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USING CUBESAT/MICRO-SATELLITE TECHNOLOGY TO DEMONSTRATE THE AUTONOMOUS ASSEMBLY OF A RECONFIGURABLE SPACE TELESCOPE (AAREST)

Abstract

Future space telescopes with diameter over 20 m will require new approaches: either high-precision formation flying or in-orbit assembly. We believe the latter holds promise as a potentially lower cost and more practical solution in the near term, provided much of the assembly can be carried out autonomously. To gain experience, and to provide risk reduction, we propose a combined mico/nano-satellite demonstration mission that will focus on the required optical technology (adaptive mirrors, phase-sensitive detectors) and autonomous rendezvous and docking technology (inter-satellite links, relative position sensing, automated docking mechanisms). The mission will involve two "3U" Cubesat-like nanosatellites ("MirrorSats") each carrying an electrically actuated adaptive mirror, and each capable of autonomous un-docking and re-docking with a small central "15U" class micro/nano-satellite core, which houses two fixed mirrors and a boom-deployed focal plane assembly. All three spacecraft will be launched as a single 40kg micro-satellite package. The spacecraft busses are based on heritage from Surrey's SNAP-1 and STRaND-1 missions (launched in 2000 and 2013 respectively), whilst the optics, imaging sensors and shape adjusting adaptive mirrors (with their associated adjustment mechanisms) are provided by CalTech/JPL. The spacecraft busses provide precise orbit and attitude control, with inter-satellite links and optical navigation to mediate the docking process. The docking system itself is based on the electromagnetic docking system being developed at the Surrey Space Centre (SSC), together with rendezvous sensing technology developed for STRaND-2. On orbit, the mission profile will firstly establish the imaging capability of the compound spacecraft before undocking, and then autonomously re-docking a single MirrorSat. This will test the docking system, autonomous navigation and system identification technology. If successful, the next stage will see the two MirrorSat spacecraft undock and re-dock to the core spacecraft in a linear formation to represent a large (but sparse) aperture for high resolution imaging. The imaging of stars is the primary objective, but other celestial and terrestrial targets are being considered. Teams at CalTech and SSC are currently working on the mission planning and development of space hardware. The autonomous rendezvous and docking system is currently under test on a 2D air-bearing table at SSC, and the propulsion and precision attitude control system is currently in development. Launch is planned for 2015. This paper details the mission concept, technology involved and progress to date.