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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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APPLICATION OF SELF-DEPLOYABLE TRUSS TO STARSHADE

Abstract

The observation of exoplanets has become active along with the improvement of indirect observation techniques in recent years, such as transit photometry. However, the direct observation of a planet orbiting around a fixed star has not been realized yet because the star's light enters the space telescope and disturbs the observation of the planet. Hence the starshade system is suggested as a solution to enable the direct observation. The starshade is a direct observation system of the exoplanets that blocks the star's light by placing a large membrane shield (occulter) of dozens of meters in diameter between the space telescope and the star. NASA proposes a deployable flower-shaped occulter, which seems too complex mechanical system. The author has proposed a self-deployable truss structure that consists of self-extensible booms, and formulated the deformation theory of the boom and the truss structure. We have evaluated the deployment behavior of the truss by the numerical simulation and the experiment of conceptual models up to 20m in diameter. The author has proposed a design method based on the theory and the evaluated result. Conventional self-deployable structures have been applied only to simple structures such as de-orbit devices of several meters in diameter. On the other hand, the proposed truss can be applied to much larger deployable structure to support a thin membrane such as a starshade. The proposed self-deployable truss has three major advantages over other deployable structures. The first one is that the deployment is more reliable with simpler mechanisms and no motor-powered actuator. The second one is that its development cost is lower because of its simple mechanism. The last one is that it is fabricated with the design assured theoretically and experimentally. However, the proposed truss does not correspond to the curved shape such as the flower-shaped occulter so far, because the booms extend straightly. In this paper, the concept of self-deployable membrane truss structure with curved shape is proposed to apply to the occulter. The structure consists of the self-deployable truss, a thin membrane covering the truss surface, curved films, and small actuators such as macro fiber composites (MFC) and shape memory polymers to adjust the films to the required shape with high accuracy. The design procedure of the proposed structure is evaluated by the deployment experiment of the prototype.