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Space Structures - Dynamics and Microdynamics (3)

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SURFACE SHAPE MEASUREMENT OF VIBRATING MEMBRANE INDUCED BY IMPACT LOADING

Abstract

Since a membrane space structure has a feature of an ultra-lightweight and high packaging capability, the membrane space structure has wide attention to accomplish a future advanced space mission. However, due to its high elastic flexibility, a vibration easily occurs after the deployment. Once the vibration occurs on the membrane structures, it has no small effect on the operation function in an orbit. Accordingly, a clarification of the membrane dynamic behavior is a significant issue to establish the future membrane space structure.

To clarify the membrane dynamic behavior in detail, it is necessary to measure the dynamic responses of the membrane, which are composed of a wave propagation phenomenon, a transition phenomenon from the wave propagation to a stationary vibration and the stationary vibration phenomenon. Especially, when the wave propagation phenomenon is captured, the shape measurement method capable of capturing a whole field surface shape of the vibrating membranes with a high spatial resolution is required.

So, in this work, as a continuous surface shape measurement for the vibrating membranes, a photogrammetric measurement based on a grating projection method is applied. Since the grating projection method has a feature of capturing three dimensional coordinates of the object by a pixel to pixel basis, the surface shape of the vibrating membrane can be obtained with a high spatial resolution. A measurement object is a rectangular polyimide film whose size is 0.70 x 0.40 m2 and its thickness is 12.5 x 10-6 m. In this work, the dynamic responses of the rectangular membranes, which held fixed at three corners and subjected to an impact loading at the remaining corner, are measured.

The measurement results show that the continuous surface shape measurement of the grating projection method suitably capture the dynamic membrane behavior with a high spatial resolution. Especially, the complicated dynamic responses, which are the wave propagation phenomenon, a transition phenomenon from the wave propagation to the stationary vibration and the stationary vibration phenomenon, can be successfully obtained in exact detail.

This paper presents the effectiveness of the grating projection method for measuring the surface shape of the vibrating membranes, and the discussion results on the mechanical properties of the vibrating membranes based on the shape measurement data.