ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (5)

Author: Mr. LI DONGBAI
Research Center of Satellite Technology, Harbin Institute of Technology, China

Prof. Baolin Wu
Harbin Institute of Technology, China
Prof. ZHANG YINGCHUN
China
Mr. Xiaoyu Lang
Research Center of Satellite Technology, Harbin Institute of Technology, China

ADAPTIVE ATTITUDE CONTROL FOR SPACECRAFT WITH UNKNOWN DEAD-ZONE OF THRUSTER

Abstract

Attitude control systems are required to provide the present generation of spacecraft with attitude maneuver, tracking and pointing capabilities. The equations that govern attitude maneuvers and attitude tracking are nonlinear and coupled. Thus, the attitude control system must consider these nonlinear dynamics. Various nonlinear control algorithms have been proposed for solving the attitude tracking control problem for spacecraft.

The various attitude control approaches are based on an assumption that the spacecraft operates without any dead-zone nonlinearity in its actuators. However, in practice, the dead-zone phenomenon exists in spacecraft actuators, such as thruster. The dead-zone phenomenon of thruster is caused by Minimum Impulse Bit and the rise time from the ON-command of the thruster valve till 90% of the nominal thrust is reached. The effect of the thruster dead-zone severely limits attitude control performance. Therefore, the effect of thruster dead-zone should be taken into consideration in the design and analysis of attitude control systems. To the best knowledge of the authors, there are few papers investigate this issue.

This paper aims to develop adaptive control scheme for spacecraft attitude tracking in presence of the unknown thruster dead zones and external disturbances. Unit quaternion, which is globally nonsingular, is used for attitude representation. A smooth inverse of the dead-zone is employed to compensate for the effect of the actuator dead-zone in controller design. The dead-zone parameters and the upper bound of the disturbance-like term are estimated by adaptive schemes. Using Barbalat's Lemma, the stability of the resulting closed-loop systems is guaranteed. Numerical simulations show that the spacecraft can approach the time-varying desired attitude in the presence of the unknown actuator dead zones with the proposed control scheme.