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REAL TIME GAIN STABILIZATION OF FLEXIBLE SPACECRAFT DURING ORBIT MANEUVERS USING THRUSTER OFF-MODULATION BASED CASCADED NOTCH FILTER DESIGN

Abstract

Low Earth Orbiting (LEO) spacecraft experiences gradual orbital decay due to the atmospheric drag and hence frequent orbit maneuvers are required to raise the altitude of the spacecraft orbit. During orbit maneuvers, thrusters are fired simultaneously to provide the sufficient ΔV required along a particular direction for raising the orbit height. Due to thruster mounting location and uncertainties in Spacecraft Center of Gravity (CG), the net torque acting on the spacecraft during thruster firing for orbit maneuver is high. Due to momentum and torque limitations, reaction wheels could not be used for attitude control during this region. Hence, attitude control is carried out by operating thrusters in off-modulation. As such, the net torque acting during orbit maneuver is a non-zero mean rectangular pulse train, for which the frequency response is a sync waveform multiplied with a series of impulses at frequencies that are dependent on the frequency of rectangular pulse train and causes oscillations of the spacecraft at those frequencies which results in poor attitude pointing and thus the expected orbit rising may not be achieved. Also, if this frequency interacts with the flexible spacecraft frequency, the amplitude of oscillations will be more and the orbit rising will be further deteriorated. Hence, for precision pointing, a cascaded notch filter is designed with real-time computation of notch frequencies corresponding to flexible appendages and the frequency of rectangular pulse train due to off-modulated thruster firing. With this proposed structure, Gain stabilization is achieved at these frequencies thereby eliminating the control structure interactions.