

SPACE SYSTEMS SYMPOSIUM (D1)
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Author: Prof. Mehran Mirshams
K. N. Toosi University of Technology, Iran

Mr. Hojjat Taei
K. N. Toosi University of Technology, Iran
Dr. Alireza Novin zadeh
Space Research Lab., K.N.Toosi university of technology , Iran
Ms. Fatemeh Ebadi
Space Research Lab., K.N.Toosi university of technology , Iran

A 3-DOF SATELLITE SIMULATOR DESIGN AND DEVELOPMENT

Abstract

Simulation is one of the best methods for education and understanding events and used in many fields of science, for example: space researches. For this reason, creating of a frictionless environment that can simulate the operations of satellites will be very usable and appropriate.

Spherical air bearings, that we call them TEST-BEDs in this paper, are one of the most common devices used in satellite attitude dynamics simulation, because they provide three degrees of freedom rotational motion. They are employed to develop, improve and carry out operational tests of sensors, actuators and attitude control algorithms in experimental framework.

In spherical air bearings, pressurized air passes through holes in the grounded section of bearing (cup) and establishes a thin film that supports the weight of sphere.

This environment will be frictionless (because the air film is an effective lubricant) and will provide unconstrained rotational motion, thus it can simulate a satellite.

We have manufactured a test-bed with 200kg payload capacity in Space Research Lab. Our test-bed can rotate 360 in roll and yaw axes, and 25 in pitch. This work has been done in four stages: 1) Deriving equations of motion of test-bed with dynamical methods. 2) Designing of a control algorithm with consideration equations. 3) Selection of subsystems and assembling them. 4) Examination of test-bed with several test-algorithms and validation of our design and development.

Test-bed has several subsystems: power unit, attitude determination sensor, three reaction wheels aligned along the roll, pitch and yaw axes as actuators, on-board computer and spherical air bearing.

In this paper, one can find explanation of test-bed technical characteristics, limitations and manufacturing details, control algorithm with consideration requirements and limitations for system, and the way of choosing suitable hard-wares for actuators, attitude determination sensor, on-board computer and power unit. Development of simulator with test algorithms and its results will be presented in this paper, too.