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AN ACTIVE ATTITUDE CONTROL SYSTEM FOR A DRAG SAIL SATELLITE

Abstract

The paper will describe the development and in-orbit commissioning results of the full ADCS subsystem for the DeOrbitSail drag sail mission. The DeOrbitSail satellite was developed as part of an European FP7 collaboration research project. The satellite will be launched and commissioned in May 2015. Various new control and estimation algorithms, actuators and sensors designed for this mission will be presented. The DeOrbitSail satellite is a 3U CubeSat deploying a 4 by 4 meter drag sail from a 650 km circular polar low earth orbit. With an active attitude control system it will be shown that by maximising the drag force, the expected de-orbiting period from the initial altitude will be less than 50 days. A future application of this technology will be the use of small drag sails as low-cost devices to de-orbit LEO satellites (when they have reached their end of life), without having to use expensive propulsion systems.

Simulation and Hardware-in-Loop experiments proved the feasibility of the proposed attitude control system. A magnetic-only control approach using a Y-Thompson spin, is used to detumble the 3U Cubesat with stowed sail and subsequently to 3-axis stabilise the satellite to be ready for the final deployment phase. Minituarised torquer rods, a nano-sized momentum wheel, attitude sensor hardware (magnetometer, sun, earth) developed for this phase will be presented. The final phase will be to deploy and 3-axis stabilise the drag sail normal to the velocity vector, using a combined Y-momentum wheel and magnetic controller. The design and performance improvements when using a 2-axis translation stage to adjust the sail centre-of-pressure to satellite centre-of-mass offset, will also be discussed, although for launch risk reasons this stage was not included in the final flight configuration. To accurately determine the drag sail's attitude during the sunlit part of the orbit, an accurate wide field of view dual sensor to measure the sun vector and nadir vector was developed for this mission. The in-orbit performance and calibration results for this new Cubesat sensor (CubeSense), will also be presented.