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LOW-THRUST TRAJECTORY DESIGN AND MARS ORBIT INSERTION STRATEGIES FOR INTERPLANETARY CUBESATS

Abstract

Despite first being imagined as an educational tool, CubeSats are widely understood to be revolutionizing space exploration today. Their versatility, small dimensions, short development period and high return-to-cost potential make them attractive options for technology demonstration, scientific studies and commercial purposes. They are increasingly attractive for applications beyond Earth orbit.

This paper focuses on interplanetary CubeSats in Mars orbit. It considers Earth-Mars trajectory design from launch to Mars Orbit Insertion (MOI). Three CubeSat options (3U, 6U and 12U) are assessed and compared, taking into account different low-thrust propulsive technologies such as gridded ion thrusters and Hall-effect thrusters. The interplanetary Earth-Mars transfer is modelled with finite manoeuvres using the open-source tools PyKEP and PyGMO, allowing for interplanetary trajectory optimizations. Several options for orbit capture at Mars are evaluated to cover different mission profiles depending on the arrival conditions and targeted orbital parameters.

In this context, this paper provides a useful baseline for the trajectory design of interplanetary CubeSats missions to Mars and shows that CubeSats can successfully be integrated to support interplanetary missions.