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LOW ENERGY TRANSFER TO DISTANT RETROGRADE ORBIT IN EPHEMERIS MODEL

Abstract

Distant Retrograde Orbit (DRO) is a type of stable periodic orbit in circular restricted three body problem (CR3BP) with unique and potential application in future space missions. For example, asteroid defending systems, data relay satellites, and even space stations are planned to be deployed in DRO. However, the stability of DRO guarantees the non-existence of any stable/unstable manifolds and makes it difficult to achieve the low energy transfer. The traditional and wide-used methods for low energy transfer in Lyapunov orbit and Halo orbit are no longer suitable for DRO transfer.

This paper proposed a method to construct pseudo-manifolds in the ephemeris model, and then achieved the low energy transfer to DRO. Because of the existence of perturbation force in the ephemeris model, DRO becomes instantaneous unstable. As a result, the state transfer matrix is different from that in CR3BP and has real eigenvalues smaller than 1, which corresponds to an effective direction for DRO insertion. An alterable pace ergodic method is developed to constructed the pseudo-stable-manifold of DRO along that direction. This study further analysis the main factor that generate the pseudo-manifold, including the eccentricity of the moon, solar gravity, and solar radiation pressure. Based on the pseudo-manifolds and manifold-patching, the low energy transfer from the Earth to DRO is achieved.

Results shows that the low energy transfer generated by the method we proposed reduced ΔV cost of DRO insertion by 75% compared with the traditional method utilizing the manifolds of other periodic orbits and by 90% compared with lunar gravity assist transfer. Further analyses show that this method can also be used to design the low energy transfer among other stable periodic orbits and libration points.