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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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MODELLING AND SIMULATION OF HYPERSONIC VEHICLE

Abstract

Abstract Aiming at the problem of the coupling between the rigid body mode and elastic mode caused by the light structure design and slender geometry of the hyper-sonic vehicle, and effect of liquid sloshing in tanks on the vehicle. For more accurate analysis of complex dynamics of hyper-sonic vehicle and to improve the control precision of hyper-sonic vehicle, the nonlinear dynamic model of a flexible vehicle is established in the case of the vehicle's elastic deformation and considering the influence of the liquid sloshing in tanks. First of all, the aircraft is equivalent to a slender beam. According to the equivalent model, we established the equation of elastic vibration. Secondly, the liquid sloshing is equivalent to simple pendulum model, and the sloshing equation is formed on the basis of the model of pendulum. Then, considering the elastic deformation caused by the elastic vibration of the vehicle, the inertia force caused by the swing of the engine and the liquid sloshing, the force analysis on the aircraft is carried out, and the force and the generalized force acting on the aircraft are obtained. After this, we can establish complete aircraft dynamic equations, based on the theorem of momentum and moment of momentum theorem. Finally, based on the dynamic model, a simulation analysis is carried out. And we compared the simulation results of the model obtained by the above method and traditional model of elastic deformation and liquid sloshing is not considered. Furthermore, in the case of using the same control scheme, control effect of the model and the traditional model were compared, and we analyzed the influence of the elastic deformation and liquid sloshing on the control system. The simulation results show that the influence of the elastic and sloshing effects on the flight characteristics of the hyper-sonic vehicle is obvious, and the control system is more demanding.