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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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THE APPLICATION OF ATTITUDE FOR HIGH-ORDER NONSINGULAR TERMINAL SLIDING MODE CONTROL OF DYNAMICS MODEL OF HYPERSONIC VEHICLE BY DIFFERENTIAL LINEARIZED PROCESSING THROUGH CHANNEL OF SPEED AND HEIGHT

Abstract

Currently, the research of hypersonic vehicles has drawn more and more attention through the whole world, and becomes a main area of near space flight technology, due to its significant value in both military and civil affairs. And the flight control technology of the hypersonic vehicles is a main and difficult point, besides it is a hotspot in the research of all the countries. Compared with general vehicles, the hypersonic vehicles adopt the engine-airframe integration technology, which results in strong coupling between propulsion system and structural dynamics ,and brings highly nonlinear characteristics to the hypersonic vehicle models, in which there are also many uncertain aerodynamic parameters. Furthermore, the hypersonic vehicles are flying in the conditions of high altitudes and Mach numbers, the perturbations from the environment and uncertainties are obvious, so the flight stability of the hypersonic vehicles is influenced. All the factors mentioned have brought great challenges to the model confirming and control system designing of the hypersonic vehicles. In this Paper, in order to grasp the hypersonic vehicles complex aerodynamic characteristics, firstly, the full-state, nonlinear and 6-freedom motion differential equations of the hypersonic vehicle model are established. And the engine model is analyzed. Secondly, the numerical method is adopted to estimate aerodynamic coefficients of the hypersonic vehicles in different flight conditions. By analyzing the results, the aerodynamic characteristics are understood. And the longitudinal dynamics equations are obtained by decoupling analysis. Eigenvalue and dynamic response of the longitudinal dynamics equations are studied to deeply know the particularities of the hypersonic vehicles. And it is possible to provide an appropriate control object to flight control system designing for the hypersonic vehicle. For the strong coupled and highly nonlinear hypersonic vehicle longitudinal model, feedback linearization method is utilized to make the longitudinal model output/input exact linearization. And based on it, high-order nonsingular terminal sliding mode control system is designed combining with the linear quadratic controller. The control system designed not only can decouple the output and input of the longitudinal model, but also can ensure the veracity of commands tracking and flight stability. Numerical simulation is done via MATLAB/SIMULINK to verify the good performance of control system designed.