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THE ATTITUDE AND ORBIT CONTROL FAULT DIAGNOSIS AND BACKUP BRAKING DESIGN DURING MARS ORBIT INSERTION

Abstract

There is about 40 minutes communication delay between Mars probe with the Earth during Mars Orbit Insertion(MOI). we could not handle abnormalities of Mars probe in time, that maybe cause failure of MOI. It is very important that Mars probe diagnoses and handles abnormalities during MOI by itself. The autonomous fault diagnosis and backup control strategy design of Mars probe has been illustrated in this paper. Firstly, gyros and accelerometers are used to measure attitude and orbit of Mars probe. Gyros and accelerometers data are diagnosed in the following aspects: whether the communication is not normal, or whether the data is unchanged , or whether the data exceeds the threshold during a certain time. If that happens, this gyro or accelerometer is considered to be fault. If more than one gyros are available, the attitude of Mars prob is calculated according to the priority of available gyros, otherwise using the data before. If accelerometers are unavailable, the data of accelerometers are assigned zero, and the burning time of engine is set to the maximum time of MOI, otherwise, using only one accelerometer data, or combining the theoretical acceleration to compare the data of multiple accelerometers and then selecting optimal acceleration value. After that, orbit and attitude control thrusters will be diagnosed by accelerometers and gyros data respectively. Secondly, the MOI strategy will be reconstructed if the attitude deviation exceeds threshold or the orbital control thruster is insufficient. The principles of reconstruction strategy are as follows: 1)Attitude control thrusters are used to control the orbit and attitude in order to complete MOI if the orbital control thruster is insufficient. 2)Shutting down the x-axis(x-axis along the direction of the speed increment of MOI) attitude control thrusters while the attitude deviation of this axis exceeds threshold. 3)Switching to backup set of attitude control thrusters, if the non-x-axis attitude deviation exceeds the threshold. Thirdly, backup MOI strategy is designed by linear interpolation and quadratic interpolation. According to the data measured by accelerometers, the incremental speed during MOI is accumulated. If the orbital control thruster is unavailable before shutdown condition, the residual incremental speed is used to calculate the backup MOI strategy of the attitude control thruster to complete MOI. Finally, the simulation analysis is given to verify the feasibility of the autonomous backup control strategy design described above.