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FAULT DIAGNOSIS METHOD FOR REDUNDANT HETEROGENEOUS SENSOR OF ELECTROMECHANICAL ACTUATOR IN TVC SYSTEM

Abstract

The thrust vector control (TVC) unit is a typical actuator in the flight control system of rocket, which controls the swing angle of the engine nozzle by the electrical servo system to change the attitude and flight path of the rocket. Due to the severe working environment of the TVC actuator, such as heavy load, intense vibration and high temperature ambient, the faults are likely to occur in the TVC actuator especially at the linear displacement sensor in the case of reusing. If the redundancy measurement is performed by multi sensors with the same types or same measurement position, the faults from the sensors might appear simultaneously because of the same working principle and operating environment, and the extra volume and weight are required. Therefore, in the present paper, a better approach is performed utilizing redundant measurement by the existing heterogeneous sensors, such as the motor's angular sensor within the actuator. Aim at this problem, the angular sensor of the servo motor is employed as the indirect measurement source on the displacement of TVC actuator, and a diagnosis method is proposed based on the idea of energy transfer matching motion transfer. The redundant measurements of sensors of liner displacement, angular displacement, voltage and current are achieved to obtain the reliable output displacement information of electromechanical actuator (EMA). The voltage and current sensors of the electrical servo system are implemented as the third-party independent arbitration source, in accordance with the information of the working current and voltage, the motor rotation angle and output linear displacement of the EMA can be acquired by the unscented Kalman filter (UKF). Then the intercomparisons are carried out between estimated value of motion calculated by UKF and measured value from sensors, whose residual error distribution can be applied as the criterion to recognize and isolate the faults. This method can improve the working reliability of the rocket TVC system, even can keep the EMA to operate normally in a short period when both faults occurring in the linear and angular sensors. On this basis, the redundancy measurement of heterogeneous sensors and the verification of fault diagnosis are carried out. The results indicate its accuracy on the fault diagnose of EMA sensors, realizing the dynamic switching of feedback information source for closed-loop control, and ensuring the proper functioning of EMA after sensors failure and improving its reliability obviously.