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ORIGAMI-BASED MEMBRANE STORAGE AND DEPLOYMENT TECHNOLOGY FOR DE-ORBITING SATELLITES

Abstract

This paper presents the innovative structural concept to deploy a membrane for de-orbiting small satellites. Based on the concept, our team is currently developing a component to deploy a 4.5m-size square membrane for a 100 kg-class small satellite to be launched in 2016. The significance of the concept, the details of a preliminary component design, and some results of tests using prototype models are reported. In order to satisfy the 25-year rule, various de-orbiting methods have been proposed and some of them have been demonstrated in orbit. One prevailing approach for small satellites is to deploy a membrane using deployable booms made of convex tapes (carpenter tapes). This kind of design can make deployment mechanisms simple because the deployable booms themselves provide deployment force

for both membrane and booms. However, the problem is that convex booms are often not stiff enough to prevent buckling during and after the deployment. The situation is made worse by the fact that conventional membrane folding patterns restrict the membrane to be connected only at the booms' tip, which causes the booms' buckling. In addition, conventional deployment mechanisms for convex booms often use violent deployment, which may cause the membrane to be torn. In order to solve the abovementioned problems, this paper describes the membrane-deployment component that has three distinct features. First, an innovative membrane folding pattern, based on Japanese traditional Origami (the art of paper folding) concept, enables the membrane and the booms connected at multiple points along the boom length. This significantly relaxes the loading condition for the booms. Second, a new type of bi-convex boom has been invented that has much higher bending stiffness than conventional convex booms. And finally, the proposed step-wise deployment mechanisms realize the controlled deployment, which has less impact on the satellites attitude. The component is currently at the prototyping phase and has been tested on the ground.