TECHNOLOGY DEVELOPMENTS FOR PICO-SATELLITE FORMATIONS AND THEIR APPLICATION POTENTIAL IN SPACE WEATHER AND EARTH OBSERVATIONS

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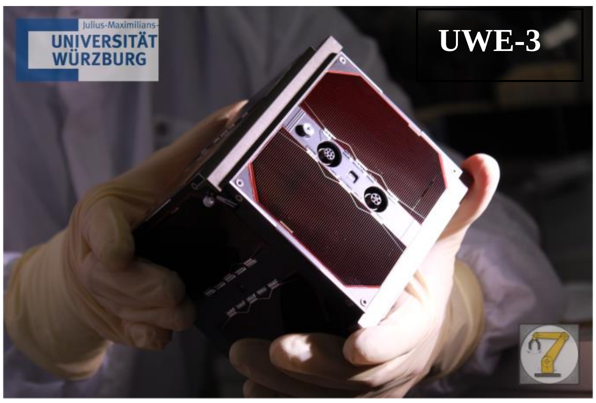
Abstract

Progress in small satellite technologies supports realization of distributed, networked multi-satellite systems at similar costs like traditional multi-functional single satellites. Even at the size of pico-satellites (with a mass of about 1 kg) suitable instruments have been developed for detection of electromagnetic fields and waves, radio waves, plasma and particles, photometers and imagers (in a spectrum range including near IR, UV, X and gamma rays) [8] [7]. Thus the pico-satellites currently move from educational projects [14], [10] towards commercial applications [5], [7]. This offers perspectives for innovative measurement approaches by satellite formations in fields like interferometry, gravimetry, distributed telescopes, virtual apertures [4], [1]. Here the significant baseline distance between detectors, placed on different satellites of the formation, offers advantageous observation conditions. The objective of this contribution is to provide a survey on suitable sensors for pico-satellites and their application potential in formations, as well as the technology base to realize pico-satellite formation missions.

So far multi-satellite systems have been mainly realized in form of constellations, where each satellite is individually controlled from ground (examples include GPS, CLUSTER, Rapid Eye, IRIDIUM). Only recently formations of two satellites have been realized, based on relative distance measurements and a closed control loop in space in order to autonomously coordinate position and orientation (missions like GRACE, Tandem-X, PRISMA) [1], [4].

At the pico-satellite level, currently QB50 (www.qb50.eu) addresses a constellation of about 50 spacecraft for multipoint in-situ observations of the poorly explored lower thermosphere (90 - 380 km altitude), to be launched 2016 by a Cyclone-4 from Brazil. There is currently much academic interest for further small satellite constellation missions [9]. The UWE-program (***U***niversity ***W***uerzburg's ***E***xperimental satellites) has its scientific focus on enabling technologies for formation flying at pico- or nano-satellite level [12], [11], [13]. For this purpose several pico-satellites at a mass budget of 1 kg had been realized and tested in orbit: UWE-1 (launched 2005, [3], [10]) addressed communication based on Internet Protocols for networks in the space environment. UWE-2 (launched 2009) and UWE-3 (launched 2013, [2]) had emphasis on attitude determination and control. Foreseen for launch in 2015, UWE-4 will test an electrical propulsion system based on vacuum arc thrusters for orbit control [6]. After this, all crucial technologies have been prepared and tested in orbit. As next challenge formation flying with four very small satellites will be demonstrated in the NetSat-mission, planned for launch in 2017.



This contribution will address details of related technology developments for pico-satellites as well as for sensor systems with respect to the two candidate mission profiles related to gradiometry and to optical multi-perspective observations.

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