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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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DEVELOPMENT AND MICROGRAVITY TESTING OF ORIGAMI-INSPIRED STRUCTURES FOR FUTURE SPACE APPLICATIONS

Abstract

Many space technologies are enabled by deployable mechanisms or structures: solar panels, radiators, and even crewed stations and rovers subsystems need to be stowed and deployed to fit in a launcher fairing and avoid unwanted vibrations during launch. Among those structures, the deployment of large membranes and panels can be designed with the help of an unexpected technique: origami folding. The idea has been spreading in every field of engineering in the past few years; compact, rigid-folded structures that can change shape in one simple motion fascinate micro-roboticists as well as aerospace engineers.

Origami-inspired structures can be engineered to answer many needs. The available launch volume can be optimized, creases can improve the rigidity of a structure while keeping it lightweight, thickness can be accounted for, and complex surfaces can be approximated by flat-foldable mechanisms. The Japan Aerospace Exploration Agency (JAXA) was the first aerospace actor to test origami-inspired solar panels in space in 1995 aboard the Space Flyer Unit; NASA is currently considering a similar approach for an upcoming telescope mission, by launching a compactly folded Starshade demonstrator, deploying as a large membrane to allow for exoplanets to be observed by occulting their star.

Following these breakthroughs, the project presented in this paper was selected for the Parabole 2022 contest, an opportunity to test research projects in microgravity aboard a parabolic flight in October 2022. The aim of this experiment is to characterize and analyze the deployment and folding of innovative origami structure models for current and future space applications, especially enclosed volumes for deployable habitats, fuel tanks, or other resource containers such as asteroids and regolith. A system of stereo cameras will capture the geometries at different set speeds. The models tested will be as similar as possible to their full-size counterparts, being made of space-grade polyimide, and their dynamics will be assessed in near-0g conditions to have a deployment environment that is as accurate as possible. This paper will discuss the design and production of such structures and the elaboration of the microgravity experiment.