Symplectic Numerical Method for Nonlinear Feedback Optimal Control and Its Application in Tethered Satellite Systems

***H.J. Peng, Q. Gao, and Z.X. Cai**

Department of Engineering Mechanics, State Key Laboratory of Structural Analysis for Industrial Equipment
Dalian University of Technology, Dalian, Liaoning, China

*Corresponding author: hjpeng@dlut.edu.cn

The symplectic numerical method for solving nonlinear feedback optimal control based on receding horizon control was first proposed and then applied into the problem of the subsatellite's deploy and retrieval process of tethered satellite system. First, the nonlinear feedback control problems of tethered satellite system were transformed into the iteration form of linear nonhomogeneous Hamilton system's two-point boundary value problems (TPBVP) by quasilinearization method. Then the linear nonhomogeneous Hamilton system's TPBVP is transformed into the solving of a set of linear equations by the symplectic numerical method. Finally, by updating the state and control variables on each time step, the feedback control of tethered satellite system can be completed. The numerical simulation showed that compared with the Legendre pseudospectral method, the symplectic numerical method has desirable computation and iteration speed when solving feedback control problems of tethered satellite system. Furthermore, the numerical simulations of the open-loop control and closed-loop feedback control problems of tethered satellite system showed that with the presence of initial errors, the open-loop control could not lead the system to a stable state, while the closed-loop feedback control can eliminate the initial errors within a certain period of time and the final state was still stable.

Keywords: Symplectic method, Hamilton system, Optimal control, Nonlinear feedback, Tethered satellite system