Paper ID: 50004
oral
student

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

Author: Ms. Federica Angeletti
Sapienza University of Rome, Italy, federica.angeletti@uniroma1.it

Prof. Paolo Gasbarri
Sapienza University of Rome, Italy, paolo.gasbarri@uniroma1.it
Dr. Marco Sabatini
Sapienza University of Rome, Italy, marco.sabatini@uniroma1.it
Mr. Paolo Iannelli
Sapienza University of Rome, Italy, iannellipaolo.94@gmail.com

DISTRIBUTED NETWORK OF SMART ACTUATORS/SENSORS FOR ACTIVE MICRO-VIBRATION CONTROL IN LARGE SPACE ANTENNA STRUCTURES

Abstract

One of the major needs of future Earth Observation spacecrafts is to fulfil high demanding pointing requirements when using instrumentation supported by or mounted at the end of very large flexible truss structures. Both imaging missions and communication satellites pose challenging environments for micro-vibration control and mitigation. Those spacecrafts often call for the capacity of performing fast and precise manoeuvres without losing strict control over flexible parts. In this context, avoiding geometric distortions in images or issues affecting the accuracy of communications is a critical objective to be achieved in the near future.

On-board mechanical disturbances can be generated by frequently used devices as attitude control equipment and pointing mechanisms. Thermal deformation and thrusters jetting can also affect the system required accuracy. Those perturbations are transmitted from the spacecraft platform to the antenna supporting structure, deteriorating the mission performance. In this perspective, a network of smart actuators/sensors can be embedded in the supporting frame elements to make the structure active and to counteract undesired elastic vibrations.

In this paper, the problem of micro-vibration control for an in-orbit spacecraft equipped with a very large flexible antenna is addressed. The instrument is sustained by a deployable active truss frame hosting an optimum network of distributed actuators and sensors dedicated to vibrations suppression. The fully coupled 3-D equations for an in-orbit flexible spacecraft subjected to gravitational forces and orbit disturbances are derived taking into account the presence of the smart materials. The 3-D flexible structure model is developed and validated via FEM formulation by using commercial codes. The model is then reduced to obtain a system to be easily handled by control systems algorithms. A typical profile of an attitude manoeuvre is then simulated by applying a torque generated either from reaction thrusters or motors connected to reaction wheels while simultaneously suppressing unwanted vibrations. To achieve high performance, advanced multivariable methods are implemented to coordinate the simultaneous action of actuators devices and ensure structural accuracy and pointing requirements are satisfied during operations. In addition, the properties of space components may be affected by slight changes due to launch loads or orbit aging. The effects of the attitude and vibration control authority and its robustness to uncertainties on mechanical and elastic parameters of both passive structure and actuators are also analysed and discussed.