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ATTITUDE CONTROL ACTUATORS, SENSORS AND ALGORITHMS FOR A SOLAR SAIL CUBESAT

Abstract

The paper describes the development of the full ADCS subsystem for a small 3U Cubesat solar sail mission. The various new control and estimation algorithms, actuators and sensors designed for this mission will be presented. The Cubesail mission will deploy a 5 by 5 meter solar sail from at least a 750 km circular polar low earth orbit to limit the effect of aerodynamic drag and maximise the influence of solar radiation pressure on the deployed sail. This proof of concept will demonstrate an one degree change in the orbit inclination over a period of less than a year due to solar sailing. The mission aim will therefore be to validate existing solar radiation pressure models. A future application of this technology will be to use small solar sails to deorbit LEO satellites without the use of an expensive propulsion system. 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 stabilise the sail during the deployment phase. Minituarised torquer rods and magnetic sensor hardware developed for this phase will be presented. The next phase will be to despin the deployed sail and to 3-axis stabilise the sail normal to the orbital plane, using a 2-axis translation stage for attachment of the sail to the Cubesat bus. An improved new controller including a nano Y-momentum wheel will be discussed and the performance results presented. To accurately determine the solar 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. The performance and calibration results for this new Cubesat sensor, named as CubeSense, will also be presented.