Least Squares Sliding Mode Control Tracking of Spacecraft Large Angle Maneuvers

Robinett, R.D., Parker, G. G.


Abstract
A method for sliding mode control tracking of Euler parameter commands for large body angle maneuvers is presented. The closed-loop responses of the four-attitude Euler parameters are specified as stable sliding surfaces in the error-error rate Euler parameter phase planes. The matrix coefficient of the typical discontinuous disturbance accommodation portion of the sliding mode control law is chosen as the configuration-dependent transformation between body-fixed coordinate angular velocities and the quaternion rates. This choice of control law parameterization results in a globally asymptotically stable closed-loop response where the tracking performance matches the desired in a least-squares sense. In addition, all inherent kinematic singularities are removed since the Euler parameters are directly tracked. Simulation results for a typical satellite system are presented exemplifying the theoretical development of the robustness-to-mass property and the initial condition uncertainty.

Keywords: Spacecraft Maneuvers, Least Squares Method, Sliding Mode Control, Euler Equations Of Motion, Tracking Control, Angular Velocity, Command And Control, Coordinate Transformations, Asymptotic Methods, Control Stability, Parameter Uncertainty