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DESIGN OF INTERPLANETARY MISSIONS: AN IMPROVED GRAPHICAL TOOL

Abstract

There exist many computer programs aimed at performing astrodynamic computations at various levels of complexity and approximation that are based on different approaches. The great majority of these codes are aimed to design the trajectory once the starting and arrival points (in space and time) and the required corrections to be performed on the way are stated. Most allow the user to introduce a number of maneuvers, like multiple flybys, aerobraking or aerocapture and so on. However, this may not be what the user needs when starting to design a mission, considering many possible alternatives. For this task – and for evaluating the possibilities opened by an innovative propulsion system – a simplified code that allows for the computation of many different trajectories starting and arriving at different times, may be of great use. This was the aim of developing the IRMA (InteRplanetary Mission Analysis) toolbox, written in the MATLAB environment. When studying low thrust missions, the trajectory and the thrust profile were computed using indirect methods, based on solving a Boundary Value Problem (BVP). In the MATLAB environment this is done by using the routines bvp4c or bvp5c. The previous versions of IRMA used the latter, but in some instances, mainly in the case of Constant Exhaust Velocity (CEV), the code failed to obtain results. This was partially solved by writing a specific routine using the Simple Shooting Method, which increased the chances of success, at the cost of longer computation times. At any rate, MATLAB, which is an interpreted language, causes relatively long computer times, up to more than 20 hours in the case of Bacon plots with a large number of points. To decrease the computer time, a new version was developed: while maintaining the Graphical User Interface in MATLAB (or other interpreted environments like Gnu Octave or Compose) because of its user friendliness, the computational intensive parts were rewritten in FORTRAN, and compiled in the form of .mex files. The IRMA toolbox now has the option to choose from several different state-of-the-art solvers for the numerical solution of the BVP. These include the well known COLNEW software package, which uses Gaussian collocation methods, and also the MUSN solver, which uses multple shooting methods. The results and the computer times of each solver are compared for a number of test cases using the old and the new version of IRMA.