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Space Mission & Campaign Design

RENDEZVOUS MISSION DESIGN AND DEFLECTION OF ASTEROID 2023 PDC

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ABSTRACT

The hypothetical asteroid impact scenario proposed for the 2023 IAA Planetary Defense Conference (PDC), is used as a reference to study the deflection of fictitious asteroid 2023 PDC by utilizing the ephemeris data provided by the organizers of the conference. This paper deals with the conceptual design of a low-thrust rendezvous trajectory to the asteroid using the shape-based method of Finite Fourier Series (FFS). Porkchop plots based on ΔV and V_{∞} are constructed to analyze mission feasibility. Launch dates are chosen based on the porkchop plots so that the mission is optimized. Various deflection techniques are considered based on the kinetic energy needed for deflection and the asteroid-Earth impact time, i.e., both high impulse and slow push categories are assessed. The NASA/JPL NEO Deflection App (NDA) is used as a tool to analyze the effectiveness of the impulsive asteroid deflection techniques. It is expected that changing the impact point towards a sparsely populated and easy-to-evacuate region is more effective than a full deflection approach in case of a shorter warning time. The kinetic energy needed for such a deflection will also be less and is possible based on the current Technology Readiness Levels (TRL). The advantages and disadvantages for each deflection method is carefully examined and a technique is chosen such that the trajectory is optimized with the spacecraft mass and the warning time as constraints. The political and legal atmosphere for such a mission along with adherence to international laws is also discussed and a summary of the technical and socio-political aspects for a planetary defense mission planning for a hazardous asteroid (2023 PDC) is illustrated in the paper.

Comments:

Student paper – (The author is a student at SASTRA University, India, email: 123017017@sastra.ac.in)