Assessment of geometric accuracy of ALOS/AVNIR-2

Masayuki MATSUOKA(1)

(1) Faculty of Agriculture, Kochi University, 200 Monobe-otsu, Nankoku, Kochi, JAPAN, E-mail: msykmtok@kochi-u.ac.jp

Abstract
The geometric accuracy of the AVNIR-2 was assessed by comparing the geographical position of the image pixel with reference map. Three types of error (along track, cross track and rotation) were greatly reduced by modifying the sensor geometric parameters in the product of AVNIR-2.

Keywords: AVNIR-2, geometric accuracy.

1. INTRODUCTION

AVNIR-2 (Advanced Visible and Near Infrared Radiometer type 2) is one of the two optical sensors onboard ALOS. Geometric calibration should be implemented for the purpose of improving and keeping the accuracy of geolocation recorded in the product. The objective of this study is to assess the geometric accuracy of AVNIR-2.

2. METHOD

The assessment was implemented by comparing the geometric accuracy of AVNIR-2 product with reference i.e. ground control points, and by modifying the sensor geometric parameters in order to minimize the geometric error.

2.1. Acquisition of GCP

Three existing digital data over Japan were used as the ground control point (GCP) data. 1:2500 vector map is used to get the latitude and longitude. 50 meters mesh digital elevation model and geoid data are used to get the GCP height from the earth ellipsoid. All of these data are maintained by Geographical Survey Institute of Japan [1].

Corresponding points are acquired from vector map and band 3 image of AVNIR-2 (reference band of AVNIR-2 sensor model) by means of GCP acquisition tool (Fig. 1). GCP such as traffic intersection, bridge and seawall is picked up and image position (line and sample) and geographic position (latitude and longitude) were derived from AVNIR-2 image and vector map, respectively. Height from earth ellipsoid was subsequently derived for each GCP by adding digital elevation and geoid.

Six products of AVNIR-2 over Kanto area observed from October 2006 to April 2007 were applied for this assessment. Since the pointing angle, which means the angle of pointing mirror equipped in AVNIR-2 in order to change the observation area in cross track direction, is one of the source of error, products were selected from wide range of the pointing angle. Observation coverages and outline of the products is shown in Fig. 2 and Tab. 1 respectively. Over 100 points were selected in all products. Example of GCP is shown in Fig. 3.

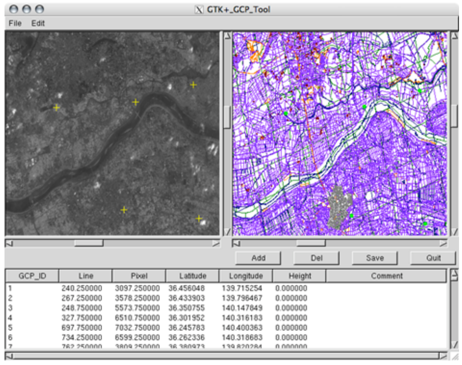


Figure 1. GCP acquisition tool

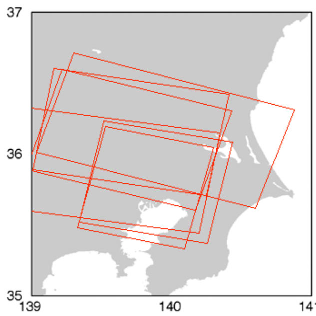


Figure 2. Observation coverage of assessed products

Table 1. Outline of assessed products

Observation date	Pointing angle	Number of GCP
10, Mar. 2007	-41.5	137
28, Jan. 2007	-34.4	221
06, Apr. 2007	-21.5	143
01, Mar. 2007	0.0	175
17, Oct. 2006	34.3	162
09, Mar. 2007	41.5	105

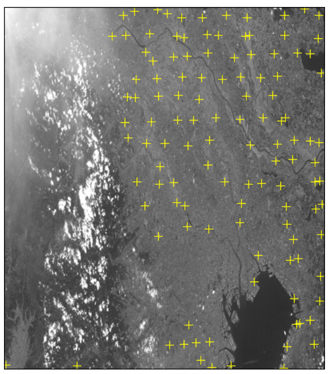


Figure 3. Example of GCP (10, Mar. 2007)

2.2. Modification of sensor parameters

Geographical points of AVNIR-2 pixel is calculated by means of sensor model, orbit and attitude. these information are recorded in image file, leader file and supplemental file of AVNIR-2 product [2]. Since the orbit and attitude of ALOS are assessed and calibrated using higher resolution PRISM data, it is assumed in this research that these are sufficiently precise in reference to the spatial resolution of AVNIR-2. Therefore, the modification of the geometric error is achieved by calibrating the sensor geometric parameters. Geometric sensor model of AVNIR-2 was developed in reference to the earth observation data application handbook for ALOS [3] and the geometric parameter recorded in supplemental file. Software version number, which is recorded in products and indicate the version of processing software and parameters, is same (045003075002) for all assessed products. All of the geometric parameter except the pointing angle is assumed to be constant. Pointing angle is modified by products, because it is shifted by observations and setting inaccuracy is considered to be the main source of error especially in cross track direction (personal communication). The modification of the parameter was attempted manually.

