Paper ID: 11074
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control - Part 3 (9)

Author: Mr. Mingliang Xu
National University of Defense Technology, China, mingliangxu@126.com

Dr. Luhua Liu
China, mingliangxu@126.com
Dr. Ye Yang
Beijing Aerospace Automatic Control Institute, China, nudt_1@126.com
Prof. guojian tang
China, mingliangxu@126.com
Prof. kejun chen
China, mingliangxu@126.com

NEURAL NETWORK BASED PREDICTOR-CORRECTOR ENTRY GUIDANCE FOR HIGH LIFTING VEHICLES

Abstract

A neural network (NN) based predictor-corrector entry guidance algorithm has been developed and evaluated for vehicles with high lift-to-drag ratios. The predictor-corrector method enables the guidance system to design the entry trajectory and guide the vehicle adaptively without the need to rely on a pre-stored trajectory. This capability gives enormous flexibility for the vehicle to handle greater dispersions and accommodate more severe off-normal conditions that would otherwise be difficult for a fixed reference trajectory to adapt to. The analytic predictor- corrector (APC) algorithm has been studied quite early to be applied to aerocapture guidance in Mars exploration, but the trajectory in APC must be tuned to a special form to get the analytic closed form solution. With the advent of on-board computation capability, the numerical predictor corrector (NPC) guidance algorithm has received increasing attention. However, the conventional NPC requires the complete integration of the remaining trajectory at each guidance cycle, which requires too much processing power to be implemented on-board real missions nowadays. In this paper, the artificial neural network is employed to solve the NPC on-board computation difficulty. The input of NN is the current vehicle state, and its output is the terminal vehicle state. The NN training is offline, and the training data pairs are chosen via cross design method. In real entry mission, based on the current vehicle state the trained NN could predict the final condition of vehicle accurately at an instant, which is used as a substitution of the integration process in conventional NPC guidance. The guidance algorithm is validated via three degree-of-freedom trajectory simulation, and all the path and terminal constrains are satisfied. Results of Monte Carlo simulations including uncertainties in atmosphere, aerodynamics and initial state are presented, which show that the proposed guidance algorithm has a strong robustness.