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BEZIER-BASED SEQUENTIAL CONVEX PROGRAMMING METHOD FOR LAUNCH ASCENT GUIDANCE

Abstract

This paper proposes a modified sequential convex programming (SCP) method for ascent guidance of launch vehicles subject to strict path constraints. Due to their highly nonlinear nature, ascent guidance problems are extremely difficult to be solved onboard in real time. SCP methodwhich transforms non-convex problems into a series of sub-convex optimization problems, is considered as one of the most potential technology to achieve the above objective. However, its computational efficiency and convergence are still not be guaranteed. In this paper, Bezier curves are first to represent of the control variable, by which the computational efficiency of SCP can be greatly improved. Besides, according to the convex-hull property associated with Bezier curves, the number of path constraints can be efficiently reduced. Then, numerical continuation method is included to improve the convergence of SCP, the idea of which is to embed the homotopy parameter into the formulation of the sub-convex optimization problems, and the optimal solution to the original problem can be obtained by tracing the solutions of the embedded ones by starting from a relatively easy problem. Finally, the efficiency and the convergence of the proposed method, with potential for online guidance, is demonstrated by numerical examples and comparisons with other methods. The simulation results illustrate that the calculation time of the proposed method is only about 12.4% of the existing method, with no failure in the whole guidance.