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Spacecraft Attitude Determination Simulation and Experiment to Improve the Efficiency of a Star Tracker

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ABSTRACT

Knowing a spacecraft's orientation is crucial for many vital functions. Attitude is often determined using a star tracker. Star tracker attitude determination must be fast and efficient given the limited on board computing resources. To determine its attitude, a star tracker must take an image of its environment, locate the stars in that image, recognize a pattern among those stars, match it with patterns in a catalog, and determine the rotation matrix that relates the spacecraft to the inertial frame. Searching through catalogs to match patterns is a costly step in this process. This work aims to develop a more efficient catalog and quantitatively select the best matching criteria to use. Programs to perform these steps were created to test the star tracker performance. Here, a new catalog generation method is presented. For this catalog, three parameters are necessary to find a certain match with an uncertainty of 1% for each parameter. This catalog requires over five times as many triangles as the existing catalog and three parameters instead of one, but only 39% as many stars. For this star tracker, the catalog requires more memory than an existing catalog, but is guaranteed to find a match on the first attempt, potentially making the new catalog faster. The size of the catalog decreases with larger fields of view, so catalogs for other star trackers may be smaller. Depending on the hardware and computing requirements of the mission, catalogs generated with the new method may be faster and more efficient.

KEYWORDS

Star tracker, star catalog, field-of-view, optimized, attitude, orientation, estimation, simulation