MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

Author: Dr. Xiaofeng Wu
The University of Sydney, Australia

A NOVEL SHAPE MEMORY ALLOY ACTUATOR FOR SOLAR SAILING ATTITUDE CONTROL

Abstract

Despite the potential for solar sails, there is little knowledge regarding the best method of attitude control, and it is uncertain if a highly scalable system can be developed. In this paper, we present investigations into the use of a shape memory alloy actuator to perform a novel boom deflection attitude control mechanism for near and long term solar sailing missions. This study presents the design and manufacturing of the actuator device, and testing of its dynamics response in a simulated space environment. Considerations regarding the integration of the device into existing solar sailing infrastructure, power requirements, and temperature conditions are presented. We introduce a simple static model to evaluate the potential of the attitude control method for a range of sail sizes. The developed actuator mechanism has high potential for controlling the attitude of a solar sail, with numerous advantages include significant mass reductions over existing techniques. It was concluded that with existing technology, the approach could provide adequate attitude control for interplanetary missions over a large range of solar sail sizes. An SMA coil training device and a 3D printed silicone rubber mould were both designed and manufactured to produce several prototype devices for testing. An experimental setup suitable for testing the dynamic response of the SMA coils and the flexible actuator devices in a thermal-vacuum chamber was designed and built. The attitude control concept and actuator device appear to be a viable alternative to current solar sailing attitude control mechanisms. The approach is highly scalable and can operate for both small and large sail sizes with existing sail technology. Advantages over traditional mechanisms include significant weight reductions, an overall lack of additional infrastructure and support, large generated cm/cp offsets and control torques, ease of integration into existing boom stowage and deployment mechanisms, low power requirements, and potential for both slow and fast actuation.