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COUPLED ORBIT-ATTITUDE CONTROL OF A HIGH AREA-TO-MASS RATIO SATELLITE

Abstract

A high area-to-mass ratio (HAMR) space-chip satellite is highly perturbed by environmental forces, which is comparable with or even larger than central-body disturbation of earth which causes lots of interests in past few years. This feature contributes to coupled orbit and attitude dynamics of a HAMR satellite and the possibility to control the orbit trajectory with attitude controller. Thus, this paper investigates how environmental forces, such as solar radiation pressure and atmospheric drag, can be utilized in orbit control with active control by a small-reaction device of attitude control system. An average technique is used here to deal with the asymmetric solar radiation pressure, in the presence of shadow of earth, and a coupled orbit-attitude control is designed, in an averaged orbital elements sense to ensure a long-term lived orbit of a HAMR satellite. By averaging the control operators, averaged controllability is to estimate the orbital elements of the time-variant system, out of partial measurements, done on the average with respect to the unknown parameters. Under averaged control, attitude deviation and orbital deviation can be both eliminated. With mission requirements and unexpected disturbing forces, orbit transfer problems are studied, showing the satellite can transfer to another stable equilibrium orbit from the initial position. This work can be regard as a reference in single HAMR satellite application or designing long-lived earth-centered orbits for swarm of micro-scale HAMR devices in space.