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VIBRATION CONTROL FOR MEMBRANE BY SMART DYNAMIC VIBRATION ABSORBER

Abstract

The purpose of this study is to suppress vibration of a membrane efficiently and robustly by a smart dynamic vibration absorber. In recent years, space structural systems have been required high precision and high functionality for advanced space missions. Tension-Stabilized Structures which have lightweight and high storage efficiency have attracted attention as large structural systems to meet those requirements, and were used for large space structures including solar sails and mesh antennas before. They are composed predominantly of strings and membranes. Therefore, vibration control for strings and membranes is one of the most important issues to realize high mirror accuracy of antennas for high-resolution observation and high-capacity communication. Tension control is one of the methods for vibration control for strings and membranes. But it can not perform sufficiently for micro vibration suppression because the damping force is perpendicular to the direction of vibration. In contrast, a dynamic vibration absorber is able to suppress micro vibration of strings and membranes without a decrease in performance. However, it is sensitive to the change of natural frequency of the controlled object, so it has been a problem that aging degradation and temperature dependency decrease the performance of a dynamic vibration absorber. The present study was aimed at solving these problems by self-sensing actuation of a smart dynamic vibration absorber. In this paper, a small cantilever with piezoelectric transducer was used for a smart dynamic vibration absorber. It was enough small and light to attach to a membrane. The natural frequency could be tuned by variable mass attached to the tip of the cantilever. A membrane was supported by flexible beams modeled on actual Tension-Stabilized Structures in space. We propose the control method to estimate the system state values from only the sensor signal of smart dynamic vibration absorber by the extended Kalman filter, because there is no jig to equip any sensor to observe the absolute displacement of the membrane in actual space structures. In experiments, the smart dynamic vibration absorber was used on the surface of the membrane. Experimental results showed that the vibration was suppressed by the passive and smart dynamic vibration absorber, and that the present control method improved the effect and robustness. This study verified that a smart dynamic vibration absorber was efficiently and robustly able to suppress the vibration of the membrane.