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SEMI-ANALYTIC TECHNIQUES FOR NON-CONTROLLED FORMATION FLYING TRAJECTORY DESIGN IN BINARY SYSTEMS OF IRREGULARLY SHAPED CELESTIAL BODIES

Abstract

Trajectory design in irregular gravity fields requires specific modelization techniques to ensure a good fidelity. This is typically translated in extremely high computational costs and times, preventing from the direct adoption of global numerical techniques such as genetic algorithms. Furthermore, the presence of two attractors orbiting around each other introduces the so called "Three Body Problem", known for its mostly chaotic nature and not suitable for non-targeted numerical algorithms. The direct solution to the aforementioned issues comes from the definition of semi-analytical techniques, based on local numerical optimization schemes exploiting analytical pre-built objectives, collected into an overall cost function. Local optimization, however, introduces a set of new problematics. Firstly, the nature of the local optimization scheme requires the definition of good initial guesses, relatively near the final solution, leading otherwise to a poorly converging or non-converging correction process. Secondly, the occasional presence of algebraic constraints, such as collision avoidance, into a continuous differential cost function, may lead to a locally over-constrained problem, preventing the algorithm from finding a physically coherent solution. Other issues are related to the impossibility of obtaining a number of solutions higher than the set of initial guesses, and to the loss of control on the single objectives with respect to the overall cost function.

The present work aims at the definition of various improvements to the local optimization scheme, to enhance its performance in the formation trajectories search. The single improvements will target selectively the aforementioned issues, according to the criticalities in the overall process, with the purpose of solving them or proposing more effective alternatives. Direct application of the enhanced scheme will be presented, with reference to the Didymos binary asteroids system, for a two nanosatellites formation flying mission concept.