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METHODOLOGY AND ESTIMATION COSTS FOR PROXIMITY MANEUVERING SPACECRAFT FORMATIONS IN THE VICINITY OF LIBRATION POINTS

Abstract

In this paper we consider a methodology for proximity maneuvering spacecraft formations by means of finite elements in time. The problem is essentially set up as an optimal control problem, where the objective function is directly related to the delta-v expenditure of the satellites in their controlled trajectories. Once formulated, we solve it via a variational numerical method where collision avoidance and other type of restrictions are dealt in a natural way. In particular, during the process, mutual distances between spacecraft are checked and possible collisions are avoided.

A key point in the approach is the flexibility introduced by the finite element method and the theory underlying it. As a result, an important fact of this implementation is that the mesh of trajectory intervals can be automatically tuned by the algorithm when computing optimal reconfigurations. In particular we present a suitable algorithm based on adaptive remeshing that recomputes and refines the trajectory for a given error threshold.

Another point of the paper is to present an study on the cost of proximity maneuvering for formations about libration points. For this purpose we consider the different parameters that play a role in the reconfiguration maneuvers: the position of the spacecraft in the libration point orbit, the orientation of the formation, the security distance between spacecraft and the time span associated to the maneuver. The objective of this section is to give a good estimation cost for basic maneuvers in order to easily evaluate the cost of more complex missions and its lifetime.