IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IPB)

Author: Mr. Fuqiang Duan
National University of Defense Technology, China

Mr. Hongyi Xie
Politecnico di Milano, Italy
Prof. Franco Bernelli-Zazzera
Politecnico di Milano, Italy

RCDS-BASED FEEDBACK CONTROL OF A SOLAR SAIL SPACECRAFT AT THE EARTH-SUN L1 POINT WITH DUAL POINTING REQUIREMENTS

Abstract

This paper presents a novel station-keeping control strategy for a solar sail spacecraft equipped with rotational attachment at the Earth-Sun L1 point in a year. The integrated spacecraft comprises a solar sail featuring Reflectivity Control Devices (RCDs) responsible for orbital station maintenance and attitude control, and a sizable rotational laser communication apparatus for signal transmission. The laser communication device maintains alignment with a relay communication satellite in Geostationary Orbit (GSO).

This concept can be as an example adopted to design and operate a spacecraft embedding a powerful supercomputer exploiting the huge solar power available at the L1 point while keeping permanent communication link with ground, thus facilitating large-scale offline analysis and computation.

A sliding-mode attitude tracking controller is devised to counteract the disturbed angular momentum led by the rotational attachment and further ensure the precise sun-toward orientation of the sail plane, maximizing the absorption of the sun's power. Additionally, an orbital station-keeping scheme is formulated to uphold the spacecraft's mass center precisely at the Earth-Sun L1 point. Half of the RCDs are activated while the remainder remain closed at this Lagrange point. To counter deviations from this ideal position, more than half of the RCDs are opened to increase Solar Radiation Pressure (SRP) when the spacecraft drifts towards the Sun, while the reverse occurs when it drifts towards the Earth.

Moreover, the orbital station-keeping algorithm adjusts the states and the distribution of active RCDs based on the requirement of attitude tracking, incorporating orbit-attitude tracking considerations into both attitude control and orbital station maintenance strategies. This integrated approach ensures precise positioning and attitude control of the solar sail spacecraft, enabling efficient utilization of solar radiation for propulsion and communication purposes at the Earth-Sun L1 point.