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MODEL-FREE CONTROL FOR ACTIVE MULTI-MODE VIBRATION CONFINEMENT OF SPACEBORNE TRUSS USING A SIX-DEGREE-OF-FREEDOM STEWART PLATFORM

Abstract

Spaceborne truss, frequently applied in aerospace engineering, exhibits multi-mode vibration when subjected to external disturbance, which is detrimental to the structure health. In terms of active multi-mode vibration suppression of the truss structure, an effective resolution may be to use a six-degree-of-freedom (6DOF) Stewart platform as the controllable mount to support the truss structure. Due to the uncertainty and complexity of the truss structure modeling in application, the prior model-based control methods which require precise system modeling may not be applicable to robust vibration attenuation. Therefore, this study proposed a new model-free control approach that is independent of the system model, leading to significant robustness enhancement. The important element of the present method is linear extended state observer (LESO), which estimates the uncertainties and unmodeled portions of the system. In this way, by eliminating the estimated uncertainties and unmodeled portions in the controller, the actual complex system is transformed to be a simply modeled system that is suitable for robust control. The study carefully investigates this model-free method for multi-mode vibration confinement of a triangle truss mounted to a 6DOF Stewart platform numerically and experimentally. Governing equations of the multi-degree-of-freedom coupled dynamic system are derived, and then numerical simulations are performed. It is seen that multi-mode vibration of the truss is effectively attenuated, and the control performance is robust against significant variation of the truss structure mass. Finally, experiments of the first three mode vibration attenuation of a triangle truss mounted to the Stewart platform using the proposed control method are conducted, which verifies the viability of the present method for performance robustness enhancement.