HIGH RESOLUTION DSM GENERATION FROM ALOS PRISM
- STATUS UPDATES ON OVER THREE YEAR OPERATIONS -

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1. INTRODUCTION

Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) carried by Advanced Land Observing Satellite (ALOS) was designed to generate worldwide topographic data in respects of its high resolution and stereoscopic observation. For this objective, the on-orbit geometric performance of PRISM sensors has been widely assessed and calibrated since launch in January 2006 as the activity of calibration and validation team of Earth Observation Research Center (EORC) / Japan Aerospace Exploration Agency (JAXA). This ongoing activity has generated various geometric performance data over three year on-orbit period of operations. A suite of geometric model parameters was calibrated to express those geometric characteristics of PRISM sensors. These include static interior parameters (CCD unit camera parameters) and dynamic exterior parameters (orbit data, attitude data, and sensor alignments). The interior parameters were calibrated by the test-field self-calibrations with test sites of dense Ground Control Points (GCPs). The exterior parameters were calibrated by adaptive image orientations with test sites of world-wide GCPs. Those parameters are correlated to the direct geo-referencing accuracies of PRISM sensors and are being monitored and validated to maintain those performances. And the performance analysis of Digital Surface Model (DSM) derived from those geometric model parameters was performed. The detailed characteristics of triangulation results were analyzed by GCPs and height accuracies were evaluated from the comparison with high accuracy and high resolution reference DSM data sets derived from airborne Lidar instruments. The DSMs are being routinely processed on a scene basis at EORC and mosaiced for the generation of global standardized dataset. This paper reports on the methods and results of PRISM geometric calibrations and DSM generations obtained over three year operations.

2. PRISM GEOMETRIC CALIBRATION

One of major technical challenging missions of ALOS-PRISM project is the high accurate direct geo-referencing (i.e. automatic image orientation) using the precision geometric model parameters. PRISM performs the along-track triplet stereo observations by forward (FWD), nadir (NDR) and backward (BWD) independent panchromatic optical line sensors of 2.5m ground resolution in 35km wide swath. FWD and BWD sensors are arranged at an inclination of +/-23.8 degrees from NDR to realize a base to height ratio = 1.0. The geometric model parameters of those triplet imageries consist of static interior parameters and dynamic exterior parameters. The static interior parameters are the CCD unit alignment data of triplet optical sensors and have been already enough calibrated in the early phase of the operations. On the other hand, the dynamic exterior parameters are the satellite orbit data, attitude data and sensor alignments of PRISM triplet sensors. The absolute accuracy of orbit data was confirmed within sub-meter level by Space Laser Ranging (SLR) campaign in early phase of operations. Since the orbit data is enough accurate, the direct geo-referencing errors of PRISM imageries attribute to attitude and sensor alignment errors. Analysis of several calibration scenes was required to separate the errors of satellite attitude and changing trend of sensor alignments. The sensor alignments have time depending changing trends due to the changes of on-orbit thermal conditions. Those alignment changes are correlated to satellite positions on an orbit cycle and the date of observations and are independent between triplet sensors. Hence, we have modeled those changing trends with GCP sites sampled from various locations in the orbit cycle and various observation dates from among over three year operations. The absolute accuracy of direct geo-referencing of PRISM depends on the characterization and modeling of those changing trends and we have achieved the planimetric absolute accuracies in 5~7 m RMSE for all triplet sensors with the latest models. However, we suppose we have not yet enough understood the behavior of the changing trends and still have to monitor the error trends and update those models if necessary. Consequent triangulation accuracies of FWD, NDR and BWD triplet stereo imageries were also assessed with those calibrated geometric parameters as the ability of a three-dimensional measurement for DSM generations.

3. PRISM DSM GENERATION

The along-track triplet stereo observation enables to generate more precision DSM frequently than usual pair stereo observations with the calibrated geometric models mentioned above. For this specific stereo image configuration, the exclusive triplet stereo images matching algorithm was applied for the DSM generation. The image matching algorithm is based on the conventional area-based cross correlation. Traditional techniques for stereo image matching e.g. epipolar geometry, a coarse to fine image pyramid, etc. were adaptively applied to the cross correlation parallax search in the exclusive triplet image matching algorithm. This algorithm enables the high robustness against the matching blunders compared with the conventional pair stereo matching. Various test sites including various terrain characteristics were prepared and used for the validations of DSM with the reference data sets derived from Lidar instruments or aerial photo matching. The accuracy of DSM generated from PRISM imageries acquired over three year operations were widely assessed by the comparison with those reference data sets. This paper reports on the results of some new reference sites and the characterization of generated DSM i.e. with or without GCP, the accuracy dependence on scene areas, the accuracy differences between scene dates, and so on. The DSMs are being routinely processed on a scene basis at EORC and more than a thousand scenes have been processed during the PRISM operations so far. Those scene-based DSMs are then mosaiced and re-framed on regular cell frames as the global standardized data sets. The preliminary results and issues of this ongoing mosaic processing are discussed in this paper.