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TOM - ADVANCES IN FORMATION FLIGHT AND DATA PROCESSING

Abstract

Formations of small satellites enable remote observation of Earth's atmosphere and surface from multiple directions simultaneously. This approach provides unprecedented perspectives on processes such as volcanic eruptions and resulting ash clouds. The TOM (Telematics Earth Observation Mission), conducted by the Center for Telematics (ZfT), aims to demonstrate photogrammetric observation of these phenomena using a formation of 3U+ CubeSats.

The photogrammetric evaluation of recorded image data heavily relies on precise temporal synchronization across all three satellites. To ensure suitability for subsequent scientific processing, the time difference between photos taken by different satellites must be minimized, ideally within a few milliseconds. Given that the camera data also serves vision-based attitude control, meticulous timing of image capture becomes paramount to enable concurrent data usage.

In pursuit of precise and coordinated target pointing, a distributed vision-based attitude control approach was developed, as previously introduced. Additionally, a novel image-based navigation method is planned to be tested during the TOM mission. This method enables precise determination of the satellite's position and attitude in the inertial frame by matching known ground control points (GCPs) stored in an onboard database with corresponding points identified in the satellite's camera images.

To evaluate the described time synchronisation, control and navigation capabilities across all satellites in the formation, a multi-satellite camera test environment was designed. This environment comprises configurable elements tailored for various scenarios. The results of these diverse camera and attitude control tests will be presented and evaluated in the forthcoming paper. We will detail the architecture and design of the image capture process. Furthermore, we will delve into the comprehensive scientific processing pipeline, which encompasses data calibration, feature extraction, and georeferencing - all essential steps for accurate photogrammetric analysis. Additionally, the paper will explore the ground station network, which plays a pivotal role in receiving data from our satellite formation. These networked ground stations facilitate seamless communication, data downlink, and synchronization across all satellites.