EARTH OBSERVATION SYMPOSIUM (B1)
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MULTIPLE APERTURE EARTH OBSERVATION SYSTEMS

Abstract

In the past, a high functionality of Earth observation payload was always associated with complex, heavy and costly instruments flown on a large spacecraft. Making use of the newest technology developments in the field of miniaturized instruments and space bus systems as well as material and mechanics, capable multi-aperture Earth observation instruments appear feasible in the coming years at a fraction of the cost and development time of their predecessors.

In this article the system design and trade-offs for an innovative Earth observation instrument are described. The synthetic aperture instrument payload platform is based on a cubesat or balloon constellation. This space system engineering topic refers to the trend in pursuing the application of lightweight aerospace structures and small scale optics driven by volumetric restrictions.

The development of dedicated nanosat cameras requires deployable transparent structures to create sufficient collection aperture of the optical instrument. An inventory of the state-of-the-art and newest technologies in the field of optical reflectors and materials will be made. The goal was to come up with a foldable optical system being light weight and small of volume which is part of a small spacecraft.

Stepwise dedicated sytems trade-offs between Attitude Determination and Control System (ADCS), orbit selection and optical resolution (spatial and spectral) are explored for a single spacecraft as well as a constellation. Beside a mechanical systems study for a light-weighted deployable structure, the required and achievable quality of the optics was studied. If a single optical camera had too limited performance in terms of signal-to-noise and spectral and/or spatial resolution, a multiple aperture solution was investigated. This means the application of multiple cameras, each one placed on a different constellation object of either a cubesat, microsat or balloon constellation. The constellation ADCS is the key factor in the validation and qualification of such a solution. This meant that beside the basic optical design also the combined aperture performance had to be characterized in terms of system S/N, radiometric performance and accuracy, opto-mechanical stability and the modulation transfer function. The latter was modelled to enable the breakdown of the resolution budget over the system.

The system study results are mission concepts as well as multi-aperture solutions. Conclusions will be provided on the technical feasibilities, costs and development roadmap.