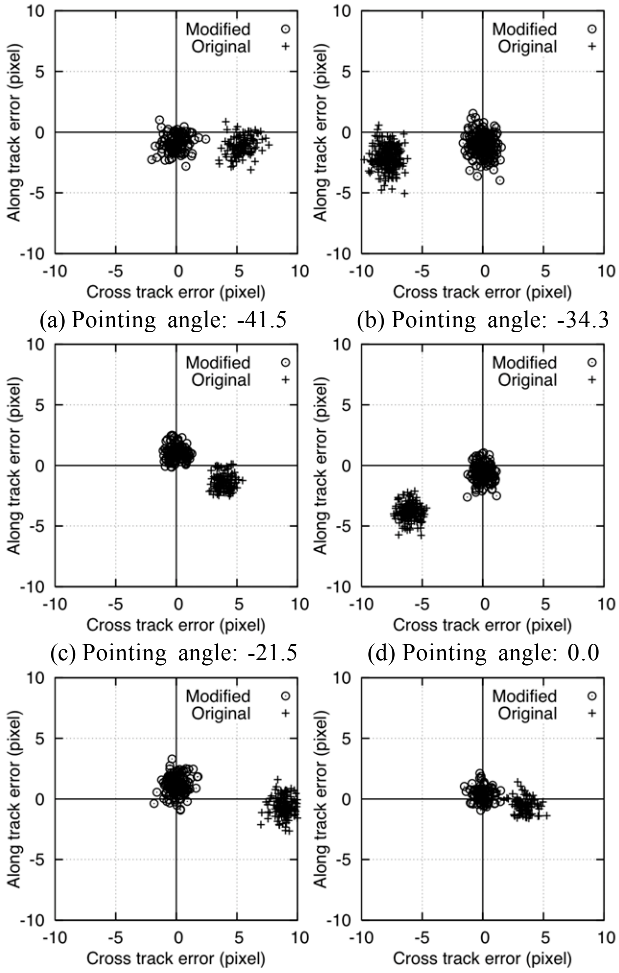
3. RESULTS AND DISCUSSIONS

Geometric error of the products is shown in Fig. 4. The mark of + indicates the error of original data i.e. before modification. Average of the cross track errors ranging approximately from -6 to 9 pixels are relatively larger compared with along track error, because of the pointing angle inaccuracy. average error in along track are approximately from -4 to 0.

After modification, all errors are clustered around the origin. Pointing angles were changed from -41.5 to -41.50465, from 34.3 to -34.29350, from -21.5 to -21.50325, from 0.0 to 0.004963, from 34.3 to 34.29259, and from 41.5 to 41.49721 respectively. Since the pointing angles are modified by products, the cross track errors were clustered around zero with the averages of exactly zero. The along track error, on the other hand, is corrected sensor parameters which is common for all products, therefore, the averages of errors are still ranging from -1 to 1.

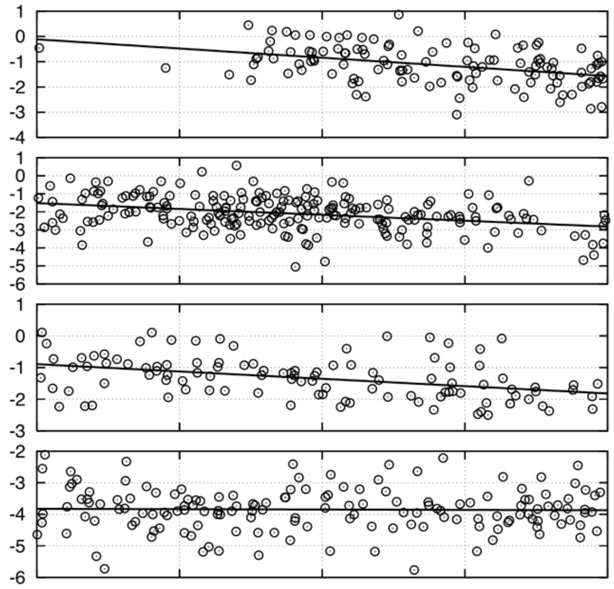
Fig. 5 shows the along track error against detector number before modification. Though the variation of the error is large, the trend of the error associated with detectors is identified. In case of the pointing angle of -41.5 degrees, the difference of along track is approximately 1.5 pixel between both edge of the detector. Linear regression was applied for each products, and the slopes of the regression line were plotted against the pointing mirror angle. The slope was shifted against the pointing angle, that is, the rotation types of along track error is severe in large pointing angle (off-nadir observation). The results after modification are shown in Fig. 6 and Fig. 7. No clear trend of error were detected against the detectors.

