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MAPPING TRAJECTORIES OF AN ASTEROID THAT IS DEFLECTED BY A COLLISION

Abstract

The evidences of collisions between celestial bodies in the solar system are well known, from small craters on asteroids to large impacts on Mercury and the Moon. As recent events showed, an important contribution to the field of planetary defense is the study of the best form to deflect asteroids from a possible Earth collision, saving countless lives (BOARD; COUNCIL et al., 2010). Several options have been considered, however, most studies are based in deflections generated by an impulse applied to the asteroid target. One of the mechanisms used to generate this impulsive relies in a kinetic impact momentum transfer generated by the impact of one or more spacecrafts on the asteroid's surface. This, in turn, instantaneously changes the target velocity and, by extension, its orbit characteristics. The impulse is to be calculated in such a way that the asteroid's orbit is modified enough to avoid a collision with Earth. In this context, the objective of this work is to search for the best impulse geometry for a planetary collision avoidance. All the possible angles to hit the asteroid are simulated, generating a map of the effects of this collision in the minimum orbit intersection distance (MOID), between the Earth and the asteroid. Several values are assumed for the impulse, velocity increment, applied to the asteroid, as well as for the deflection time before the predicted closest approach. The impact mapping gives a general idea of the best conditions to deflect the asteroid, as well as the associated value of the velocity variation. In order to do so, it is assumed a Circular Restricted Three-Body Problem system, composed by an asteroid, the Earth and the Sun; where the asteroid is in a collision course with the Earth. The problem consist in applying an impulse to the asteroid, producing a variation in its velocity, in such a way that it modifies its trajectory enough to avoid a collision with the Earth. The velocity variation is defined by a magnitude and two angles in the asteroid's local reference frame. This type of map can show the general behavior of the trajectories and guide more detailed studies about this topic.

BOARD, S. S.; COUNCIL, N. R. et al. Defending planet earth: Near-Earth-Object surveys and hazard mitigation strategies. [S.l.]: National Academies Press, 2010.