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INTEGRATED CONTROL DESIGN OF ATTITUDE CONTROL/MOMENTUM MANAGEMENT/POWER STORAGE USING SGCMGS AND FLYWHEELS

Abstract

The space station project has motivated numerous investigations into the problems of ACMM (Attitude Control and Momentum Management) and IPACS (Integrated Power and Attitude Control System). With the employment of ACMM, propellant consumption is saved for that the special attitude configuration TEA(Torque Equilibrium Attitude) can avoid reaction jets frequent work to unloading the momentum of CMGs (Control Moment Gryo) and flywheels. With the employment of IPACS, the number of spacecraft electrical storage batteries is reduced for that the CMGs and flywheels can storage energy as well as being used for attitude control. These savings and reductions are especially evident for a large and long-time spacecraft, as for space station. Therefore, with the development of space station, ACMM and IPACS had been studied extensively. However, the current works always deal with ACMM and IPACS separately, and seldom works treat them together. In this paper, we will show that the integrated control of attitude control, momentum management and power storage can be implemented by using SGCMGs (Single Gimbal Control Moment Gyroscope) and flywheels (including energy storage flywheels and attitude control/energy storage flywheels) as an integrated set of actuators. And the integrated attitude control design is suitable to different attitude control tasks including attitude maneuver, TEA holding and earth-pointing holding, as well as normal modes and failure modes. We firstly describe the core idea of the proposed integrated control. We design the integrated control from two base control modes: one is the IPACS based on momentum management and the other is IPACS with momentum feedback. Using the momentum management, the TEA holding are added to IPACS attitude tasks including attitude maneuver and special attitude pointing (Earth-pointing), in which angular momentum of the actuators remains small and cyclic. Using momentum feedback, IPACS will make actuators angular momentum constant, keeping actuators out of saturation. And then, we propose the controllers in the integrated control for different control tasks with normal and failure conditions. They are attitude Maneuver ADRC (Active Disturbance Rejection Controller), TEA-hold CMAC (Cerebellar Model Articulation Controller) and earth-pointing controller. Finally, the simulation results are provided to testify the effectiveness of the proposed integrated control design. Simulation cases include three attitude control tasks with power storage, two devices modes combining SGCMGs with flywheels, two normal cases and four failure cases.