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LUNAR REGOLITH REPULSION MECHANISM FOR ROVER RADIATORS USING THE STANDING WAVE ELECTRIC CURTAIN METHOD

Abstract

Lunar missions are an important and growing aspect of space exploration. However, the harsh climate and environment, such as extreme temperatures, present several technical constraints that must be considered in the mission design. Moreover, the Moon is covered in a very fine dust known as lunar regolith. Past studies have shown that this regolith is electrostatic and extremely abrasive and can interfere with different instruments. In fact, due to its low thermal conductivity, the accumulation of lunar regolith on the surface of rover radiators impedes their ability to properly regulate their internal temperature. Thus, lunar regolith accumulation can cause mission critical components, such as batteries and on-board computers, to operate outside of their recommended temperature range, which can affect their efficiency and reduce the mission's lifetime.

A novel system has been designed to efficiently repulse lunar regolith from the surface of rover radiators, based on the Standing Wave Electric Curtain (SWEC) method. This work consists of building and characterizing a physical prototype of the dust removal system for the PEEKbot rover's radiators, done in collaboration with the Canadian Space Agency (CSA). An electric circuit is used to generate a sinusoidal dynamic voltage distribution on a periodic array of three electrodes engraved into the radiator, which creates an electric field strong enough to eject dust particles from the radiator's surface. This electric circuit is mounted on two PCBs, which are powered by an external voltage source and automated using an Arduino microcontroller.

Literature review indicated that an electric field between 10 to 40kV/cm is sufficient to displace particles, which has been obtained by spacing each electrode by 0.7mm and using a peak voltage of 500V. The results of tests based on the wave frequency, the particle mass and size and the pulse duration are presented. The tests were done under Earth-like atmospheric conditions but the results are extrapolated for lunar use. These parameters have been optimized in order to enhance the system's dust removal efficiency and reduce the power budget.