ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics - Part 1 (3)

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STATION KEEPING OF A SOLAR SAIL IN THE SOLAR SYSTEM

Abstract

Solar sails are a concept of spacecraft propulsion where one takes advantage of the solar radiation pressure to propel a spacecraft. A first approach to model the dynamics of a solar sail is to consider the Circular Restricted Three Body Problem (CRTBP) adding the solar radiation pressure. In this framework, the effect of the solar sail creates a family of "artificial" equilibria parametrised by the orientation of the sail.

These equilibria offer interesting mission applications such as Geostorm Warning Mission or Polar Observer, where a solar sail must remain close to a fixed location. In previous works [1,2] we have used dynamical systems tools to derive a station keeping strategy for a solar sail close to an equilibrium point.

The main idea is to obtain the dynamical properties of the phase space in the vicinity of an equilibrium point for a fixed sail orientation, and to understand how these properties vary when we vary the sail orientation. Then we can find a sequence of changes in the sail orientation so that the system acts in our favour, managing to maintain the trajectory of the sail close to the equilibrium point.

We have already tested this station keeping algorithm with GeoStorm and Polar Observer missions [1]. During the simulations we have considered the CRTBP + solar radiation pressure as a model, including random errors on the position and velocity determination as well as errors on the sail orientation. We have seen that the errors in the sail orientation are the most relevant.

In this work we extend this study considering a more realistic model, including the gravitational effect of other planets. Our first goal is to check the robustness of the algorithms in a more realistic setting. We also propose to study the effect of errors both in the determination of the position of the probe and in the orientation of the sail, in a similar way it was done in [1].

References:

[1] A. Farres and 'A. Jorba. Dynamical system approach for the station keeping of a solar sail. The Journal of Astronautical Science, 58(2):199-230, 2008.

[2] A. Farres and À. Jorba. Solar sail surfing along families of equilibrium points. Acta Astronautica, 63:249-257, 2008.