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SIMULTANEOUS ORBIT-ATTITUDE CONTROL OF FORMATION FLYING SOLAR SAILS AROUND SUN-EARTH L2 USING REFLECTIVITY MODULATION

Abstract

Satellite formation flight has been long proposed as a means to achieve very large apertures for high spatial resolution optical astronomy. This is because while achievable spatial resolution is proportional to aperture size, there is a physical limit to the achievable aperture size for satellite-mounted monolithic telescopes. Formation flight interferometry can achieve resolution equivalent to that of a large telescope by distributing the optical elements and adjusting the observation baseline between spacecraft. This concept, however, requires extremely precise relative position control. In this study, it is proposed to perform this formation-flight interferometric observation around the Sun-Earth L2 libration point. The L2 point was chosen as it is particularly suitable for astronomical mission because of its extremely stable thermal and communication environment. This advantage is further enhanced by selecting a halo orbit with an artificially reduced radius. Using the artificial halo orbit as the reference orbit, a new formation flight in the vicinity of the reference orbit is proposed. Considering the use of solar sails, it is found that orbit tracking is possible with a thrust order of the solar sail because of the proximity of the equilibrium point. This allows formation flights for interferometric observations to be achieved without fuel consumption by using a solar sail. Previous work by the authors has shown that formation orbits for interferometric observations here can be achieved with solar radiation pressure. As a first level study, the attitude and the output of reflectivity control devices were taken as control inputs to be chosen freely. A reflectivity control device is a device that can change optical characteristics by applying a voltage. The required thrust is achieved by changing the thrust direction according to the sail's attitude and the thrust norm according to the reflectivity control device. The reflectivity control device is affixed to the sail, and the throttle is adjusted by the ratio of ON/OFF. As a follow up, this study establishes a switching control system that simultaneously adjusts thrust for trajectory tracking and torque generation for attitude tracking by kneading the attitude motion. The ON/OFF ratio history of the reflectivity controller for orbit control is determined. This constrained simultaneous control is a problem unique to this study in situations where thrust and torque change simultaneously due to inputs from the reflectivity control device. This simultaneous control is achieved by biasing the ON/OFF distribution of the devices for torque generation.