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NOVEL FAULT TOLERANT NAVIGATION SENSOR FOR A 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 navigation stimulates great interests and growing researches in the navigation community. The faults may occur in control equipment, sensors or system. The solution of constant deviation failure in Gyro, which is a very common fault in aircraft systems, is considered in this paper. This paper proposes a novel Fault Tolerant Navigation Sensor for improving the performance of an RLV preliminary navigation system. The proposed sensor contains two parts: fault detection and isolation part, and a main-part for reconfiguring system toward the faults occurrence in the RLV navigation system. 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 Gyro on the basis of once failure mode, in accordance with their respective characteristics to create a control system expression. Thirdly, the innovative fault-tolerant navigation program is based on using symmetrical dynamic behavior of the yaw and pitch channels observe. On this base yaw dynamic is identified by RLS identification techniques during flight time. By applying pitch control deflection as pitch channel input to identify yaw dynamic, pitch rate can be derived as pitch output which is determined with Gyro. Therefore, the residual between gyro rates (pitch rate) and estimated rates of the sensor provides a measure for detecting the gyro fault as fault detection. When a fault occurs, the residual exceeds its corresponding threshold and transmits an alarm signal to the fault tolerant system for accommodation of the fault occurrence. Afterwards, faulty Gyro output is replaced by developed proposed sensor. And finally, analysis the RLV specific hardware failures and simulate, and simulation for sensor failures, which verifies the effectiveness and feasibility of fault-tolerant navigation sensor. The work process of RLV with fault conditions is simulated and verified by nonlinear 6-DOF mathematical simulations.