

TIM: A Small Satellite Formation for Joint 3D Earth Observation

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Abstract

Photogrammetric methods use coordinated joint observations from different viewing angles to generate 3-dimensional images. In “**TOM** – **T**elematics earth **O**bservation **M**ission” a core of 3 pico-satellites enable such technology demonstrations by addressing related attitude control challenges of pointing the 3 satellites continuously to the same surface area. TOM will be augmented by additional 9 satellites in “**TIM** – **T**elematics **I**nternational **M**ission” to further increase 3-dimensional image quality by data fusion methods. This contribution reviews the mission concept, the intersatellite link capacity in X-band, IP-based communication protocols, the related networked control challenges for coordination, mission operations approaches for formation coordination and the implemented test scenarios based on high precision turntables. Specifically precise attitude control to focus on joint target areas is to be simulated by hardware-in-the-loop implementation. This test facility also provides the development and evaluation environment for the sensor data fusion methods to generate the final 3D-image product.

Keywords

Pico-satellites; formation flying; Earth observation

Introduction

Today’s state-of-the-art of multi-satellite systems are constellations consisting of satellites individually controlled from ground control [1]. Few examples exist so far of formations, where self-organizing principles are applied in orbit in order to perform optimal measurements by coordination of the different satellites [2]. The rapid technology progress in the field of pico-satellites [11] enables at a mass of a few kilograms capabilities to realize such formations, as the needed capabilities for attitude and orbit control, as well as for intersatellite communication links and networked controls are emerging [5], [6], [7]. Also standardization approaches help to efficiently implement multi-satellite systems [10], [9]. Thus Cubsats provide excellent opportunities to address now first formation missions in application fields, such as Telecommunications, Space Weather or Earth observation [5].

Photogrammetric Methods

In the “**TOM** – **T**elematics earth **O**bservation **M**ission” [8] 3 pico-satellites carrying cameras are oriented towards the same target area by an appropriate attitude control system. The different perspectives form the basis to apply photogrammetric approaches [3], [4] for sensor data fusion to generate 3-dimensional images of the target area.

Conclusions

For TOM the formation concepts based on a cartwheel orbit, a satellite architectural design by a CubeSat approach and payload camera selection has been done. The related implementation is currently evaluated and tested in a dedicated multi-satellite hardware simulation environment (see Fig.1).



Fig.1: Two precision turntables providing a realistic attitude simulation background for testing the Earth observation characteristics for a satellite formation. The Earth surface model at the ceiling is moving to represent the orbit motion of the satellites.

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