 4019898.670 | 346462.520 | 4019887.330 | -5.960 | 11.340 |
| 7 | 348312.040 | 4016897.710 | 348303.570 | 4016894.900 | 8.470 | 2.810 |
| 8 | 343306.080 | 4016514.690 | 343307.560 | 4016509.880 | -1.480 | 4.810 |
| 9 | 351270.760 | 4015756.930 | 351262.160 | 4015754.890 | 8.600 | 2.040 |
| 10 | 346553.960 | 4014788.280 | 346549.190 | 4014780.560 | 4.770 | 7.720 |
| RMSE | | | | | 4.770 | 2.951 |

Table 2. Roads layer

| Point | Digital map(m) | | Ortho image(m) | | Deviation(m) | |
|---|---|---|---|---|---|---|
| | X | Y | X | Y | X | Y |
| 11 | 344188.630 | 4025030.660 | 4025022.410 | 344188.630 | 8.910 | 8.250 |
| 12 | 347637.410 | 4025396.910 | 4025406.480 | 347637.410 | -4.790 | -9.570 |
| 13 | 352223.510 | 4024648.470 | 4024656.830 | 352223.510 | -5.920 | -8.360 |
| 14 | 344156.880 | 4020640.240 | 4020629.110 | 344156.880 | 7.870 | 11.130 |
| 15 | 348461.950 | 4021205.770 | 4021195.200 | 348461.950 | -5.440 | 10.570 |
| 16 | 352640.460 | 4019414.900 | 4019422.500 | 352640.460 | 3.350 | -7.600 |
| 17 | 347503.490 | 4017411.180 | 4017415.140 | 347503.490 | 8.550 | -3.960 |
| 18 | 352035.410 | 4015766.990 | 4015775.330 | 352035.410 | 2.950 | -8.340 |
| 19 | 342706.530 | 4014319.940 | 4014311.500 | 342706.530 | 1.660 | 8.440 |
| 20 | 349706.100 | 4013940.240 | 4013932.640 | 349706.100 | -6.400 | 7.600 |
| RMSE | | | | | 6.273 | 9.009 |

Table 3. River layer

| Point | Digital map(m) | | Ortho image(m) | | Deviation(m) | |
|---|---|---|---|---|---|---|
| | X | Y | X | Y | X | Y |
| 21 | 347020.060 | 4026234.530 | 347022.450 | 4026245.030 | -2.390 | -10.500 |
| 22 | 353432.070 | 4026027.110 | 353437.650 | 4026017.780 | -5.580 | 9.330 |
| 23 | 349801.860 | 4023801.020 | 349807.300 | 4023795.340 | -5.440 | 5.680 |
| 24 | 353032.630 | 4022650.880 | 353041.300 | 4022643.510 | -8.670 | 7.370 |
| 25 | 344541.810 | 4020005.660 | 344537.500 | 4020000.010 | 4.310 | 5.650 |
| 26 | 349891.480 | 4019449.790 | 349897.230 | 4019444.360 | -5.750 | 5.430 |
| 27 | 346890.300 | 4018272.780 | 346887.410 | 4018262.360 | 2.890 | 10.420 |
| 28 | 353406.640 | 4016115.800 | 353412.490 | 4016113.530 | -5.850 | 2.270 |
| 29 | 350659.610 | 4014129.370 | 350649.920 | 4014135.630 | 9.690 | -6.260 |
| 30 | 345594.000 | 4013627.220 | 345600.510 | 4013618.660 | -6.510 | 8.560 |
| RMSE | | | | | 5.942 | 6.892 |

Table 4. Structures layer

The accuracy analysis results for 30 check points which were selected in ortho imagery, root mean square error of roads layer is ±4.770m in X and ±2.951m in Y. And RMSE of rivers layer is respectively ±6.273m, 9.009m in X, Y and of structures layer is respectively ±5.942m, 6.892m in X, Y. It is within the permissible accuracy required for the map revision on a scale of 1 to 25,000 on the mapping rule notified by the National Geographic Information Institute of Korea.

As a result, ortho imagery generated by SPOT5 single image is sufficiently satisfied in plane positional accuracy required for the map revision. It is evaluated a good possibility of ortho imagery production using SPOT5 single image and expected that the results of this research will be fully used in ortho imagery mapping and applications using an existing digital map and a single satellite image. Figure 6~8 show deviation of each layers.

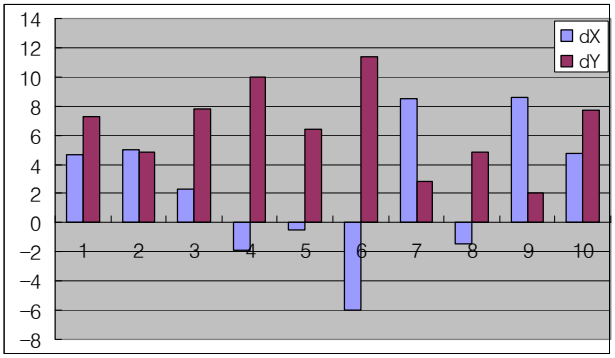


Figure 6. Deviation of road layer

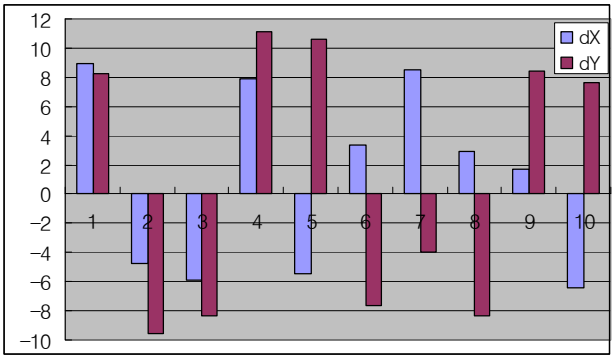

Figure 7. Deviation of river layer

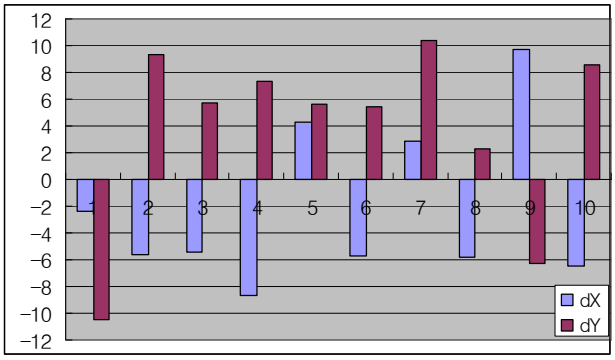


Figure 8. Deviation of structures layer

## 5. CONCLUSIONS

In this research, ortho imagery was efficiently generated from SPOT5 single image and an existing digital map. And analysis of positional accuracy of ortho imagery which was generated from SPOT5 single image was performed by comparing with reference digital map produced by National Geographic Information Institute of Korea. It would be presented for ortho imagery mapping and applications using SPOT5 single image.

The accuracy results of ortho imagery which was generated from SPOT5 single image were calculated respectively ±5.666m in X and ±6.284m in Y. And these results are within the permissible accuracy required for the map revision on a scale of 1 to 25,000 on the mapping rule notified by the National Geographic Information Institute of Korea. It is proved that ortho imagery using a single satellite image is effectively used to applications considering economical efficiency and reality. The present topic of mapping and map revision using ortho imagery by a single satellite image is a limit to scale, but if it use satellite imagery with higher spatial resolution, it will be useful to mapping applications of a large scale.

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## ACKNOWLEDGEMENTS

This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST)(No. R01-2006-000-11331-0)