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RECONFIGURABLE SATELLITE ATTITUDE CONTROL SCHEME USING TWO REACTION WHEELS FOR LIMITED MISSION

Abstract

Reaction wheels, thrusters, and control momentum gyros are widely used to control the satellite attitude for various missions. If actuator failure occurs, the mission of a satellite cannot be accomplished or will be limited. For the extended life and the smooth mission of a satellite, the reconfigurable controller of the satellite attitude control system should be considered to deal with this problem. In the attitude control system of KOMPSAT(KOrea Multi-Purpose SATellite)-3, four reaction wheels are used to control the attitude of a satellite. Since four reaction wheels are mounted in a pyramid configuration, the attitude control of a satellite can be performed by the composition of the healthy reaction wheels when reaction wheel faults occur, and the performance is influenced by the failed reaction wheels. Recently, various reconfigurable control algorithms have been studied to cope with the one reaction wheel failure case, which include the adaptive sliding mode control method, the finite reaching time continuous sliding mode control method, and the iterative learning approach. However, these methods cannot provide the satisfactory performance for more severe reaction wheel failure case such as multiple failures. In this study, two reaction wheel failures case of the KOMPSAT-3 system is considered. If two among four reaction wheels have faults, then the mission of a satellite can be limited because of the large attitude errors. To minimize the large attitude errors, the big attitude angle and the angular rate commands will be generated. This may destabilize the closed-loop system because of the limited control efforts. To prevent this problem, the limited mission should be defined to perform the mission for the multiple failure case, and the controller designed for the limited mission will reduce or limit the attitude angle and the angular rate commands. In this study, the fault tolerant control algorithm will be proposed to cope with the failures of two reaction wheels in the limited mission. Since the satellite dynamics are not controllable for two reaction wheel failure case, the satellite system cannot be stabilized using the classical linear controller or time-invariant continuous feedback controller. An alternative control method will be proposed to control the attitude of a satellite using the combination of nonlinear control methods, which can make a satellite perform the limited mission using the remaining healthy actuators. The performance of the proposed fault tolerant attitude control algorithm for pointing the observation area will be verified by numerical simulations. The proposed algorithm can be applied for the satellite control system to improve the reliability of the satellite system, and eventually will extend the life of a satellite operating in extreme environments.