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Published in:
Geophysical Research Abstracts

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Geophysical Research Abstracts
Vol. 21, EGU2019-9822, 2019
EGU General Assembly 2019

Space Debris Detection and Tracking Using Star Trackers

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The near Earth space environment is becoming crowded with space debris and must be regarded a critical resource for future spacecraft missions. To ensure continuous access to this resource, future Low Earth orbit users have responsibility, both for savvy usage, as well as to contribute knowledge of the environment. The latter can be achieved employing a novel technique for debris population characterization, at low cost and high fidelity, applied to instruments on future as well as existing spacecraft.

Star trackers traditionally provide arc-second attitude recovery for spacecraft navigation by matching observed star positions in source images to an on-board star catalogue. Typically, the 10-20k brightest stars are included in the matching, effectively enabling the star tracker to detect celestial objects with visual magnitude levels as faint as mV 7-9. Relative motion of debris is different from the apparent motion of the star field, using that apparent star positions are known, wherefore the star tracker autonomously discerns the debris from true stars. Apparent position and trajectory of such debris may hence be collected. Since a great number of star trackers are readily in-orbit, global coverage may be achieved with already launched and operated hardware. At least, this functionality should be incorporated in new missions.

The μASC star tracker from DTU (Technical University of Denmark) is the primary attitude sensor on-board a great number of spacecraft missions, including ESA's Swarm triad and the MAG investigation on NASAs Jupiter explorer JUNO. The Swarm triad provides routine diagnostic images from the nine sensors on the three segments. By employing the above mentioned technique on these images the prospective performance has been characterized.

We present the sensitivity and performance of on-board debris detection and tracking augmentation of the star trackers. We also discuss methods to suppress false debris detection from e.g. locally produced temporary debris from thruster firings, as well as the potential for in–situ tracking of fellow spacecraft. Finally, we give examples of this technique used by the NASA JUNO mission detecting and tracking natural objects in orbit about Jupiter.