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Muñoz Tejeda, J. M.; Morón Montesdeoca, D.; Verma, M. K.; Fajardo Peña, P.; Verhoeven, C.

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Author: Mr. Jesús Manuel Muñoz Tejeda
Universidad Carlos III de Madrid, Spain, jesus.munoz.tejeda@gmail.com

Mr. Daniel Morón Montesdeoca
Universidad Carlos III de Madrid, Spain, damomo95@gmail.com
Mr. Maneesh Kumar Verma
Delft University of Technology (TU Delft), The Netherlands, The Netherlands,
m.k.verma@student.tudelft.nl
Prof. Pablo Fajardo Peña
Universidad Carlos III de Madrid, Spain, pfajardo@ing.uc3m.es
Dr. Chris Verhoeven
Delft University of Technology (TU Delft), The Netherlands, c.j.m.verhoeven@tudelft.nl

ENVIRONMENTAL ANALYSIS OF NANOROVERS IN A SWARM FOR LUNAR'S SCIENTIFIC MISSIONS

Abstract

Deep space missions are exposed to extremely high doses of radiations and a broad range of temperatures when compared to Earth bound satellite missions. Passive and active thermal methods have been developed to protect spacecraft subsystems from fatal levels of radiation and unacceptable temperature levels inside the spacecraft. This makes its thermal control system (STCS) a very complex discipline to both design and estimate.

Given that every kilogram launched beyond Earth's orbit has significant costs, space systems' miniaturization has become a necessity with increasing popularity; as nowadays technology is being driven successfully towards that direction. Those complex systems need to be not only precisely simulated but also verified with realistic experimental tests. Otherwise, an unexpected environmental situation could end up in a total mission failure.

For such small spacecraft, mostly passive systems are used to be able to accomplish mission requirements in terms of cost, mass and energy utilization.

In this specific mission, miniature space exploration vehicles will be connected together in a network, analyzing data from multiple remote points acting as a single device. Environmental analysis of a rover from this space swarm constellation is addressed in this paper. Its thermal behaviour is analyzed in all phases, (from the beginning of the mission on Earth to its final destination on the Moon's surface), using MATLAB software. An easy-to-apply and computationally efficient Ray Method is used to compute visual factors between different rover's faces and heat sources (such as the Sun rays). Moreover, radiation issues will be also covered, accounting for a complete environmental analysis that will prevent any potential breakdown. Results are discussed afterwards, including temperature operating range and a step-by-step guide of how the thermal mathematical model can be implemented in any free commercial software for other missions. To validate model accuracy, results will be first compared to the ones obtained using a dedicated program for thermal space applications (such ESATAN). Then, experimental validation tests will be carried out in European Space Agency facilities (thermal vacuum chamber in ESTEC, Netherlands) to get a complete overview of implemented model's potential and limitations.