ASTRODYNAMICS SYMPOSIUM (C1)
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Author: Mr. Junoh Jung
Yonsei University, Korea, Republic of, astonut@gmail.com

Prof. Sang-Young Park
Yonsei University, Korea, Republic of, spark@galaxy.yonsei.ac.kr
Prof. Kyu-Hong Choi
Yonsei University, Korea, Republic of, khchoi@galaxy.yonsei.ac.kr
Mr. Dongwook Koh
Yonsei University, Korea, Republic of, dwkoh@galaxy.yonsei.ac.kr

LABORATORY EXPERIMENTS FOR VALIDATING SPACECRAFT ATTITUDE CONTROL LAWS

Abstract

Recently, the control technology test system using Hardware-In-the-Loop (HIL) simulation has received high attention as to ensure reliability of spacecraft attitude configurations. In this paper, we present potent experiments to validate spacecraft control algorithms using air-bearing attitude control simulator. The HIL Simulator (HILS) consists of three momentum wheels and eight cold gas thrusters for 3-axis attitude actuations. An adaptive controller is utilized to estimate the mass properties such as the mass distribution and moment of inertia of the system before any performance test of the HILS. A Proportional Integral Derivative (PID) controller, a Bang-bang and a Pulse-Width and Pulse-Frequency (PWPF) modulator are applied to the actuator's operation. In addition, the spacecraft attitude controllers employing theories of state feedback design, Lyapunov based adaptive controller and Modified Rodrigues Parameters (MRPs) concept describing spacecraft attitude are tested by HILS. Moreover, tracking control laws are simultaneously implemented to HILS by utilizing both momentum wheels and thrusters. All controllers are implemented in the software based on the simulator using the PC104 which is an embedded computer (Onboard PC) communicating with a host PC and attitude sensors. Results of the numerical HIL simulations are then compared with software experimental results using commercial tools such as MATLAB/SIMULINK. As the results reveal, the simulation successfully demonstrates the capability of the HILS and the experiments appropriately validate the numerous spacecraft attitude control algorithms for the spacecraft with momentum wheels and thrusters.