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FRACTIONATED SATELLITE SYSTEMS: STATION KEEPING STRATEGIES

Abstract

This paper discusses the benefits and limitations in exploiting a satellite formation to build a virtual aperture instrument for Earth observation applications. The satellite cluster exploitation to implement the fractionated system allows the formation a geometrical reconfiguration in order to be compliant with performances requirements risen by different set of observations to be achieved along the formation operational life. The strategy identified to station keeping, reconfigure and dispose such a formation is here critically presented, each vehicle in the formation is considered as a 6 dof orbiting object. Focus is on the formation astrodynamics design to minimize the powered manoeuvers while being compliant with the scientific performance requirements. The vehicles are assumed as identical platforms, in terms of those aspects affecting their orbital dynamics, which are the mass, shape and on board thrusters; quantities with respect to which solutions can be parametrized to support the whole mission design. The driver for such an assumption is the differential perturbation effects minimisation. The further degree of freedom of the formation geometry is here exploited; in particular, the along track, staring and sliding formations have been designed and compared. As far as the along track formation is concerned, the satellites share the same osculating orbit with a defined longitude separation. In the staring formation, the satellites are placed on an elliptic halo sub-orbit in a plane orthogonal to the Earth orbit radius; in this configuration semi-major axis, eccentricity, inclination and argument of pericentre are the same for all satellites while right ascension of the ascending node and true anomaly are equally spaced on the sub-orbit ellipse. In the sliding formation, each satellite is placed on an elliptic halo sub-orbit different from the others being the eccentricity of the osculating orbit different for each satellite. The station keeping performance requirements have been derived for each of the aforementioned configurations, by means of a semi-analytical orbit propagator which includes the whole set of Earth perturbations. As a further step forward, the guidance strategies have been obtained to correctly respect the relative positions accuracy requisites in terms of ground resolution, coverage and revisit time, which basically reflected in longitude and inclination control box for each spacecraft in the formation. The results are discussed in the paper together with the sensitivity of them with respect to the on-board thrusting units selected.