 Paper ID: 6985

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

Author: Dr. Kosei Ishimura
Japan Aerospace Exploration Agency (JAXA), ISAS, Japan, ishimura@isas.jaxa.jp

Dr. Atsuhiko Senba
Nagoya University, Japan, senba@nuae.nagoya-u.ac.jp
Dr. Takashi Iwasa
Japan, iwasa@mech.tottori-u.ac.jp
Prof. Yoshiro Ogi
Japan, ogi@iis.u-tokyo.ac.jp
Dr. Takeshi Akita
Japan Aerospace Exploration Agency (JAXA), Japan, akita.takeshi@jaxa.jp
Prof. Hiroshi Furuya
Tokyo Institute of Technology, Japan, furuya@enveng.titech.ac.jp
Prof. Kenji Minesugi
Japan Aerospace Exploration Agency (JAXA), Japan, minesugi@svs.eng.isas.jaxa.jp

PREDICTION, MEASUREMENT AND STABILIZATION OF STRUCTURAL DEFORMATION ON ORBIT

Abstract

Requirement for shape stability of space structures such as barrel for space telescope tends to become more precisely. In addition to it, large size over 10 meters is sometimes required for such support structure to meet advanced science missions. To realize large and precise support structures, comprehensive techniques including prediction, measurement and stabilization techniques on orbit are needed. In this paper, we introduce some fundamental techniques to keep the precise shape for a slender box truss as a representative support structure. The structural deformation on orbit is induced by thermal distribution, disturbance (RW/MW/SAD etc.) and so on. In this paper, we focus on the relative displacement between both end-surfaces of the slender box truss as structural deformation because such a relative displacement is very important for some support structures. For example, if some instruments such as mirrors and detectors are attached on the both end-surfaces, the relative displacement must be well controlled on orbit. At first, we analyzed thermal distribution and thermal distortion of the truss structure to predict the thermal deformation. The accuracy of analysis results is evaluated through experiments with a five-bay truss structure. Then, system identification is carried out to identify the stiffness of the structure because precise identification of the stiffness is required for the precise prediction of thermal deformation in the case of indeterminate structure. As a first step, the stiffness matrix is identified by using particle swarm optimization method from the experimental data of natural frequency. The natural frequency obtained from the identified stiffness matrix has error within 1%. At last, we attempt to compensate the deformation induced by thermally and non-thermally causes. For the compensation, we used thermal expansion conversely through temperature control of some truss members. Analysis and experiments including an internal measurement system of the deformation are carried out. As a result, it is shown that the deformation of truss structure could be compensated with good accuracy, for example, within 200μm for 2m truss.