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RECONFIGURATION OF SPACECRAFT FORMATIONS IN THE VICINITY OF LIBRATION POINTS

Abstract

During the lifetime of a formation flying mission, the formation pattern can need of reconfigurations many times. For this reason, a robust and efficient optimal control technique avoiding possible collision risks is a key point. In this work we develop a methodology to compute optimal reconfigurations of a formation of satellites in a given fixed time interval using a systematic approach.

This methodology consists on modelling the trajectories of the satellites using 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. Geometry of controls depending on the orientation of the thrusters, and weighted trajectories can also be taken into account if for instance the fuel resources or a particular satellite are in a better or worse state than others.

Once formulated, the problem is solved 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.

In this presentation we study the costs, in terms of delta-v, of the reconfiguration of the formation in the vicinity of libration points. The mesh of the finite element method is obtained using adaptive re-meshing techniques, which as a limit states can be directed either towards bang-bang controls (when possible) or to low-thrust arcs. The maneuvers, computed initially for linearized equations about a nonlinear base orbit, are later considered for the full nonlinear model, either using the RTBP or JPL ephemeris.