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NETSAT - A FORMATION OF FOUR 3U-SATELLITES USING ELECTRIC PROPULSION

Abstract

NetSat (Networked Satellite Distributed System Control) is a mission consisting of four 3U Satellites and is set to be launched in the Summer of 2020. Formation control using electric propulsion and inter-satellite communication will be demonstrated in orbit for the first time using nano-satellite platforms. Furthermore, miniaturized reaction wheels will be employed on each satellite for attitude control and coordinated pointing maneuvers. Automated manufacturing has been explored during development and state-of-the-art integration processes, including robotic and sensory augmentations, are used for subsystems and solar cell positioning. Additionally, innovative testing procedures have been developed specifically for formations of multiple small satellites. The NetSat formation will be launched into LEO with minimum relative velocities, which are ensured by fine tuning of the deployer springs and the ejection sequence. After commissioning, various formation topologies will be tested and the capabilities of each subsystem, as well as the combined satellite network, will be explored. The satellites are based on an extended UNISEC Europe system bus, which has been developed and successfully tested on the UWE satellites. As an alternative to the commonly used PC/104 architecture, the UNISEC-Europe system bus has been developed and successfully flown on multiple 1U CubeSats. Using a modular and flexible backplane design, the satellites are optimized towards size, mass, and energy efficiency. Redundancy in data and power lines in addition to a cutting-edge software-based radiation shielding provides a very robust and extremely reliable alternative to traditional CubeSat designs. The attitude determination and control system of the satellites is based on a distributed approach, which places sensors and actuators not only on the ADCS board, but also on the solar panels. These reaction wheels are supported by magnetorquers, which provide additional attitude control and desaturation options, if needed. Attitude data is acquired with the help of multiple sun sensors during the illuminated part of the orbit. Miniature GPS sensors are used to obtain orbit data, which is exchanged via the UHF inter-satellite link. Formation control will be performed autonomously on the satellites and will follow a model predictive control approach to compute optimal continuous thrust maneuvers and minimize fuel and power consumption. This paper will focus on the formation aspects of the NetSat mission, explaining in detail each subsystem's contribution to coordinated, networked satellite control.