Image Processing and Attitude Estimation Performance of Star Camera with Extended Bodies in the Field of View

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Abstract

Spacecraft optical navigation (OPNAV) systems process a sequence of images of celestial bodies against a star field background to estimate the position and velocity of the vehicle. While attitude is often available from an onboard star tracker, it is often desirable to recognize stars in the OPNAV images to better align the image. While many image processing algorithms exist for finding stars, efficiency and reliability remain key issues and the presence of extended bodies (e.g. the Moon, Earth), especially when attempting to solve the full lost-in-space problem. Therefore, we require new and robust approaches. This work presents modified algorithms for star centroiding and identification to estimate the vehicle attitude in the lost-in-space case, both with and without the extended bodies in the camera field of view (FOV). Furthermore, star identification is carried out by a pattern matching technique to match observed stars in an image to specific stars from the star catalog, all while ignoring false returns which do not belong to the catalog.

The emphasis of the work is on developing a simple and robust end-to-end image processing chain for an OPNAV camera. Therefore, different algorithm concepts for each element of the chain will be implemented, tested, and compared. Furthermore, star image simulation software will be developed, allowing performance and speed tests of the single blocks and the processing chain as a unit. Night sky images with and without the extended bodies in the FOV will be also used to test and verify the proposed image processing algorithm.

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