Modified parameters are shown in Tab. 2. InstRotation and PmaDeviation are modified in order to correct the rotation type of error shown in Fig. 7.



(a) Pointing angle: -41.5 (b) Pointing angle: -34.3
(c) Pointing angle: -21.5 (d) Pointing angle: 0.0
(e) Pointing angle: 34.3 (f) Pointing angle: 41.5

Figure 4. Geometric error before and after modification



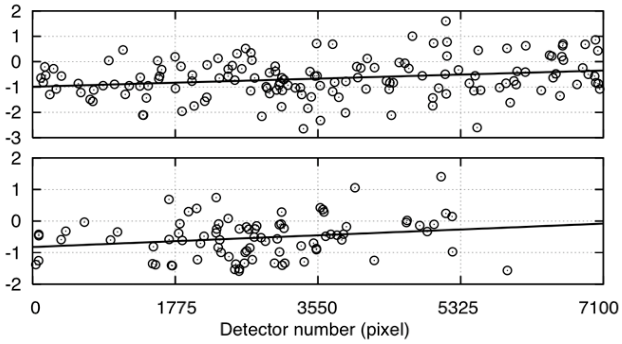


Figure 5. Along track error (in pixel) against detector number before modification (pointing angles are -41.5, -34.3, -21.5, 0.0, 34.3, and 41.5 degrees from the top)

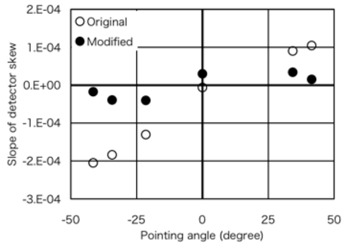


Figure 6. Slope of along track error against pointing angle before and after modification

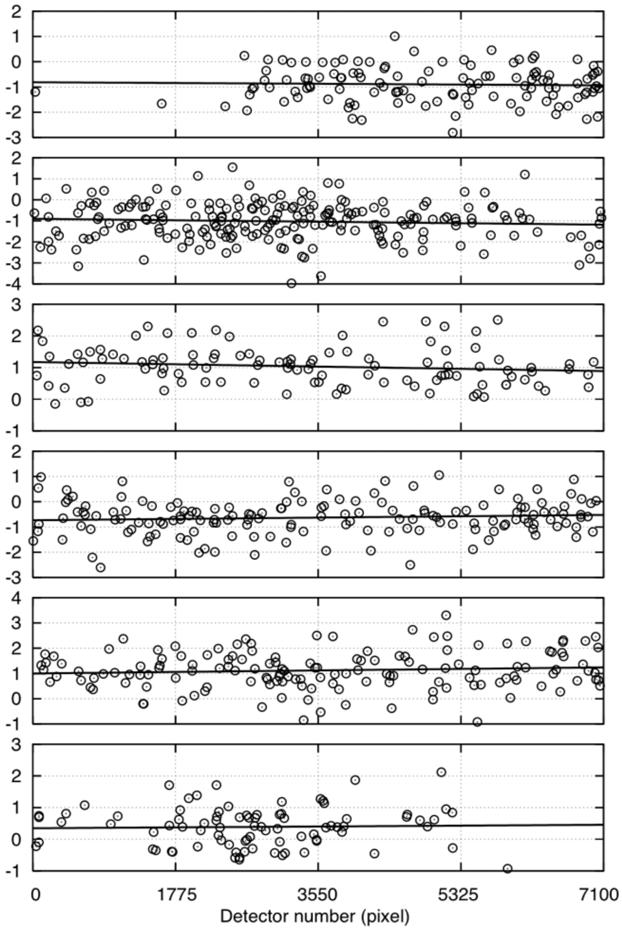


Figure 7. Same as Fig. 6, but after modification

Table 2. Modified parameters

Parameter keyword	Original	Modified
InstRotation	-8.100E-04	-7.813E-04
Focal Length	799.066	798.951
OptDeviationX	-9.70E-06	-8.00E-05
PmaDeviationZ	-9.70E-06	4.00E-05
Avnir2Alignment	-4.79453E-02 4.45453E-02 4.69727E-02	-4.79715E-02 5.40700E-02 5.02331E-02

4. CONCLUSIONS

Geometric accuracy of the AVNIR-2 was assessed and some geometric parameters were modified in order to minimize the along track error, cross track error and rotation type of error. The modified results showed good improvements of geometric accuracy, though the residuals was still remain. The systematic optimization of the parameters such as non-linear optimization will be applied to get the better combination of the parameter.

acknowledgement

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References

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