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LEO AND GEO APPLICATIONS OF BIO-INSPIRED SMART DEPLOYABLE STRUCTURE

Abstract

Ever larger structures are required to fulfil the need of current and future manned and unmanned space missions. These very large structures include antennas, reflectors, concentrators, solar arrays or boom elements. Due to launch vehicle payload size restrictions, these structures have to be designed deployable in order to be stored in a much smaller volume during launch. Common deployment mechanisms like umbrella deployment with its large number of components and hinges are complex and expensive. An alternative bio-inspired design has been developed where multiple hundreds of inflating cells form a deployable lightweight space structure. With added micro pumps or MEMS valves between neighbouring cells, the whole structure becomes capable of changing its shape and can thereby adapt to changing mission objectives. This paper presents two applications of the developed shape changing structure. The first application is a large boom structure on a Low Earth Orbit with different initial orientations. The multibody simulations show how the orientation and the orbit of this boom structure can be changed by the actuation of the shape changing elements. The system's simplicity and low storage volume makes it perfect for small satellites to stabilise themselves, deploy appendices or to increase the satellite's area for post mission de-orbiting. The second application presented is a deployable structure mounted on a Geostationary Orbit satellite; common very large structures on these satellites are reflectors, concentrators or antennas. An example of such a structure could be a solar power satellite in a GEO orbit that needs to redirect and concentrate the sunlight on stationary solar cells over the pass of a day. The developed smart reflector has the capability of changing its orientation and focal point due to curvature change by actuating the structure making an additional AOCS system unnecessary. The simulation carried out in this paper shows the reflectors deployment and actuation capability with added three body perturbations.