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ATTITUDE ACQUISITION OF SPACECRAFT WITH MULTIPLE LIQUID STORES

Abstract

Attitude maneuvers of spacecraft using angular momentum transfer technology have been studied for a long time and used widely due to their ease of implementation and propellant and sensor minimizing features. In recent studies, the angular momentum exchange technique was applied to a satellite equipped with a single spherical propellant tank and a momentum wheel fixed in the body frame. Computer simulations were conducted for several cases mainly in order to observe how the propellant slosh influences the attitude acquisition of the satellite. Computer simulation results revealed that slosh propellant as a perturbing mass significantly affect the nutation of the spacecraft, depending on the fuel tank's location. Also an analytic model was developed to predict minimum wheel torques achieving desired turnover and maneuver times. However, due to the complexity of the spacecraft model, the previous studies mostly used a rigid body spacecraft with a single propellant tank or without at all. Nowadays most of spacecraft including communication satellites carry large multiple propellant tanks for a longer space mission or an extended orbit life. Especially, the satellites that use bipropellant propulsion system need multiple propellant tanks. In this study, we will develop physical and mathematical models for attitude motion of a spacecraft which is equipped with multiple control wheels and liquid stores. In order to describe the motion of the fluid in tank lots of assumptions will be made. One of those is to replace the slosh masses by equivalent mechanical models such as spherical pendulums. Based on Newton-Euler method, full nonlinear equations of motion will be derived. Derived mathematical model should be general to simulate most of reorientation problems of the satellite system. Numerical technique will be used mainly to solve the equations of motion and analytical work for some particular cases will also be made and compared with numerical solutions.