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Surrogate-based Parameter Optimization and Optimal Control for Optimal Trajectory of Halo Orbit Rendezvous

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This work considers the optimization of rendezvous trajectories for spacecraft starting on different z-amplitude Halo orbits. A surrogate-based parameter optimization strategy is proposed for the optimal trajectory of Halo orbit rendezvous in the Sun-Earth system. The optimal rendezvous problem is transformed into an optimal control problem which fixes the initial flight time and the time of flight for the rendezvous trajectory. Further, the initial flight time and the time of flight are taken as design variables for parameter optimization under the objective of minimum fuel consuming. Since the precise optimization model is typically time consuming and computational expensive, the surrogate model is constructed using data drawn from the precise model, and provides fast approximation of the objective at new design points. Therefore, the surrogate model is feasible and employed for Halo orbit rendezvous in this paper. Numerical simulations show that the surrogate-based parameter optimization takes advantages over the global traversal method and the global optimization method (genetic algorithm). At last, the influences of the different relative z-amplitude Halo orbits for optimal trajectory of Halo orbit rendezvous have been studied by employing the surrogate-based parameter optimization strategy in the numerical simulations.

Keywords: Circular restricted three body problem (CRTBP); Halo orbit rendezvous; Nonlinear optimal control; Surrogate based optimization; Design of experiment