SPACE SYSTEMS SYMPOSIUM (D1)
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NETWORKED CONTROL OF DISTRIBUTED PICO-SATELLITE SYSTEMS

Abstract

A paradigm shift is emerging in spacecraft engineering from single, large, and multifunctional satellites towards cooperating groups of small satellites. This will enable innovative approaches in areas like Earth observation, science exploration or telecommunication. Crucial interdisciplinary key challenges in formation control and in networked satellites are topic of this contribution.

Modern miniaturization techniques allow realization of satellites with continuously smaller masses, thus enabling cost-efficient implementation of distributed multi-satellite systems. In preparation, our team has already realized two satellites at only 1 kg mass in the University Würzburg's Experimental satellite (UWE) program, emphasizing core components for formation flying, like communication (UWE-1, launched 2005) and attitude determination (UWE-2, launched 2009). In 2013 attitude control (UWE-3) based on integrated magnetic torquers and one reaction wheel, as well as orbit control (UWE-4) by an electric propulsion system on basis of vacuum arc thrusters are prepared for demonstration in orbit.

As next step formation control for four pico-satellites in-orbit are analyzed. This objective requires innovative multi-satellite networked orbit control based on relative position and attitude of each satellite. Related sensor systems used are already tested in our laboratory in research for cooperating teams of mobile robots, and will be transferred to the space environment. Breakthroughs are expected by combining optimal control strategies for coordination of relative motion with a robust flow of information in the network of satellites and ground stations, implemented via delay tolerant networks and ad-hoc networks in space. This approach should offer the basis to demonstrate autonomous distributed formation control in orbit.

This distributed system design is expected to open up significant application potential for future satellite services in Earth and Space Weather observations based on multipoint measurements.