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OPERATIONAL ORBIT ACQUISITION FOR A LARGE APERTURE DISTRIBUTED SPACE TELESCOPE

Abstract

There is an ever-increasing requirement for extremely large space-based telescopes to advance astronomic knowledge. However, monolithic satellites introduce a serious constraint to the aperture size. Indeed, the idea to use multiple satellites in formation to achieve the requirements of distributed, ultra-large apertures in the order of 100's metres is gaining momentum. Locating these telescopes in the outer solar system can have further advantages, as there will be significantly less interference from the sun. The large radius, heliocentric orbit acquisition for the formation will be however an important issue for these projects. To this end this paper develops a manoeuvre planning and optimization concept with guidance and control of the relative state vector by first applying the orbit transfer theory of a single spacecraft. Then, the paper tackles the issue of a very large inter-planetary orbit transfers for formation flying satellites and the ramifications of the absolute trajectory selection on the relative state of the formation. Due to the fact the manoeuvre considered is a deep space manoeuvre the major perturbations that can affect the relative dynamics can be preliminary considered as negligible. The relative dynamics is indeed modelled as a non-linear time-variant dynamical system in the heliocentric frame. A number of strategies for the manoeuvre are introduced, and an optimized strategy is considered taking into account the optimum propellant usage and the constraints a relative trajectory can impose on the absolute trajectory. The strategies considered are the following, 1. Fixed formation configuration orbit transfer 2. Pre-transfer reconfiguration followed by orbit transfer 3. Partial Pre-transfer, Partial Post-transfer reconfiguration 4. ”Satellite reconfiguration during orbit transfer” An impulse orbit transfer manoeuvre is considered for strategies 1-3, to be defined by means of a convex optimization technique.. The fixed formation configuration is the simplest of the orbital transfer strategies and it involves maintaining a constant configuration throughout the manoeuvre. The Pre-transfer reconfigurations involve an optimization algorithm to optimize the propellant usage while minimizing the drift in relative motion post-transfer. Strategy 4 involves instead a continuous reconfiguration manoeuvre. A number of simulations using different configurations are performed and presented to evaluate the different techniques, and an approach suitable for a stable telescope configuration in deep space is determined.