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TARGET PHASING MANEUVER PLANNING FOR MANNED ORBITAL RENDEZVOUS

Abstract

In manned rendezvous and docking mission, the target is required to run on a near-circular repeating-ground-track orbit. When the chaser's orbital injection point comes into the target's orbital plane, the initial phase angle, i.e. the difference between the two vehicles'argument of latitude, is required to be in a definite scope. In the target phasing mission, the target performs several maneuvers with acceptable propellant consumption to adjust the initial phase angle, while satisfies the near-circular repeating-ground-track orbit requirement. The target phasing is of great significance for increasing the chaser's launch window, standardizing the chaser's rendezvous maneuver process and effectively configuring the finite TTC resource. The target phasing is a long-time multiple-revolution multiple-impulse rendezvous problem. Because the time when the chaser's injection point comes into the target's orbital plane varies according to the target's maneuver, the target phasing is not a typical fixed time rendezvous problem. Previous studies directly employed the nonlinear programming to obtain the fuel optimal solution, while its hard to acquire global optmial solution because of the existence of multiple local optimal solutions. Due to the long duration to rendezvous, the computation cost to evaluate the objective once is so high that it is not suitable to use the intelligent optimization algorithms. This paper proposes a new target phasing planning approach which can obtain global optimal solution with acceptable computation cost. The maneuver revolution number, the maneuver location's argument of latitude and the maneuver impulse magnitude are used as the design variables. To avoid solving the problem by complicated mixed integer nonlinear programming, a bi-level planning framework is employed. The branch-and-bound algorithm is employed to search the maneuver revolution numbers in the higher level planning, and the sequential quadratic programming algorithm is used to optimize the maneuver location's argument of latitude and the maneuver impulse magnitude in the lower level planning. To accelerate the convergence of the lower level planning, the relation between the impulse and the terminal condition based on the relative motion equation is adopted to provide an analytical gradient. The proposed method is tested by a practical twenty-day target phasing problem. Compared with the directly nonlinear programming method, the proposed method can obtain similar or better objective. Compared with the genetic algorithm, the proposed method can obtain similar objective while with much less computation cost.