

SPACE SYSTEMS SYMPOSIUM (D1)  
Innovative and Visionary Space Systems Concepts (1)

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STRUCTURE DESIGN AND MODELLING OF AN ORIGAMI-INSPIRED PNEUMATIC SOLAR  
TRACKING SYSTEM FOR NPU-PHONESAT**Abstract**

A novel PhoneSat design which is a foldable picosatellite using smart phone technology is proposed in this paper, which is from a young pioneer satellite project at Northwestern Polytechnical University called "NPU-PhoneSat project". The proper functioning of the NPU-PhoneSat requires the collection of sufficient power for onboard instruments. However, due to the small overall surface area of the picosatellite, body-mounted solar cells are incapable of providing enough power. Deployment of large light-weight solar arrays could increase the solar power to some extent; however, the efficiency of solar power conversion system is rather low if the angle between the solar array and sunlight is small.

Various plants have the ability to follow the sun with their flowers or leaves via a mechanism known as heliotropism, which is characterized by pressure gradients between neighboring motor cells. By adapting this bio-inspired mechanism, in this paper, we present a novel origami-inspired pneumatic solar tracking system for NPU-PhoneSat, which is capable of pointing the solar array towards the sun constantly, thereby ensuring the power supply of the NPU-PhoneSat.

The developed overall structure is made up of a cylindrical boom based on origami patterns, with inflatable air bags folded in the crease of the cylindrical boom. In contrast to the traditional solar tracking system, the origami-inspired pneumatic solar tracking system is inexpensive, simple to fabricate, light in weight and compact in packaging state. After launch, the inflation powders inside the airbag will sublimate, resulting in the semi-unfolded state of the solar tracking system. In order to achieve the omnidirectional tracking without altering the attitude of the NPU-PhoneSat, corresponding longitudinal air bag is inflated through heating the gas inside it, thus achieving the continuous bending of the solar tracking system with the folding line of the origami acting as the hinge as well as providing structure support. The specific attitude of solar array is achieved through the selection of the longitudinal air bags on the circumference and control of the temperature inside it.

This paper will give an overview of the system architecture, as well as addressing the theoretical modeling of the dynamics of the origami-inspired pneumatic solar tracking system. The model is simulated using measured physical parameters of the prototype. Moreover, the theoretical results are verified through a detailed comparison to experiments. Experimental results confirm that the proposed model describes the motion of the tracking system accurately.