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PRECURSOR OF A FORMATION FLYING SYNTHETIC APERTURE RADAR (FF-SAR) BY A CLUSTER OF CUBESATS

Abstract

Formation Flying Synthetic Aperture Radar (FF-SAR) is a specific case of distributed multistatic SAR system, in which many co-flying platforms cooperate with each other to implement new and complex SAR modes, otherwise impossible with the current monolithic systems. No space mission has been realized yet, demonstrating and exploiting FF-SAR properties and peculiarities. Examples of mission concepts for a SAR distributed among several formation flying satellites have been recently proposed based on sub-500 kg class satellites. However, their realization is slowed down by major challenges that still affect the feasibility and the reliability of FF-SAR concept. These include: i) satellite formation flying, intended as the problem of relative motion design (including formation acquisition and reconfiguration) and relative navigation, as well as autonomous formation maintenance, reconfiguration and control; ii) multistatic SAR synchronization, both in time and in phase to enable the suitable coherent combination of signals collected by different platforms; iii) multistatic SAR processing, that is digital beamforming to generate higher performance images/products from the low performance signals collect by each receiver separately. The paper proposes a precursor FF-SAR mission based on a formation of CubeSats (each less than 25 kg) for testing and validating solutions to the above-mentioned challenges. Similarly to NASA CPOD (CubeSat Proximity Operations Demonstration) and Israeli Adelis-SAMSON (Space Autonomous Mission for Swarming and geOlocation with Nano-satellites) missions aimed at formation-flying demonstration by CubeSats, each satellite shall use actuators for formation control, GNSS sensors for accurate orbit reconstruction, and an inter-satellite link to support autonomous formation flying. Multistatic SAR capabilities shall be instead experimentally demonstrated through the collection of signals transmitted by several ground-stations acting as bright radar point targets. This allows for the verification of both synchronization and processing using a very compact payload which reduces to a modified Software Defined Radio (SDR). The paper is focused on mission definition and preliminary design of the main mission elements.