ASTRODYNAMICS SYMPOSIUM (C1)
Optimization (1)

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GRAVITY-ASSISTED MANEUVERS APPLIED IN THE MULTIOBJECTIVE OPTIMIZATION OF INTERPLANETARY TRAJECTORIES

Abstract

In this work, the problem of optimization of interplanetary trajectories with minimum fuel consumption, but with a time limit was studied. It was used a methodology known as the Patched Conics, where the trajectory is divided into three parts: 1) departure phase, inside of the sphere of influence of the departure planet, 2) heliocentric phase, during the journey between the planets; 3) arrival phase, inside of the sphere of influence of the arrival planet. Furthermore, was considered the possibility of gravity-assisted maneuvers (swing-by) to reduce the fuel consumption. In this case the complete trajectory would be divided into more parts, depending on the number of maneuvers. Therefore, the goal of this work was to find a combination of conical trajectories, using gravity-assisted maneuvers, which perform the transfer from a nearby of the departure planet to the vicinity of the target planet, spending a minimal fuel with minimal time for the journey. Considering the minimization of the time, the solution can not be the solution of minimum fuel consumption, because the minimization of time and the minimization of the fuel are conflicting objectives. Thus, a multi-objective problem must be solved. Hence, was used a methodology based on the Non Inferiority Criterion (Pareto 1909) and the Smallest Loss Criterion (Rocco et al. 2003), capable of considering multiple objectives simultaneously, without reducing the problem to the case of optimizing a single objective as occur in the most methods found in the literature. A mission to Pluto, similar to the NASA's New Horizons Mission, was studied considering gravity-assisted maneuvers in Mars, Jupiter and Saturn. Simulating the trajectories and the maneuvers using the Transfer Trajectory Design Programs (Sukhanov, 2004), several possibilities were analyzed for many combinations of fuel consumption, time of departure, time of arrival and planet used for the swing-by. Then, using the Multi-Objective Optimization Program (Rocco, 2003) the problem was solved seeking the best combination. The results can provide a good assistance for the mission analysis, reducing the cost and duration of the journey to achieve the target planet.

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