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APPLICATION OF TOPOLOGY AND SIZE OPTIMIZATION FOR A MICRO-SATELLITE STRUCTURE DESIGN

Abstract

This paper presents the application of topology and size optimization on the structure subsystem of a real micro-satellite. The satellite is tentatively scheduled to be launched in 2020. Several tests, such as remote sensing, mechanism deployment and air traffic arrangement, will be carried out during the 12 months lifetime. As the satellite is developed by university, it gives a great opportunity for students to acquire a hand on practical experience for building a complete satellite. Now, the project has gone into critical design phase.

Preliminary structure design of the satellite has been finished. Typical frame-layer configuration is adopted for this satellite with the dimension of no more than 350m*350mm*650mm and the mass less than 30kg. The satellite is divided into 9 modules by panels in different heights, while fixed by four longitudinal beams in the corner. Subsystem components such as battery and on-board computer are assembled on the panel within 300mm*300mm area.

The preliminary design fulfill the requirement of strength and stiffness, however, the overall weight of structure subsystem is relatively heavy, which will lead to a higher cost. In this condition, the panels with the thickness of 5mm are replaced by the panels with a less thickness while reinforced by stiffeners under it. Topology optimization will be applied in this paper to determine the stiffener layout based on the force path of the satellite. Size optimization is carried out later to find the detailed specifications of the structure design, including thickness of panel and cross section size of stiffener. The final design will be completed on the basis of optimization results.

The comparison between the initial and improved design shows that the final design has reduced the mass by more than 60%, while satisfying all the strength and stiffness requirements. The techniques investigated in this paper could be applied to any aerospace structures to find an improved design for better performance.