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INTERFEROMETRIC BASELINE ENLARGEMENT WITH PASSIVE REFLECTORS FOR GEOSYNCHRONOUS ORBIT DETERMINATION PRECISION ENHANCEMENT

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 Hydroterra mission. Hydroterra will help scientists unravel the details of the daily water cycle. Thereby, in the event of natural hazards, they would be able to continuously monitor the development of foods, landslides or subsidence allowing emergency services to safely evacuate the citizens before the disaster. GEOSAR presents a main challenge: it requires unprecedented orbit determination precision (metric scale using autofocus techniques) in order to form properly focused images. Since no GEO mission has ever required such tracking performance, the authors have developed a precise satellite tracking system based on interferometry. It receives the DVB-S TV broadcasting signals from the non-cooperative ASTRA 19.2 E geostationary satellite constellation. The relative phases measured between each pair of antennas are used as orbit observables.

The first iteration of the experiment showed how a separation between receivers of 10 m (compact baseline) is able to reproduce the trajectory of the geosynchronous satellite with poor precision. This work presents the results from the second iteration of the experiment. A set of passive reflectors have been deployed more than 100 m away from the main antenna in order to increase the interferometric baseline. Hence, the sensitivity of the measurements is higher and the orbit determination precision is enhanced. Increasing the baseline is not trivial since the receiver antennas must be clustered within two meters connected by short cables to a common local oscillator in order to preserve phase coherence. Therefore, the team has done a careful design of the passive repeater links, ensuring feasible levels of signal-to-noise ratio at the receiver. Finally, the orbit of the satellite is successfully retrieved by means of an Extended Kalman Filter and a dynamical model which considers the main orbital perturbations at GEO.

The entire team is supervised by a professor whose original idea started the project. It consists of three graduate students who are in charge of three differentiated parts: receiver hardware development, signal processing and orbit determination methods. All the members are involved in the system assembly and deployment.