Research Project 2 - Optimal Control of a Solar Sail at the Vicinity of L1

Student: Naama Gilat*
Advisors: Vitaly Shaferman† and Oded Golan‡
Technion - Israel Institute of Technology, Haifa 3200003, Israel

I. Abstract

The objective of the present work is to lay the foundations for the control problem of a sailcraft (solar sail spacecraft) formation, placed at the shifted inner Lagrange point L_1', acting as a sunshade for cooling the Earth. To this end, the current study focuses on the dynamics of a single sailcraft in this region. In the first part of this work, the results obtained by Bookless and McInnes [1] are reproduced. It includes deriving Hill's equations of motion with a solar sail, zero velocity surfaces, Lissajous orbit, and an infinite horizon LQR controller to track the orbit using only two attitude angles. In the second part, a manifold of equilibrium points around L_1' is found, and the controllers ability to maintain the sailcraft on it is demonstrated. For future work, we aim to incorporate perturbations into the simulation, derive a new controller with reflectivity control, and evaluate the controller's robustness. Then, a formation of sailcraft will be considered, tasked with maintaining position on the manifold, keeping bounded distances, and properly shading Earth.

References

[1] John Bookless, Colin R. McInnes, "Control of Lagrange Point Orbits Using Solar Sail Propulsion," *Acta Astronautica*, Vol. 62, 2008.

*Undergraduate student, Faculty of Aerospace Engineering. E-mail: naamagilat@campus.technion.ac.il
†Associate Professor, Faculty of Aerospace Engineering. E-mail: vitalysh@technion.ac.il
‡Full Research Fellow, Faculty of Aerospace Engineering. E-mail: oded.golan@technion.ac.il