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SIMULTANEOUS INTERFEROMETRIC TRACKING OF A MULTI-SATELLITE GEOSYNCHRONOUS CONSTELLATION FOR GEOSAR MISSIONS

Abstract

LEOSAR missions (Low Earth Orbit Synthetic Aperture Radars) present a main limitation regarding their revisit time of several days or weeks. They cannot provide continuous monitoring over the same area of the planet. In order to mitigate this limitation, the GEOSAR concept (Geosynchronous Synthetic Aperture Radar) aims to provide almost permanent illumination over wide areas of the planet. This work is performed in the context of an on-going GEOSAR mission: Hydroterra will help scientists unravel the details of the daily water cycle. The Advanced Radar Geosynchronous Observation System (ARGOS) is an upgrade in order to enhance its performance. It consists of a multiple-input-multiple-output synthetic aperture radar (SAR) system hosted on a swarm of minisatellites in quasi-geostationary orbits. The real aperture would be achievable in about 40 minutes, enabling applications so far unseen, such as monitoring fast deformations, landslides, and other applications for emergency and security.

GEOSAR missions require unprecedented orbit determination precision (metric scale using autofocus techniques) in order to form properly focused images. In previous works, interferometry has been experimentally validated as a feasible orbit determination technique with the successful tracking of the DVB-S TV broadcasting signals from a single satellite of the non-cooperative ASTRA 19.2°E geosynchronous constellation. The large processing gain of the interferometer allows the system to make use of low gain antennas. Thus, the pointing of the ground receivers is equally valid for all the satellites of the same constellation. In order to simulate the ARGOS configuration, this work explores the simultaneous orbital

tracking of three satellites (ASTRA 1L, ASTRA 1M and ASTRA 1N) by means of a time domain multiplexing approach. The slow evolution of a geosynchronous spacecraft trajectory with respect to Earth allows the system to tune one satellite at a time in intervals of some minutes without losing track of any of them. Therefore, a single interferometer with fixed pointing is capable of precisely tracking different satellites of the same geosynchronous constellation simultaneously. The entire team is supervised by a professor whose original idea started the project. It consists of two PhD students who coordinate the main differentiated areas: hardware development, signal processing and orbit determination. Three undergraduate students work on the design and testing of the hardware modules which acquire the orbit observables. A graduate student and two undergraduates are responsible of the orbital model development, system simulations and orbit retrieval from experimental data.