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# MULTI-OBJECT AND MULTI-CONSTRAINT TRAJECTORY OPTIMIZATION FOR HYPERSONIC REENTRY GLIDING VEHICLE

**Abstract**

Trajectory optimization of hypersonic reentry glide vehicle, which is an optimal control problem, is a hot topic at present. Pseudo-spectral Method is a newly developed technique to solve optimal control problems and several papers have been published to solve trajectory optimization problem via pseudo-spectral method. But the high order Lagrange interpolating polynomials pseudo-spectral method employs is a disadvantage though it claims that global interpolating polynomials can guarantee the method converging to global optimal solution, the high order interpolating polynomial is unsteady and even a minor departure from real solution can cause great oscillation. The roots of orthogonal polynomials (e.g. Legendre polynomials) the pseudo-spectral adopted as collocation points may alleviate this phenomena, it cannot settle this problem. The other weakness of pseudo-spectral method is that when the control parameters are constrained at certain range, the interpolating polynomials could only guarantee the controls feasible at the collocation points, not the whole procedure.

A direct optimization method used for a long time reentry vehicle trajectory optimization is developed. It can be classified as control parameterization techniques and the differential equations are solved via numerical integration. After discretize the controls, Akima interpolation technique is chosen to obtain the controls at each time interval to integration, because compared with classical spline, the Akima spline is an better alternative that exhibits less dramatic overshoots and undershoots.

After translate the trajectory optimization problem into an Nonlinear programming problem, multi-object evolution algorithm is adopted to solve the NLP. The minimum flying time and minimum maximum-heat-flux are the objectives. The pareto front is obtained through optimization, the result is analyzed and compared with the reference.