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Author: Dr. Nahum Melamed
The Aerospace Corporation, United States

NEO DEFLECTION WITH B-PLANE UNCERTAINTY

Abstract

An interactive Near Earth Object (NEO) deflection simulator software application (app) was developed at The Aerospace Corporation for NASA HQ in response to findings and recommendations from Planetary Defense studies and conferences. These studies highlight the need to identify NEO deflection options and design and test techniques that might be used to eliminate or lessen the likelihood of future collision threats. The simulator tool mitigates hypothetical impact scenarios by deflecting simulated, but realistic, NEOs on Earth-impacting trajectories. The app approximates the deflection caused by a kinetic impactor spacecraft that would impact the NEO at a high relative velocity, slightly altering the NEO's trajectory. A second NEO deflection method included in the app uses a standoff detonation of a nuclear explosive near the NEO to nudge the object onto a less threatening path. The simulator accounts for realistic launch capability and can aid in identifying feasible NEO deflection solutions, limitations and challenges. The simulator employs the B-plane technique to assess attainable Earth miss distance. The app's software and detailed documentation were delivered to NASA in mid-2014 and has been made available on JPL's public website (see http://neo.jpl.nasa.gov/pdc15/).

The current version of the NEO deflection app does not account for orbital uncertainty. However, a newly discovered NEO would possess orbital uncertainties that grow over time until new measurements improve the orbit. In order to consider the effect of orbit uncertainties on the deflection requirements, a new capability is being added to the tool. This capability uses a state transition matrix to propagate current position uncertainty to the impact epoch and to project an uncertainty ellipse onto the B-plane. Position uncertainty at time of Earth impact, or of closest approach of the unperturbed NEO, approximates Earth impact likelihood on the B-plane. This information is used to assess the amount of deflection needed to attain an Earth miss with a desired level of confidence; e.g., 1 in a million chance of impact. The enhanced NEO deflection app demonstrates that a significantly greater deflection effort must be mounted to counteract hypothetical NEO threats within acceptable levels of confidence. A detailed simulation is used to validate the realism of the covariance matrices, their propagation, and projection onto the B-plane.