Paper ID: 13810
oral
student

SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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PRECISION POINTING CONTROL OF A LARGE SEGMENTED SPACE TELESCOPE TESTBED

Abstract

A large, segmented space telescope requires high precision and accuracy in its mirror shape to obtain clear images. In addition, in order to obtain clear and high quality images of very distant objects, a high level of pointing accuracy is necessary. The Structures, Propulsion, and Control Engineering (SPACE) telescope testbed at the NASA sponsored University Research Center (URC) of excellence must achieve figure maintenance of the primary mirror to within 1 micron RMS distortion with respect to a nominal shape of the primary mirror while maintaining a pointing accuracy of 2 arc seconds. This paper will focus on precision pointing control of the SPACE testbed.

A Peripheral Pointing Architecture (PPA) has been designed to demonstrate the testbed's pointing accuracy. The PPA includes a dual actuator (tip/tilt) laser platform to simulate the incident light from a distant object, along with 12 accessory mirrors to focus the lasers onto the plane of the testbed's optical detectors. In order to design a controller to handle the pointing of platform, a plant model is first developed. First, a mechanical model was created in SolidWorks then imported into FEMAP (Finite Element Modeling And Postprocessing). Subsequently a Finite Element Analysis (FEA) model of the PPA is meshed in FEMAP. Finally, normal mode analysis is performed to establish the PPA's natural frequencies/eigenvalues, mode shapes, and its mass and stiffness matrices. With the modeshapes and eigenvalues in hand, the equations of motion governing the dynamics of the laser platform can be transformed into an equivalent set of equations in terms of the system's generalized coordinates. The resulting equations are decoupled and used for determination of a state-space model. Utilizing the H-infinity controllers developed to achieve figure maintenance, the pointing control of the testbed structure is achieved.