Paper ID: 18129
oral

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

Author: Prof. Paolo Gasbarri
Università di Roma "La Sapienza", Italy

Dr. Marco Sabatini
Sapienza University of Rome, Italy
Mr. Nazareno Leonangeli
Sapienza University of Rome, Italy
Prof. Giovanni B. Palmerini
Sapienza University of Rome, Italy

FLEXIBILITY ISSUES IN DISCRETE ON-OFF ACTUATED SPACECRAFT: NUMERICAL AND EXPERIMENTAL TESTS

Abstract

On orbit maneuvering of very flexible space structures requires a special caution. In fact the task of reaching the desired attitude is complicated by the extreme flexibility of the structure itself, which causes the interaction between rigid and elastic motion. For studying this problem, an experimental testbed is designed and realized at the Guidance and Navigation Laboratory at La Sapienza, University of Rome. In particular, a free floating platform with elastic appendages (simulating solar panels) enables a two-dimensional test of complex space operations such as attitude and/or in-plane station keeping maneuvers. The platform is equipped with an IMU and actuated via cold gas thrusters. In addition, an on-board camera is used to acquire the flexible displacements of the appendages. The present work is focused on studying (numerically and experimentally) the effects of the attitude control on the flexible panels dynamics and vice-versa. In fact the on-off actuation provided by the thrusters generates the excitation of the appendages that in turn could destabilize the commanded attitude maneuver. In order to limit this interaction, it is possible to act in two ways, namely changing the reference signal to track, or including an in-line information of the flexible dynamics of the system. In the first case, an Input Shaping Technique will be applied to the nominal state, transforming it from a single step function to a modulated staircase function. This technique improves the settling time and the position accuracy, while minimizing residual vibrations. For reaching this goal, the knowledge of the natural frequencies and of the relevant damping factors of the system is needed. Therefore the camera can be used to off-line estimate the natural frequencies and damping factors of the modal shapes of the multibody system. In the second case, a real-time algorithm, based on image processing is tested in order to verify the possibility to implement an active vibration damping system. The adaptive control law takes both attitude and flexible measurements into account and is based on the behavior in time of the overall system. Numerical simulation and experimental campaign will show the main characteristics of both approaches and highlight relevant advantages and drawbacks.