Optimal Interception and Deflection of Near Earth Objects

A crucial issue related to the safety of our planet is the danger represented by asteroids, which can intercept the Earth and cause catastrophic impacts. The aim of this research is to find methodologies for the optimal interception and deviation of potentially hazardous Near Earth Objects.

Several deviation strategies have been proposed within the space community. Therefore, as a first objective, a formulation of the asteroid deviation problem was developed, which allows for an analysis of the effectiveness of any proposed impulsive or low-thrust mitigation method. The achievable deflection of the asteroid is computed through proximal motion equations as a function of the variation of the orbital elements.

The second objective is the study of the asteroid interception transfer. This task requires the integrated design of the interception and the deflection phase, through a global optimisation. In fact, in order to have an effective and efficient mitigation scheme, the total mass of the spacecraft into orbit and the warning time should be minimal for a given deviation. An algorithm based on Differential Dynamic Programming was developed for the solution of the optimal control problem associated with low-thrust trajectories. The proposed approach is capable of fully exploiting the multi-body dynamics of the problem, for example when the Earth escape transfer leg is considered.

Finally a wide variety of asteroid interception and deflection missions will be presented, in the case of impulsive and low-thrust deflection actions, together with a comparative assessment of different deviation strategies proposed in the literature.