ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics - Part 2 (6)

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SOLAR SAIL ATTITUDE CONTROL USING CENTRE OF MASS/CENTRE OF PRESSURE OFFSET TECHNIQUES

Abstract

The recent launch of IKAROS, the first successful solar sail spacecraft, by the Japanese Space Agency together with a number of proposed new demonstrator missions has triggered a renewed interest in solar sail propulsion. Several different attitude control systems have been proposed in the past. Due to the large inertia of these deployable structures, the constant centre of mass (CM)/ centre of pressure (CP) offset disturbance acting on the sail and long solar sail mission durations, conventional spacecraft actuators are not suitable for sail attitude control. This paper presents two methods in controlling the sail attitude: the trim control mass (TCM) actuator and a new novel translation stage method. These methods utilize the CM/CP offset to provide the control torques required to maintain and correct the attitude of solar sails. The trim control method consists of moving masses running through the mast booms, to change the position of the centre of mass. This paper presents the theoretical development of this method and its experimental validation. An air-bearing table is used to provide a frictionless environment and facilitate the ground demonstration. This method has been successfully implemented using a proportional controller with cascaded lead compensators. A comparison between the simulation and experimental results of the ground experiment is presented along with simulation results for a Solar Sail. A new type of actuator will be presented based around a translation stage. The translation stage consists of a pair of low profile re-circulating ball linear slides per axis. This new translation stage has the advantage of decoupling the attitude control from the deployment, it does not add any parasitic control mass and can easily be scaled for larger missions. This system was developed for the Cubesail mission, an EADS Astrium funded 3U cubesat solar sail demonstrator, designed and built at the Surrey Space Centre. A first prototype has already been built with a second version under development. The translation stage is 100x100x27.22mm in size, has a mass of 150g and can displace the bus by 42mm. The redesigned translation stage will be constructed and tested on the airbearing table, similar to the TCM system.