MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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A ROBOTICALLY-ASSEMBLED 100-METER SPACE TELESCOPE

Abstract

The future of astronomy may rely on extremely large space telescopes in order to image Earth-sized exoplanets or study the first stars. These telescopes will not be possible without a radical shift in design methods and concepts that are not limited by the size of a single payload fairing. In-Space Telescope Assembly Robotics (ISTAR) is one solution. The ISTAR project has developed a concept for an optical space telescope with a collecting area of nearly 8000 square meters, launched in pieces from the ground, and assembled by highly dexterous robots in space. The concept has been demonstrated to meet optical requirements and failure criteria.

This paper focuses on the design and feasibility analysis of the telescope structure, as it has to be stiff and precise enough to maintain optical tolerances while also being amenable to robotic operations. The overall optical scheme of the telescope is first presented, which includes four main elements: a spherical primary mirror roughly hexagonal in shape spanning 100 meters flat to flat; an eyepiece containing all subsequent mirrors and detectors; a metrology system; and a sun shade. The conceived structure that connects and supports these components is then detailed, beginning with the concept of operations and assembly process and ending with the results of a comprehensive structural analysis. Particular attention is given to the truss structure that supports the primary mirror segments, called the backplane. The backplane design uses both robotic assembly and deployable structures to reduce assembly time, featuring expanding truss modules grouped with pre-assembled clusters of mirror segments that are connected together in space. The truss geometry of the structure was chosen from a vast design space, which was

first narrowed using "back-of-the-envelope" analytical methods, to satisfy vibrational stiffness and mass criteria. Higher fidelity simulations using finite element analysis and matrix methods were then used to demonstrate that the structure meets optical and failure strength requirements while subjected to loads typically encountered in the space environment.

This paper includes many of the decisions and trades made throughout the activity, providing a reference for the design of large modular space structures and laying the groundwork for future flight missions of this nature.