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OPTIMAL CONTROL OF A CONSTELLATION OF TWO SUN-SYNCHNOROUS MARTIAN ORBITERS

Abstract

In this article, the optimal control analysis for a notional constellation of two sun-synchnorous Martian orbiters(Orb-A and Orb-B) is described that provides consistent illumination and efficient coverage. The first part of this article focuses on the optimal control of the Orb-A/B orbiting the Mars in a constant sun-synchronous orbit. The perturbations due to the gravitational force from Phobos, Deimos, Sun and the non-spherical gravity field of the Mars are utilized as a framework for deriving the equations of motion of the spacecraft. A nonlinear model is developed that describes the dynamics of the system and the model is converted into a linear-like structure. Control accelerations are found to maintain the spacecraft in the constant orbit by employing an optimal nonlinear control approach, known as the State Dependent Algebraic Riccati Equation i.e. the SDRE technique. Numerical results are presented and analyzed. The second part of this article focuses on the optimal control of the constellation of two sun-synchnorous satellites that provides the maximum coverage and minimum revisit time for mapping. The same optics camera is loaded in Orb-A and Orb-B that provides efficient imaging for mapping. A design optimization approach is demonstrated using the constellation of Orb-A and Orb-B in the same plane that provides the maximum coverage and at the same time provides minimum revisit time. The sensitivity of this coverage in the presence of perturbations forces is determined, and control strategies are found to maintain the optimization coverage. Results are given for the different ground point and area targets. In the last part of the paper, an interesting application scheme is discussed at the end of the constellation lifetime. Orb-A is controlled to land on the desired Martian ground and Orb-B is manoeuvred into a special orbit with daily repeating ground traces. Then the Orb-A landing ground is visited by Orb-B that repeats at the same time every solar day. Numerical Results are analyzed for control accelerations maintaining the Orb-B in the constant sun-synchronous orbit with daily repeating ground traces.