MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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HIERARCHICAL MEMBRANE MODULAR STRUCTURES FOR FUTURE LARGE SPACE SYSTEMS

Abstract

Present large space structure systems consist of various modules classified by their individual functions, and they are generally considered to be constructed by robotic units. For example, in the case of the international space station many modules such as the power modules, habitat modules, experiment modules, and so on are assembled by robotic operations using manipulator arms with the aids of astronauts. This construction scheme needs vast amounts of construction resources, and it takes long duration to get their whole configuration. On the other hand future large space structure systems such as solar power satellites consist of many similar uniform modules, which appear repeatedly in the whole system, and each module could include the same simple function for construction. It is considered that the former is the concentrated construction scheme with high level intelligence, and that the latter is the distributed one with low level intelligence in each module. Deployment function is typical one of the construction schemes, which require only rather low level intelligence to construct the whole structure systems. Structure systems consisted of uniform modules in hierarchical order have been called hierarchical modular structure systems, which just fit to future large space structure systems, and some of their construction schemes using rigid modules have been already studied. In this paper, application of membrane deployable modules to hierarchical modular structure systems is investigated, and its basic possibility is demonstrated through the deployment experiments of laboratory scale conceptual models actuated by inflatable tubes.

A hexagonal disk-like flat membrane element is important as a basic one for future large space systems, and it can be folded spirally around its center body (spiral folding), even if it has thick property for actual space missions such as patch antennas. In this paper, hexagonal membrane elements connected with inflatable tubes through cable networks are used, and inflatable tubes are set around the peripheral parts of the elements, which corresponds to one module for the whole hierarchical modular structure system. Conceptual membrane modules for deployment experiments, which are in the scale of a laboratory room, are made of polyethylene terephthalate (PET) film. They are connected by inextensional cable nets, which keep the external shape of the module model adequately, and also give distinct interface points of the model. Six modules are connected at the interface points to form one whole structure model. Deployment behaviors of the module model and the whole model are observed to get clear understanding of the behaviors of hierarchical modular structure systems during their deployment construction.