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ON-ORBIT CALIBRATION OF PRECISION STAR TRACKER FOR THE ADVANCED LAND OBSERVING SATELLITE (ALOS)

Abstract

On January 24, 2006, the Advanced Land Observing Satellite (ALOS) was launched by an H-IIA rocket into a sun-synchronous orbit. Throughout the last 3 years since the launch, ALOS has been operated successfully on orbit, delivering a variety of high-resolution images in numerous quantities and contributing to disaster management support many times. A precision star tracker (STT) was developed for ALOS that required stringent attitude determination accuracy. This star tracker has three optical heads (STO) and provides star position accuracy of 9 arcsec (6 mag) for random error and 0.74 arcsec for bias error. Typically, two sets of optical heads and analog electronics units are used simultaneously, and STT detects positions and brightness of stars in its two fields of view. The precise star position accuracy of this star tracker is enabled by STO's low-thermal distortion structure and tight temperature regulations. All functions and performances of STT were verified on orbit in the initial check-out phase. In addition, STT's performaces, in particular, star position accuracies and star brightness accuracies, have been assessed continuously. The STT calibration parameters have been derived from numerous sets of STT's all pixel data and have been so far uploaded to the on-orbit STT five times. In the calibration, all pixel data indicated an off-nominal CCD response observed over the south Atlantic anomaly region, and another off-nominal CCD response observed only by STO-2 in a specific orbital position. These off-nominal CCD responses resulted in temporal degradation in star identification performance. As a part of calibration operations, we performed threshold tuning operations on orbit and uploaded a set of optimal thresholds determined from on-orbit experiments. This tuning resulted in stars' wide spread over the entire FOV of each STO at most orbital positions and improved the agreements of on-orbit star identification results with ground-based analyses. In addition to the threshold tuning, we calibrated image size judgement criteria, exposure time, gain, dark pixel tables, stripe correction coefficients, and optical distortion correction parameters. Despite a relative alignment anomaly due to the satellite structure, our performance verification and calibration of STT resulted in the conclusion that STT alone achieved the performance requirement. This paper describes these flight experiences and calibration results of the ALOS star tracker.