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THERMAL DESIGN AND ANALYSIS OF A MICRO ROTARY ACTUATOR FOR MARS EXPLORATION

Abstract

Mars exploration is always an important part of the deep space exploration. Different from the earth orbit where no air exists, the thermal environment of Mars is quite complicated due to the extremely low temperature and the thunderstorm generated within the atmosphere. As a result, the thermal design and management is crucial for the Mars rover as well as the mechanisms onboard to survive the harsh environment.

In this paper, the thermal design of a micro rotary actuator that can be used to construct pointing mechanisms and robotic arms onboard Mars rover is presented first. Then based on the Mars environment data measured by the two Viking landers, the Mars atmosphere model is simplified and the convective heat transfer coefficient of Mars atmosphere is calculated by Churchill and Bernstein's empirical equation. With this simplified model, a thermal simulation, which takes into account solar irradiation, wind speed, pressure and temperature, is conducted for the actuator in one Martian day by finite element analysis. The simulation gives the detailed temperature distribution of the components of the actuator at different time slot. Based on the simulation results, the appropriate operation time of the actuator on Mars is recommended. This simulation result can serve as the operational guideline of the mechanisms and robotic arms in Mars.