SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Issues (5)

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VISION BASED NAVIGATION FOR DEBRIS REMOVAL MISSIONS

Abstract

The active removal of heavy space debris (typically larger than 1000kg) has been identified as a key development to control the growth in the debris population and to limit the risk for active satellites. In that context, Astrium has been working on optimization and implement of sensors and navigation solutions onboard a Debris Removal Vehicle named "The Debritor" with the main objective to ensure high safety proximity maneuvers. In particular, special attention has been paid to design of autonomous, vision-based navigation solution for uncooperative rendezvous with space debris. The proposed solution relies on state-of-the-art image processing and navigation filtering, allowing fine estimation of chaser states with respect to debris.

Based on a monocular camera, the proposed image processing algorithm achieves a 3D tracking of the target, relying on frame-to-frame tracking and tracking by detection techniques. The main principle is to align the projection of the 3D model of the tracked debris with observation made in the image and provides the complete relative position and attitude thanks to non-linear minimization process. Running at video rate, the proposed algorithm can handle very complex targets, under degraded conditions, i.e. with Earth background, occlusion or optical peculiarities (such as poor texture or specular reflections). The Guidance, Navigation and Control system is then provided with relative states estimation. Hybridized with other sensors measurements, such as IMU or star tracker, the navigation is then able to provide with highly accurate relative states the guidance and the control, hence minimizing delta V consumption during approach and maximizing safe docking or capture (no collision risk).

The tracking algorithm has previously been tested on real images, such as Soyuz-TMA rendezvous with ISS, Atlantis space shuttle pitch maneuver and shuttle external tank debris, to demonstrate its robustness to real data. In the present paper we focus on heavy debris tracking, like satellites or launcher tanks. A test campaign on simulated images has been carried out to quantitatively show the performances and robustness of both tracking and associated navigation.