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Author: Dr. xiao hanshan
China Aerodynamics Research and Development Center(CARDC), China

Dr. Jie Liang
China

SLIDING MODE CONTROL CONTROL FOR HYPERSONIC FLIGHT VEHICLE WITH TIME DELAY ESTIMATION AND COMPENSATION

Abstract

Hypersonic flight vehicle has characteristics of fast velocity, high cruise altitude and maneuvers, etc, and it is of special strategic significant in both the the military and commercial areas. Therefore, it attacks an ever increasing attention worldwide. However, there is a strong inherent coupling among the aerodynamics, propulsion, structure and control dynamics due to the adoption of the scramjet engine, airframe/engine integrated design and other advanced technologies, and this leads to a high nonlinear dynamic model and serious uncertain. First of all, a six degree-of-freedom (6 DOF) simulation model of a conceptual hypersonic flight vehicle is presented, according to the available literatures and its flying characteristics during the cruising phase, and it includes the whole of kinetic equations and motion equations. Aerodynamic and engine thrust coefficients are given as functions of angle of attack, mach number, height and control surface deflections. Subsequently the longitudinal control and BTT control models are established. Open-loop dynamics and stability characteristics analysis demonstrates that the proposed model can reflect complex the nonlinear, coupling and fast time-varying characteristics of the hypersonic vehicle, and it can provide a platform for the design of nonlinear decoupling and robust performance of a controller. To better understand the dynamic behaviors of hypersonic flight vehicle and the potential effects of various couplings, and assess their effects on flight control system, the unique dynamic characteristics of hypersonic vehicle are analyzed from the control point of view. Based on the analysis results, the core control problems to be researched are extracted and analyzed. The thesis describes a sliding time delay compensation control law to achieve the hypersonic flight vehicle attitude angle trajectory tracking. The state information of the proposed control strategy using aircraft detected, estimate the system uncertainties, unmodeled dynamics, external disturbances has advantages of real-time online, do not depend on the system model, strong robustness. By opening and closing delay estimation can contrast experiment of computer numerical simulation, time delay estimation can be effectively estimated system uncertainties, the control system has good tracking performance, short adjusting time, and the overshoot is small, high tracking accuracy. Confirmed the reliability and validity of the method.