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ATTITUDE AND RELATIVE MOTION CONTROL OF SATELLITES IN FORMATION FLYING VIA SOLAR SAIL WITH VARIABLE REFLECTIVITY PROPERTIES

Abstract

Utilization of a group of satellites, for example formation flight, brings new possibilities in space missions. They can be used for distributed data gathering. In addition, group of satellites is more reliable because even if one satellite fails, others can continue their operation.

The main problem of formation flying utilization is the deployment and maintainence of particular group configuration. The simplest solution for this problem is to use thrusters that are installed onboard all or several satellites. On the other hand, thrusters require propellant, which can greatly affect the satellite lifetime or the payload mass. There are also several fuelless techniques for formation maintaining, e.g. the aerodynamic force or solar radiation pressure utilization. Both concepts do not require propellant but it is vital for the satellites to have the attitude control system because in this case the control force depends on the satellite cross-section area.

In this paper we suggest an algorithm of simultaneous relative motion and attitude control via solar radiation pressure that allows us to deploy and maintain the given formation of two satellites. The principle idea is to use special materials for solar sail that are able to change its optical properties. It is considered that solar sail is divided into a number of cells. Each of them can be absolutely black, i.e. it absorbs completely the solar radiation, or absolutely specular (white), i.e. it reflects all solar radiation. The necessary control force is developed by varying the average reflectivity of solar sail, and the control torque is achieved by the appropriate pattern of black and white cells.