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ADAPTIVE FAULT-TOLERANT CONTROL SYSTEM OF REUSABLE LAUNCH VEHICLE

Abstract

With the development of science and technology, the focus of the modern aerospace engineering is becoming the reused aircraft. The main advantage of the reusable vehicle (RLV was, Reusable Launch Vehicle), including lower costs, easy launch process and improve the transmission frequency, which is a power return and glide path landing vehicle. But considering about RLV's repeated use and poor working conditions, the possibility of faults happened is also greatly improved. Safety is an important issue in RLV system. The increasing importance of fault tolerant control stimulates great interests and growing researches in the control community. The faults may occur in control equipment, sensors or system. The solution of constant deviation failure in actuator, which is a very common fault in aircraft systems, is considered in this paper.

The adaptive fault-tolerant control method can effectively ensure that the attitude control system still normally operate when the sensor and actuator occurs once fault. When malfunction happens, actual was accused of process is changed, the control law can correspond adaptive restructuring, to keep controlled object of reference model output tracking. There are several advantages of this method. The system structure is simple, so the speed of iteration algorithm can be improved, and the time of restructuring the control law can be shortened. Thus the performance of the system is improved.

The research includes the main following aspects: First of all, analyze the characteristics of RLV, build the RLV nonlinear motion model and define the coordinate system and angle that are used during the modeling process. Secondly, considering about the failure mode of sensor and actuator on the basis of once failure mode, in accordance with their respective characteristics to create a control system expression. Thirdly, the adaptive fault-tolerant control program is based on using model state observe. Separate discussed the conditions that the system expression of sensors and actuators remained stable. In this process, transform the control system expression into a linear matrix inequality (LMI), and the sufficient condition of the stability of the control system is ensured by the solution of LMI. And finally, analysis the RLV specific hardware failures and simulate, and simulation for sensor and actuator failures, which verifies the effectiveness and feasibility of fault-tolerant controller. The work process of RLV with fault conditions is simulated and verified by nonlinear 6-DOF mathematical simulations.