Paper ID: 66671
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Mr. Karthick Dharmarajan
University of Rome “La Sapienza”, Italy, karthick.dharmarajan@uniroma1.it

FLEXIBLE RECONFIGURATION FOR FORMATION FLYING SPACECRAFT WITH FUEL BALANCING

Abstract

The concept of formation flying in spacecrafts is increasingly becoming a key technology that facilitate the realization of complex concepts that would have been impossible with single satellite missions. Such concepts include Multiple Spacecraft Interferometry, Space aperture telescopes using formation flying etc. Some of these formation flying missions are performed in orbits around Earth and some in Deep-Space. Quite a few of these missions incorporate multiple reconfiguration manoeuvres to complete their mission requirements. Unfortunately, due to the nature of formation flying missions the propellant utilization of each satellite is not equal. While a pre-determined reconfiguration algorithm could be utilized to equalize the fuel requirements for each individual satellite, such an algorithm necessitates a considerably rigid final formation configuration to calculate and perform the reconfiguration manoeuvres. In this paper we present a fuel balancing algorithm for a flexible reconfiguration manoeuvre. The manoeuvre reconfigures each satellite to a position in the formation that both satisfies the mission requirements as well as utilizing an optimum amount of propellant that depends on quantity of propellant left for each individual satellite. We need to consider the assumption that at least some of the satellites in the formation can perform identical functions. This assumption allows us to automatically assign each satellite to different positions in the configuration without compromising mission functions (this is the case for current and many future planned missions e.g. ESA’s Darwin). The proposed algorithm includes 3 steps: (1) computation of the reconfiguration’s cost for each individual satellite for a given time horizon, (2) comparison of the computed costs with respect to a ideal balanced partition among platforms, (3) if the balanced condition is not attained change time horizon and repeat step 1. Notice that in addition to the propellant balancing requirement an additional condition concerning collision avoidance should be met during manoeuvering phase. The proposed approach, taking advantage of the flexibility intrinsic to formation flying (as an example, by modifying the sequence of maneuvers among spacecraft or by switching their targeted final positions) shows significant advantages while searching for an optimal reconfiguration strategy. A number of simulations, related to several possible cases of interest for different variable formation size and orbits, are presented to validate the approach.