Passively actuated, triangular radiator fin array

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Track: Passive Thermal

Abstract: Thermal control is a challenge for spacecraft as they must maintain internal components within operating limits despite significant fluctuations in external and internal thermal loads. Satellites often rely on active thermal control to manage internal temperatures depending on the thermal environment. However, many of these systems are actively managed, relying on the satellite's internal electronics to control the radiator's behavior. The problem of thermal control can be compounded for small satellites, such as CubeSats, which may have high power dissipation per unit surface area, stringent size/weight restrictions, and reduced thermal mass. Passive thermal control is particularly attractive for such small systems, potentially offering increased reliability and simplicity. Efforts to achieve passive, dynamic thermal control of spacecraft radiators has been demonstrated in the literature using louvers actuated by bimetallic coils and radiators deployed by shape memory alloys. In this work, we propose a passive, dynamic thermal control method for CubeSats by using bimetallic coils to deploy an array of four triangular radiator fins that, when folded, comprise the external face of a CubeSat. The advantages of this design include reduced complexity, cost, volume, and weight when compared to traditional deployable radiators in addition to redundancy by using an array of panels. An experimental demonstration of the performance of the proposed design is presented indicating the ability to passively deploy a single radiator fin using custom bimetallic coils at a rate of 2° of angular rotation per 1 °F with minimal hysteresis. A preliminary model of our design indicates the ability to achieve a turndown ratio of greater than 7:1. Experimental and numerical prediction results are presented as motivation for exploration of the proposed design in ongoing work.