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THE PRIMARY LOCATIONS AND SETTLEMENT STRATEGIES OF INTEREST FOR FUTURE LUNAR BASES

Abstract

With the space industry expanding worldwide, both governmental and private organizations have been actively developing programs for the exploration and utilization of space resources. One of the internationally-focused topics is interplanetary settlements on other celestial bodies within the Solar System and eventually into deep space, and our direct neighbour, the Moon, seems to be the most convenient destination and testbed to execute such ambitious projects.

From decades of observations and direct studies on the surface materials, the Moon is found to contain abundant resources and unique scientific values that are hardly accessible on Earth. However, settling on the lunar surface is extremely challenging due to its harsh natural environment that limits human and robotic performances. Additional to geological and environmental factors, engineering capabilities and scientific objectives of the mission are also crucial factors on determining the ideal location(s) for the settlement.

In this work, we first summarized and analyzed some currently proposed regions and specific sites of interest for primary lunar settlements, which are roughly divided into the following categories: Polar regions, especially the South Pole, are promising for collecting near-constant solar energy and are located near possible ice reservoirs in the permanently shadowed crater bottoms; Lunar maria (lowlands) contain crucial resources, such as ilmenite, for in-situ resource utilization (ISRU) and are less geographically demanding to traverse through; Lunar limb and far side are mostly radio-quiet, thus ideal for astronomical studies, but would require extra relay satellites to stay connected to Earth and are potentially prone to impact events.

When a geographic location is chosen, factors considering the site reachability, outpost construction, life support, economic and logistic efficiencies will be evaluated. Several examples of architectural ideas and ISRU applications, including 3D-printing and microwave sintering of local materials are discussed to compare their feasibilities.

Based on these analyses, we present a set of procedures, intended to assist the decision-making process to select one or multiple locations for future lunar settlements. The procedures take interdisciplinary considerations to maximize the safety and efficiency of lunar base missions.