Paper ID: 24137
oral

SPACE SYSTEMS SYMPOSIUM (D1)
Training, Achievements, and Lessons Learned in Space Systems (5)

Author: Dr. Lorenzo Arena
University of Rome "La Sapienza", Italy

A SMALL, LOW-COST AND MAINTENANCE-FREE TEST-BED FOR AGILE SATELLITES ATTITUDE CONTROL USING MOMENTUM EXCHANGE DEVICES

Abstract

The ground test of satellites attitude motion is a task of primary importance when new attitude control devices or algorithms are used, since it allows to carry out several tests, verifying the performance before flight and permitting a fast and efficient identification of expected performance, hence limiting the overall development time and cost. The current methods to simulate on-earth the satellites attitude motion use robotics manipulators and spherical air bearings, which are complex, quite expensive and very delicate devices. This paper describes a small, low-cost and maintenance-free test-bed for agile satellites attitude control systems using momentum exchange devices. The test-bed consists of a small platform, equipped with momentum exchange devices, suspended on its center of mass by a sharp-tip element, providing a low friction contact needful to properly reproduce the on-orbit conditions. The suspension method assures continuous operation without any external energy sources, the absence of noise, a small footprint and a simple and quick installation. The overall apparatus weighs only a few kilograms and it is suitable to simulate the on-orbit behavior of an agile small satellite. The platform is equipped with a series of sensors providing attitude and angular velocity measurements, an electronic control board, a radio module and a battery pack. The control board reads the sensors data and use them to estimate the platform dynamical state thanks a Kalman filter, receives the command data from the radio module, performs the commanded maneuver, saves the dynamical state data and send them, thanks to the radio module, to the remote control computer. The suggested spacecraft attitude control system testing platform allows direct visual inspection of the momentum exchange among the on-board moving parts. This seems a useful tool not only for control systems engineers, but also for spacecraft operators, giving a direct feeling of the commands and maneuvers dynamical consequences. Hence the platform, being easily re-configurable, portable and maintenance-free, besides spacecraft specialists training, could be a valuable space outreach tool, with an educational value, providing an interesting and exciting way to high school and university students to deeply understand the rotational dynamics of rigid bodies. This paper shows the results of a series of rest-to-rest maneuvers performed with different configurations of the momentum exchange devices and the approach used to execute them, ultimately proving the suitability of this system to be a training instrument for the attitude guide, navigation and control of a small satellite.