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14th HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM (A5)
Near Term Strategies for Lunar Surface Infrastructure (1)

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THE USE OF ORBITING REFLECTORS TO DECREASE THE TECHNOLOGICAL CHALLENGES OF SURVIVING THE LUNAR NIGHT

Abstract

One of the key difficulties for lunar exploration is the thermal control of both crewed and robotic rovers. This is due to the absence of a lunar atmosphere, resulting in large variations in surface temperature, from 100K to 390K in the equatorial regions. Of particular difficulty is surviving the lunar night due to the combination of severely low temperatures and the length of the night. To date two rovers have been designed to survive the lunar night, the two Russian Lunokhod rovers which hibernated during the night whilst using radioactive heat sources for thermal management.

This paper will investigate the possibility of using flat orbiting mirrors to reflect sunlight onto a specific location on the night side of the Moon to enable rovers, in the near term, or lunar bases, far term, to not only survive the lunar night but to be able to complete normal operations in near day-light conditions. The initial feasibility is analysed by calculating the solar flux expected to be provided for different families of orbits around the moon. The orbits that provide sufficient illumination will then be considered in a three-body problem including the masses of both the Moon and Earth. An additional perturbation that must be taken into account is the effect of solar radiation pressure, due to the large area-to-mass ratios expected for the mirrors. It can then be determined how many mirrors are required to provide sufficient illumination to the desired location. It is expected that an elliptical orbit will be advantageous, with the argument of perilune, precessing using solar radiation pressure, to be continually Sun pointing and so maintain the apolune over the night-side.

A low-thrust control strategy is applied to the mirrors and it is shown that the mirror attitude can reduce the thrust required to maintain the orbit. This analysis is performed for different positions on the lunar surface to determine areas where missions can be supported with minimum mirror mass and where the required control thrust is lowest. Finally, the overall feasibility of this concept is discussed in terms of the technological readiness of the system as well as other considerations to determine whether it is a feasible near-term solution to the problem of the lunar night. This discussion also includes a comparison of the difficulty of implementing the concept and the challenges faced in designing rovers and other systems capable of surviving the lunar night.