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

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SPACE DEMONSTRATION OF OCCULTER USING SELF-DEPLOYABLE MEMBRANE TRUSS

Abstract

Numerous exoplanets have been discovered so far. Most of them have been discovered by indirect observation, but it is necessary to observe the exoplanet directly to obtain its atmospheric information to investigate the habitable environment. However, the stellar light disturbs the direct observation since the star is so bright compared to the exoplanet. As a countermeasure against the disturbance, the starshade system has been proposed that allows direct observation of the exoplanet by blocking the stellar light using a large membrane shield (occulter) placed between the star and the space telescope. NASA is considering the starshade mission Exo-S, but the proposed occulter structure seems to be complicated. On the other hand, the authors have been studying on a self-deployable membrane truss (SDMT) consisted of a membrane and self-extensible booms that have high spring back effect and can be rolled-up into small volume. The proposed SDMT is a simple structure that deploys without any powered actuators. In addition, the authors have proposed a theoretical design method of SDMT in previous studies and verified the theory experimentally. Thus, the SDMT has two advantages against the conventional deployable structure, i.e. the development cost can be suppressed, and the design is guaranteed both theoretically and experimentally. The authors consider that the starshade mission can be more reliably achieved at lower costs by using SDMT. The occulter in Exo-S has a curved shape like a petal, but the author proposed a novel occulter suitable for SDMT that is consisted of straight booms and a non-transmissive membrane with several high-transmissive area. The authors found that the proposed occulter has the equivalent performance to the conventional occulter by the numerical calculation. In addition, it was confirmed by deployment experiments using the proposed occulter scale model that the proposed occulter deploys surely. The authors are planning to demonstrate the deployment of the occulter using a SDMT on orbit as the next step. In the space demonstration, the occulter with a diameter of 5 m will be deployed and the shape will be measured. In this paper, it will be shown that the proposed occulter has enough stiffness to maintain occulting performance through the structural analysis, and design procedure, assembly procedure, and deployability will be evaluated through the deployment experiment of BBM.