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Author: Ms. Apoorva Joshi
India

Mr. Adarsh Salagame
Northeastern University, United States

VI-STAR: VARIABLE INSULATION SYSTEM FOR THERMAL ACTIVE REGULATION

Abstract

Extreme temperature fluctuations on the lunar surface pose problems to long-term lunar exploration and habitation. Current implementations of thermal control systems use a combination of passive elements such as MLIs, surface coatings, and active elements such as radiators and heaters to maintain ambient temperature. While highly effective and precise, active thermal control systems consume a large amount of energy and space, and passive control systems struggle to cope with rapidly varying temperatures such as those found on the lunar surface. With no atmosphere to offer thermal shielding, the lunar surface undergoes massive thermal variations in the same region, with temperatures going from a low of -180C to a high of 120C. This paper suggests a method to use this variation in temperature to maintain ambient internal temperature using electro-mechanically actuated variable insulation modeled using heat map and simulation. The method leverages two-walled insulation with an internal layer that faces the area to be maintained at a specific ambient temperature and an external layer that is facing the environment. Between these two layers is an insulative material that is capable of absorbing a large amount of heat without loss and releasing it over a long period of time in a controlled manner. During the day, when there is an excess of heat in the environment, the insulation on the internal layer is increased and that on the external wall is decreased in order to allow the material in between to absorb heat. During the night, the external insulation is increased and the internal insulation is controlled so as to release the stored heat in a controlled manner into the thermally controlled area. This is a quasi-passive system that uses significantly less energy than an active thermal control system and is more controlled than a passive thermal control system.