Paper ID: 60380
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (1) (1)

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ANALYSIS OF MANOEUVRING STRATEGIES AND RELATIVE NAVIGATION FOR MULTI-STEP RENDEZVOUS TOWARD UNCOOPERATIVE TARGETS

Abstract

The need to increase the autonomy level of spacecraft, especially related to Guidance, Navigation and Control functions, is becoming mandatory in the context of missions involving Autonomous Rendezvous and Docking operations, such as On Orbit Servicing and Active Debris Removal, due to the inability to rely on commands from ground. This paper focuses on guidance and navigation aspects. First, an original multi-step strategy, inspired by the one designed for the Restore-L mission, is proposed to safely perform rendezvous toward an uncooperative target up to a close distance suitable for monitoring. Passive safety is guaranteed as long as the relative trajectories are designed so to not breach pre-defined regions of space around the uncooperative target whose dimensions are selected based on navigation uncertainty, observation geometry, chaser and target size, and capability of the propulsion system to provide the required variation of velocity. The compliance with the passive safety criteria is additionally verified by simulating manoeuvre failures. With regard to the navigation aspect, particular attention is paid to the final phase of the rendezvous manoeuvre. In particular, performance of a LIDAR-based architecture for inertia and relative motion parameters of the target is analysed, exploiting a numerical simulation environment realistically reproducing the operation of a scanning LIDAR and the relative motion between two spacecraft. Performance of the proposed manoeuvring strategy and relative navigation architecture are tested considering different targets.