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NUMERICAL APPROXIMATION OF INVARIANT MANIFOLDS IN THE RESTRICTED THREE-BODY PROBLEM

Abstract

Invariant manifolds associated to the periodic orbits about Lagrange points of the restricted three-body problem are becoming popular among trajectory designers due to their unique features. Indeed, in order to perform a libration point mission, it is required to place the spacecraft on the stable manifold of the arrival periodic orbit. In this way, the three-body dynamics provide at bringing the spacecraft up to the arrival orbit at zero cost. Other examples involve the transit orbits leading to ballistic capture and escape, and the homoclinic/heteroclinic connections.

To design such trajectories it is required to handle a global representation of the invariant manifolds. This can be done in a purely numerical way (i.e., numerical integration of perturbed periodic orbit initial conditions) or with semi-analytical methods (e.g., Lindstedt-Poincarè method or reduction to the center manifold). In this paper an alternative method for the fast approximation of invariant manifolds is presented. This method is based on a three-step algorithm: 1) the periodic orbit and its invariant manifolds are generated; 2) a spline interpolation of the latter is then performed over a two-dimensional time grid; 3) a differential correction is applied to enforce the manifold Jacobi energy. It is shown that this approach entails considerable saving in computational time if compared to the numerical integration method. The accuracy of the method is also discusses. Applications show the effectiveness of the method in handling a global, approximated representation of the invariant manifolds.