ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (3)

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THRUSTER FAULT DETECTION ISOLATION AND RECONFIGURATION FOR INDIAN MARS ORBITER

Abstract

Mars Orbiter Mission (MOM), India's first interplanetary mission to planet Mars has one 440N Engine and eight 22N Thrusters for orbit raising and attitude control. It has a high performance inertial measurement unit comprising of 3 Dynamically Tuned Gyros (DTG) and 4 Ceramic Servo Accelerometers (CSA). In MOM the autonomy and mission requirements make it essential to detect any thruster faults, take autonomous necessary corrective action onboard to avoid attitude loss. Thruster Fault detection, isolation and Reconfiguration (Thruster FDIR) algorithm is a real-time, onboard, model-based generic algorithm that can detect hard and abrupt closed mode(failed-off) or open mode(failed-on) failures of attitude control thrusters. It is independent of thruster configuration, detect multiple failures. This algorithm uses angular rate residuals for thruster fault detection and identification and updates thruster usable/not usable status used for thruster reconfiguration so as to maintain the required spacecraft attitude and angular rate. The rate change imparted to the spacecraft over a pre-fixed sampling interval is obtained from the measured gyro rate. The ideal rate change (no thruster fault condition) is computed from on board spacecraft dynamic model. This model has individual thruster torque and spacecraft Moment of Inertia as commandable inputs. The difference between measured and ideal rate change i.e. the ideal rate residual is compared against a pre-determined, commandable threshold. Fault is detected if ideal rate residual is greater than the threshold and subsequently the algorithm probes further for fault identification. Here, assuming one fault at a time a rate change matrix is computed for all possible individual closed and open mode faults. The rate residual matrix is derived by differencing the measured and computed rate change matrix. Identification of the faulty thruster and type of fault is done by comparing each rate residual with the threshold. After successful detection and identification of the fault, spacecraft control is transferred to the healthy thrusters through the Reconfiguration algorithm that takes the decision based on the faulty

thruster, number of failures and the present thruster selection scheme. Thruster FDIR was validated extensively during ground testing. It was used during all orbit raising maneuvers in MOM, there was no spurious thruster fault detection and on orbit performance was as desgined.