ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations and Optimization - Part 2 (2)

Author: Dr. Enmi Yong
Computational Aerodynamics Institute,China Aerodynamics Research&Development Center, China,
yongenmi_2004@sina.com

Dr. Wei-qi Qian
China, cardc@my-public.sc.cninfo.net
Dr. He Kaifeng
China, hzc7173@163.com

TRAJECTORY OPTIMIZATION OF LIFTING-TYPE REENTRY VEHICLE VIA GAUSS PSEUDOSPECTRAL METHOD

Abstract

A rapid trajectory optimization approach using Gauss Pseudospectral Method (GPM) for hypersonic glide-reentry vehicle is developed in which a space reentry dynamic model is considered. 1) The difficulties in trajectory optimization of hypersonic vehicles are analyzed firstly. Then, aiming at deficiencies of traditional trajectory optimization method in initial value determination and computation efficiency, a pipelining and segmenting trajectory optimization approach base on GPM, containing an initial guess generator, is proposed. It is used to solve the problems of initial value determination, highly nonlinearity and multi-constraints in trajectory optimization. 2) The mathematic model for trajectory optimization is built. It includes three-degree-of-freedom (3-DOF) dimensionless reentry dynamic equations above rotating circle earth, the path constraints, the terminal constraints, and the optimization objectives. 3) Then this approach is applied to compute the optimal trajectories of reaching a point target, an area target and the attainable region of reentry flight. The feasibility and precision of this approach is validated by comparing the GPM results with that of the numerical integration. An optimal trajectory with a range of 10000 kilometers and the attainable region of reentry flight both can be generated in about 3 minuets on a desktop computer with Matlab language. It indicates the rapidity of the presented approach. This rapid trajectory optimization method based on the new technology-GPM in optimal control enrich the methodology of trajectory optimization. The firstly proposed pipelining and segmenting trajectory optimization approach containing an initial guess generator gives a new idea to solve reentry trajectory optimization problem with multi-constraints and highly nonlinearity.