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STUDY AND DESIGN OF COMPACT ORIGAMI UNFOLDING SOLAR ARRAY STRUCTURE

Abstract

With the onset of interplanetary and deep space exploration missions, availability of alternative renewable power source has been on the rise. Solar energy is still the primary source of energy in space. Multijunction cells can be used in space which has staggering efficiencies of more than 30% but this is not enough for the power requirements of satellites used for deep space exploration and interplanetary missions. Using more solar panels is a simple solution but not a cost, space, payload and time effective one. In order to address the ever-blooming demand of more power generation through a compact aerial technology which can be easily stored in a small volume and then expanded into space has been a prominent prospect of research among scientists. This paper addresses this particular prospect with the OUSAR (Origami Unfolding Solar Array) concept which uses solar array up to 1 to 1.5 m in length which is able to provide a peak power up to 100 W and the array can be deployed from a 0.5 U CubeSat form factor, which serves as a state-of-the-art solution to power during the onboard mission. The performance metrics of OUSAR allows the solar array to be stored with the minimum linear expansion ratio of 15:1, which is a boom for the high-efficiency solar cells to be incorporated in this minimum thickness substrate for providing long operational life and achieving the power range. The paper encompasses the hold of developing OUSAR technique derived from Miura-origami pattern for Spacecraft structures along with reviewing the existing folding techniques in order to compare their expansion ratio, thickness ratio and minimal mass ratio with OUSAR. The second section of the paper focuses on examining deployed stiffness, stress analysis, gravity force calculations for strength testing, vibration testing and energy output testing is accompanied by Nastran and Patran. Finally, a design trade-off is investigated between the target shape approximation error using Tree Maker by Robert J. Lang and MATLAB to achieve a high ratio between packed volume and deployed area. Thus, the cynosure of this paper lies in developing the architecture of modular origami pattern that doesn't negatively affect the packaging efficiency once stowed. The parametric performance is targeted to provide support to CubeSats and Micro-Sats in deep space exploration and interplanetary missions lying within the power range.