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ASTEROID DEFLECTION MISSION DESIGN CONSIDERING ON-GROUND RISKS

Abstract

The deflection of an Earth-threatening asteroid requires high transparency of the mission design process. The goal of such a mission is to move the projected point of impact over the face of the Earth until the asteroid is on a miss trajectory. During the course of deflection operations, the projected point of impact will match regions that were less affected before alteration of the asteroid's trajectory. These regions are at risk of sustaining considerable damage if the deflecting spacecraft becomes non-operational. The projected impact point would remain where the deflection mission put it at the time of mission failure. Hence, all regions that are potentially affected by the deflection campaign need to be informed about this risk and should be involved in the mission design process. A mission design compromise will have to be found that is acceptable to all affected parties (Schweickart, 2004).

A software tool that assesses the on-ground risk due to deflection missions is under development. It will allow to study the accumulated on-ground risk along the path of the projected impact point. The tool will help to design a deflection mission that minimizes on-ground casualty and damage risk due to deflection operations. Currently, the tool is capable of simulating asteroid trajectories through the solar system and considers gravitational forces between solar system bodies. A virtual asteroid may be placed at an arbitrary point in the simulation for analysis and manipulation. Furthermore, the tool determines the asteroid's point of impact and provides an estimate of the population at risk. The forces due to a deflection mission can be superimposed on the asteroid and their immediate effect on the predicted Earth impact point may be assessed. Propagation accuracy has been validated against the solar system ephemeris catalogue HORIZONS by NASA's Jet Propulsion Laboratory (JPL). Asteroids that are propagated over a period of 15 years show typical position discrepancies of 0.05 Earth radii relative to HORIZONS' output. Ultimately, results from this research will aid in the identification of requirements for deflection missions that enable effective, minimum risk asteroid deflection.

Schweickart, R. L. (2004). THE REAL DEFLECTION DILEMMA. In 2004 Planetary Defense Conference: Protecting Earth from Asteroids (pp. 1–6). Orange County, California. Retrieved from http://b612foundation.org/wp-content/uploads/2013/02/Real$_D$e$f$lection$_D$ilemma.pdf