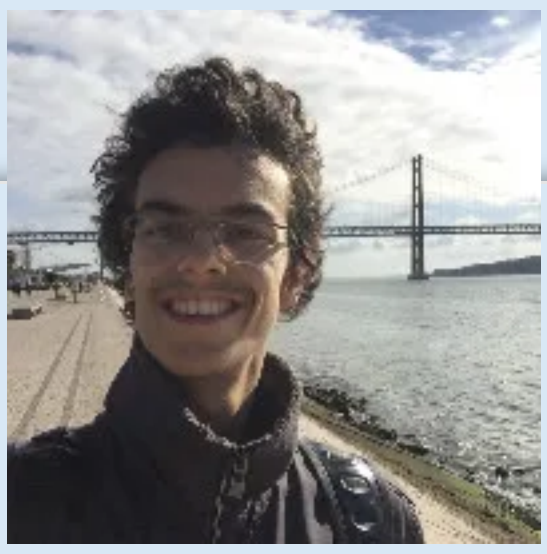
CUBESAT DEVELOPERS WORKSHOP

HOME

Preliminary Trajectory Design of a CubeSat Mission to a Near-Earth Object

This work was developed at Instituto Superior Técnico, University of Lisbon, in the context of a MSc thesis in Aerospace Engineering. The thesis and extended abstract are available here.



Vasco H. A. Grilo

Recent graduate of the Integrated Masters in Aerospace Engineering from Instituto Superior Técnico (University of Lisbon).

Tiago Hormigo

Company Founder and Head of Space Business Development at Spin.Works.

Paulo J. S. Gil

Assistant Professor at Instituto Superior Técnico (University of Lisbon).

Abstract

Comets and asteroids offer insight into planetary formation, space resources exploitation, and collision mitigation techniques for planetary defence. On the other hand, the CubeSat paradigm, which led to a reduction in entry-level costs of more than an order of magnitude for low Earth orbit missions, is expected to be extended to interplanetary missions in the 2020s. The present work performs a preliminary trajectory analysis for a CubeSat mission departing from a geosynchronous transfer orbit to a near-Earth object, assuming a maximum mission duration of 3 years and an initial CubeSat mass of 16 kg. The goal is maximising the spacecraft final-to-initial-mass ratio for each of the trajectory concepts assessed. The Earth departure is modelled as multiple finite apogee raising manoeuvres, enabled by a high-thrust stage, leading to a parabolic escape. The interplanetary transfer is based on the patched conics method, and is modelled via: Lambert Problem impulsive manoeuvres at the Earth departure and target arrival, performed by the high-thrust stage, ending in a flyby or rendezvous; or a continuous low-thrust transfer, powered by the CubeSat, ending in a rendezvous. The low-thrust transfer concerns a smaller and less launch date dependent initial spacecraft mass, thus it tends to offer a lower launch cost, more piggyback flight opportunities, and greater launch date flexibility.