Paper ID: 65552
oral
student

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

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DESIGN OF NATURAL COLLISION-FREE TRAJECTORIES FOR THE MISSION EXTENSION PHASE OF A REMOTE SENSING FORMATION FLYING MISSION

Abstract

The safety concept is of paramount importance in the trajectory design of formation flying missions. The selection of natural collision-free trajectories is based on the analysis of non-propelled relative motion among the satellites. This is beneficial for the mission both in terms of propellant consumption and control effort, allowing a naturally safe environment. This paper focuses on a novel formation flying for remote sensing missions in low Earth orbit, in the direction of future Earth observation missions. We consider as a baseline the Formation Flying L-band Aperture Synthesis mission concept, proposed by the European Space Agency. This work propose natural collision-free trajectories to extend the scientific champaign at the end of the nominal operative life of the FFLAS mission. The possibility to extend the scientific operations, before the final atmospheric re-entry phase, could provide a significant amount of data to improve meteorological and climate prediction. The scenario selected is based on a close formation flying, with a nominal inter-satellite distance in the order of tens of meters. This allows the satellites to behave as a node of a distributed payload for Earth observation, increasing the accuracy in the measurements, thanks to the increase of the radiometers aperture size. We present two possible strategies to design the extension phase of this mission. First, we consider the possibility to increase the relative distance among the satellites, maintaining the possibility to do Earth observation with distributed payloads. We perform some analyses to select the augmented geometry, with a bigger formation baseline in the order of tens to hundreds of meters. The analyses are driven by the need to use natural collision-free relative trajectories since at the end-of-life the low thrust control is limited. The second strategy is based on the possibility to place the satellites on different trajectories. This allows a more flexible trajectory design for the extension phase, where each satellite operates singularly on different orbits, as a single satellite science mission. The final decay of the satellites is provided via a deorbiting low-thrust manoeuvre, to comply with the 25-year mitigation rule. The main idea is to propose disposal in less than three months, for a spacecraft with an area-to-mass ratio of about 0.02 m^2/kg. The results of the analyses are obtained including the effects of the orbital perturbations, thanks to a high-fidelity relative motion propagator. The relative orbital elements environment is introduced to assess the formation safety more straightforwardly.