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EXPERIMENTAL PRECISE ORBIT DETERMINATION FOR GEOSAR MISSIONS BASED ON COMPACT INTERFEROMETRY

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. Thereby, in the event of natural hazards, they would be able to continuously monitor the development of floods, 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, this work is focused on testing experimentally how it can be achieved. Hence, the authors have developed a geosynchronous satellite tracking system based on interferometry. The verification experiment consists of three antennas which form compact (10 m) interferometric baselines. They receive 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 team has developed a model which considers the natural orbit perturbations as well as the periodic orbit maintenance manoeuvres at GEO. The position of the receivers is well known. Thus, an estimation procedure based on least squares use this orbital model in order to determine the trajectory which fits the best into the acquired orbit observations. The results conclude that the orbit determination precision provided by a ten metre baseline interferometer might not be enough to form focused GEOSAR images.

Still, experimental measurements agree with the simulations, proving their reliability. Finally, simulations show that a hundred metre baseline interferometer would yield the required orbit determination precision.

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 parts: hardware development, signal processing and orbit determination methods. All the members are involved in the system assembly. Two students are focused on the design and control procedures of the baseband module of the receiver and the rest work on the orbital model development, system simulations and orbit retrieval from experimental data.