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ON-ORBIT PERFORMANCE VERIFICATION OF A NANOSAT STAR TRACKER

Abstract

This paper investigates the performance of a nanosat star tracker, Sagitta. Star trackers undergo extensive ground testing for flight qualifications before launch. The performance of every step in the star tracker's algorithm is quantified and verified through a series of simulations and night sky tests. This work evaluates the flight performance of the star tracker using on-orbit telemetry data returned. The performance of imaging, star detection, centroiding, matching, and attitude estimation steps is examined and verified. Furthermore, star tracker availability in challenging situations, such as the presence of stray light and slew rate, is evaluated. Two different data types were collected for this purpose: image histograms and star tracker telemetry. While information recorded in Sagitta telemetry is sufficient to examine the solution accuracy and availability, it does not offer much insight into imaging conditions and image quality. Each processing step of the star tracker includes several tuning parameters that can be easily modified via a configuration file. This allows for quick tweaks and modifications in case of dealing with unexpected circumstances during the missions. The process began with verifying the imaging step by examining the image histograms. The purpose is to ensure that the camera parameters used are optimized for the conditions experienced in orbit. The focus of the star tracker is also checked by observing the shape of the imaged stars. The next step is to verify star detection and star detection thresholds. The detected stars and their magnitude are examined to verify that the full range of the star database is detectable during flight. After detecting the stars and calculating their centroids, a star matching algorithm is performed to find the detected stars in the on-board catalog. The accuracy of this step can be assessed by comparing the angular distance between stars in the image and the database. At the last step, the attitude tracking confidence is compared to ground qualification campaign results. Finally, the star tracker's performance in challenging conditions, such as the presence of bright objects close to the field of view and slew rate, is examined. There is a set of logics within the star detection algorithm to handle the presence of stray light within the image. Star tracker robustness to slew rate is also evaluated and compared to ground slew tolerance analysis. These processes are iterative, leading to the final adjustment of the star tracker algorithm to achieve the required performance metrics.