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The Telematics International Mission TIM for 3D Earth Observation by Pico-Satellites

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Abstract

In space technology there is a trend from traditional large multifunctional satellite towards small networked multi-satellite systems. This encourages the cooperation of partners contributing satellites to a formation or constellation to benefit from the improved data base generated by multiple satellites. Small and very small satellites are here able to complement the traditional large satellites. In this context TIM – the ***T***elematics ***I***nternational ***M***ission realizes a cooperating pico-satellite formation by 7 international partners to generate 3D images for Earth observation. The miniature attitude and orbit control system will enable the satellites to orient the instruments of the planned 9 satellites towards target observation areas. Taking advantage of the different viewing directions by photogrammetric methods related 3D-images are generated, suitable for monitoring of environment pollution, harvesting status, critical infrastructures, and natural disasters (like forest fires, volcano activities, earthquakes).
The technology challenge enabling pico-satellite formation addresses:

- networked, cooperating, small satellites, operating autonomously with minimum ground station interaction;
- developing modular, robust small satellites.

Essential subsystems needed for a formation are: the attitude and orbit determination and control system, the telecommunications system capable of inter-satellite and satellite-to-ground communication, as well as electrical propulsion for orbit control and formation maintenance. Precursor missions of the partners in this international team prepared the expertise the relevant areas in satellite research for this challenging pico-satellite formation flying application. Thus by the international cooperation a challenging and innovative Earth Observation Mission can be realized.

Keywords: pico-satellites, satellite formation, Earth observation, 3D-images, disaster monitoring

1. Introduction

Small satellites encountered in the last decennial an evolution from initial motivating educational projects [4] towards professional scientificapplication projects [8]. By combining several satellites into a cooperating sensor network in orbit the performance can be significantly increased. This very active and challenging research field is well documented by example in [1], [2], [3], [5], [6], [7].

This publication emphasizes the effect that satellite formations offer excellent opportunities to combine satellite contributions from different international partners into one formation in order to realize an interesting mission. In the ***T***elematics ***I***nternational ***M***ission TIM contributors from 5 continents cooperate in realizing a satellite formation composed of 9 pico-satellites for Earth observation.

2. Mission objectives

The aim of TIM is the use of photogrammetric methods to image by cameras specific Earth surface areas from different perspectives. This way 3D images of the target area can be generated.

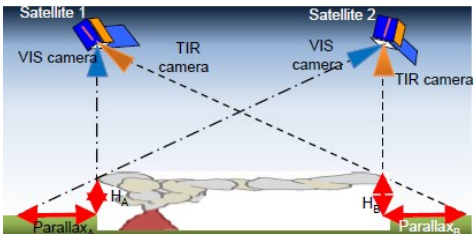

Fig. 1. Photogrammetric principle at the example of imaging an ash cloud from a volcano eruption

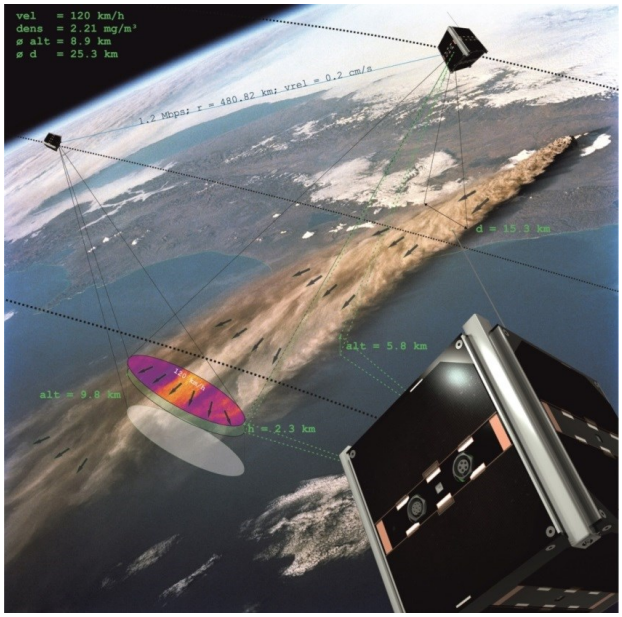

Fig. 2. Three pico-satellites imaging jointly by a coordinated attitude control the target surface area

In order to integrate components from different partners at satellite level, for electrical interfaces the UNISEC Europe standard (http://unisec-europe.eu/standards/bus/) was adopted. Thus each individual satellite can use in a flexible way contributions from all partners.
At system level of the formation, the coordination of attitude control via the inter-satellite link of all individual satellites is most essential in order to guarantee that all cameras are oriented towards the same target area.

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3. Conclusions

The components from different international partners are integrated by employing the UNISEC standard for electrical interfaces. To build up a satellite formation, it is essential to establish a joint specification of the attitude and orbit control capability as well as of the inter-satellite communication standard in order to coordinate the satellites. On this basis, sensor networks composed of distributed satellites for challenging application scenarios can be realized. In the ***T***elematics ***I***nternational ***M***ission TIM, in particular 3D Earth observation by photogrammetric methods will be enabled. Thus the potential of a collaboration for combining capabilities from international partners in order to enable a challenging pico-satellite mission will be emphasized.

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