Paper ID: 78429
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)

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THERMAL ANALYSIS OF A STUDENT-DEVELOPED LUNAR MICRO-ROVER

Abstract

Currently, TU Delft's Zebro student team is developing a six-legged micro lunar rover, which utilizes an innovative locomotion system based on six C-shaped legs and is planned to be deployed in swarms to help astronauts and bigger robotic rovers in navigation on other planets and asteroids. The rover is the size of a shoe box, which allows to minimize launch costs. Miniaturization also comes with challenges, especially related to the rigid weight constraints. Its first mission will be a technology demonstration, during which the rover will perform radiation measurements while walking a set distance on the Moon surface. The rover currently is going through its second design iteration, approaching the first test phase. This paper is intended to present the thermal analysis and design iteration performed to meet the rover survivability requirements.

Thermal analysis has been performed in Esatan TMS. The rover behaviour has been simulated at different latitudes to assess the effects of the harsh Moon environment, and the results have been used to modify and adapt the thermal control system to obtain a sturdy and reliable design in the widest possible range of latitudes. Most of the design changes have been performed using commercial off-the-shelf components, striving to meet the strict mass, power, volume, software, and budget constraints of the project. The effort in thermal design heavily changed the rover architecture, ending up with a different internal layout, a different Battery Management System, and modified electronics.

Additionally, efforts are still in progress to use the peculiar rover architecture to implement an active thermal control system, allowing the rover to change its radiator's view factor to space depending on its thermal control needs. Its insulation is also being redesigned, moving from a traditional multi-layer blanket to a sturdier structural insulation solution. Indeed, the low stance and size of the rover are hindering the performance of the blanket.

All these design changes have been verified with thermal analyses in TMS, while waiting for the planned test campaign.