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MISSION ANALYSIS AND DESIGN OF FAR FLYERS (FRACTIONATED-APERTURE RADAR BASED ON FORMATION FLYING FOR PARASITIC EARTH REMOTE SENSING)

Abstract

This paper presents a preliminary study on the feasibility of a passive distributed radar, realized through a formation of compact satellite receivers flying in Low Earth Orbit (LEO). The cluster is conceived to capture the backscattered echoes of existing space-borne SAR satellites operating in C and X bands. Moreover, it is designed to be rapidly re-configurable. This feature allows the component antennas to change their arrangement in order to perform different multi-static applications, thus overcoming the intrinsic limitations of conventional InSAR techniques, such as along-track interferometry for MTI and cross-track interferometry for DEM generation.

The paper focuses on the analysis of the relative dynamics of the space systems involved. The formation is supposed to work with different transmitters, thus very low altitude orbits (order of 300-350 km) are selected to enhance the number of "conjunctions" with active satellites and to achieve a limited lifetime. Flying the receivers at a completely different altitude from the transmitters (generally orbiting around 500-800 km) makes multi-static acquisitions achievable only at given times, when the along-track separation is below a threshold. Moreover, the difference in altitude implies different perturbing effects on the satellite trajectories, with the cluster being affected by the aerodynamic drag to a greater extent. Firstly the relative motion between the illuminator(s) and the cluster imagined as a single satellite is considered. Two different solutions are investigated, with the receiver "co-rotating" or "counter-rotating" with the transmitter(s). Then the problem of the formation design is addressed, with emphasis on relative trajectories that both satisfy multi-static observation requirements and minimize control efforts. The design approach exploits all the degrees of freedom offered by natural dynamics, on the basis of two main concepts: (a) choosing nominal dynamics that is highly stable in presence of orbit perturbations such as Earth oblateness effect, and (b) designing trajectories that minimize the collision risk using "passively safe" configurations.