ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimization (1) (4)

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KINETIC IMPACTOR MISSION DESIGN TOOL FOR NEAR EARTH OBJECT DEFLECTION

Abstract

In this paper we discuss the application of orbital and celestial mechanics in model-based mission design software within the domain of planetary defense, modeling the use of kinetic impactor spacecraft to deflect simulated near-Earth objects (NEOs), which pose a significant threat to life and infrastructure on Earth. We outline the methodology utilized in our research and development of integrated physics-based decision making algorithms, which enforce several constraints while calculating kinetic impactor spacecraft trajectories that maximize the deflection of an NEO for a range of combinations of launch dates and times of flight (TOFs) to the target. The model incorporates ephemeris data into a restricted 4-body problem, combined with a Lambert solver. Furthermore, NEO physical characteristics have been considered, and the collective results obtained are used to plot performance in terms of NEO deflection as a function of spacecraft TOF and launch date, providing a comprehensive set of results. The model thus demonstrates the performance of the kinetic impactor as a NEO threat mitigation strategy, for each NEO targeted in the simulations. Case studies using potentially hazardous NEOs were conducted in order to verify the functionality of the fully-integrated model. The resulting analysis tool is intended to be utilized as part of Phase 0 and Phase A mission design studies, or, following validation, incorporated into complex models for enhanced decision making. In addition, a comprehensive multidisciplinary literature review of the planetary defense domain, which supports our discussions of model-based testing and mission feasibility is presented. Finally, we provide recommendations for further development of the model and its incorporation into decision-making processes.