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CUBETH: NANO-SATELLITE MISSION FOR ORBIT AND ATTITUDE DETERMINATION USING
LOW-COST GNSS RECEIVERS

Abstract

The CubETH satellite is a cooperative Swiss CubeSat mission involving Swiss Federal Universities (EPF Lausanne and ETH Zurich), Universities of Applied Sciences and Swiss companies. The main objective of CubETH is to demonstrate new technologies in the area of GNSS-based navigation and use of COTS components. The satellite will carry five GNSS patch antennas, each connected to two independent u-blox multi-GNSS receivers. These very small, commercially available low-cost receivers are able to track single-frequency code and phase data of all the major GNSS, i.e. GPS, GLONASS, QZSS, Beidou (and ready for Galileo). This project makes intensive use of COTS technologies for microelectronics. To mitigate risk, we started the project with numerous tests to study the behavior of the receivers in the intended space environment and to evaluate their usability for space applications.

Four main science objectives have been defined for the CubETH mission: (1) precise orbit determination using low-cost GNSS receivers, (2) attitude determination based on very short baselines, (3) comparison of the performance in space between GPS and GLONASS (and possibly other GNSS) as an important step for further developments of space-borne GNSS receivers, (4) additional experimental measurements (e.g. for air density estimation during re-entry). The satellite will carry 3 retro-reflectors to enable satellite laser ranging for performance validation of the precise orbit determination.

Novel Cubesat technologies will also be tested. We will take into account lessons learned from the SwissCube mission, which is in operation since 2009. A new modular design for the structure as well as connectors will be flown. We also intend to demonstrate the use of a miniaturized low-power command and data handling system, which shall control the satellite. In this paper, we will present the reasons for new technologies, based on our experience with SwissCube.

Beyond these scientific and technological goals, CubETH will be a milestone for the Swiss space community. From the educational point of view, CubETH provides a valuable practical experience for students in space technologies, geodesy, computational and electrical sciences involved in the project. Participating institutions and industrial partners benefit from the joint development of seminal nano-satellite concepts and miniaturized components. This will be important concerning future formation flying and constellation missions, where miniaturized, inexpensive satellites and sensors are crucial. Overall, the space community in Switzerland will benefit from the CubETH mission by the acquisition of relevant expertise and technology for future small satellite missions.