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ANALYSIS OF THE ROBUSTNESS AND MISSION PERFORMANCE OF A CUBESAT ORBITING A BINARY ASTEROID SYSTEM.

Abstract

ESA's Hera mission plans to visit the binary asteroid system called Didymos to analyse the effect of an impactor, launched earlier by NASA, on the secondary body of the system. Part of this mission is the release of a CubeSat called Juventas into orbit around the system to observe the secondary in more detail while minimizing station keeping costs and relaying as much scientific data as possible. The goal of this research is to analyze several possible orbits for this CubeSat in more detail to determine its robustness against uncertainties present in both the dynamical model and the state of the spacecraft. Furthermore, several performance metrics will be devised that will determine how well the different objectives of the mission are met as a function of the specific orbit that is chosen and the model and state uncertainties. A high fidelity simulator is constructed that includes the non-spherical gravity of both the primary and secondary body, the solar radiation pressure of the Sun, and a rotational model of both the bodies. A novel method based on the expansion of the dynamics in terms of polynomials called the Generalised Intrusive Polynomial Algebra is used to propagate the uncertainties, which allows for a more thorough analysis of the dynamics of each orbit and also gives an indication on the robustness and bounds of the motion of the spacecraft. Using the resulting states of both the spacecraft and the secondary for a variety of different orbits, a more in depth analysis is performed on the performance against several scientific and mission objectives to determine which orbits can meet the requirements set by the mission designers. This research provides both a better idea of the effects of uncertainties on the motion of the spacecraft and the mission performance of the Juventas CubeSat, and additionally allows mission planners for future missions to determine the desired orbits around asteroids in a more time efficient and robust manner.